Promoting Scientific Creativity by Utilising Web-based Research Objects

Project acronym: Dr Inventor

Deliverable No. 8.6

Final version of evaluation report

Grant agreement no: 611383

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

COVER AND CONTROL PAGE OF DOCUMENT	
Project Acronym:	Dr Inventor
Project Full Name:	Promoting Scientific Creativity by Utilising Web-based Research Objects
Deliverable No.:	8.6
Document name:	Final version of Evaluation Report
Nature (R, P, D, O)[1]	R
Dissemination Level (PU, PP, RE, CO)[2]	PU
Version:	3
Actual Submission Date:	31/03/2017
Editor: Institution: E-Mail:	Prof. Jian J Zhang Bournemouth University, UK jzhang@bournemouth.ac.uk

ABSTRACT:
This deliverable describes the evaluation process and final evaluation results of Dr Inventor project. The evaluation process has verified the effectiveness of the core idea on analogies through targeting domain experts and reaching out to a wider range of researchers. In addition, the usability and effectiveness of the visualization components of Dr Inventor have also been thoroughly evaluated.

KEYWORD LIST:
Evaluation, analogies, scientific creativity, user surveys, system evaluation.

[1] **R**=Report, **P**=Prototype, **D**=Demonstrator, **O**=Other

[2] **PU**=Public, **PP**=Restricted to other programme participants (including the Commission Services), **RE**=Restricted to a group specified by the consortium (including the Commission Services), **CO**=Confidential, only for members of the consortium (including the Commission Services)

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7-ICT-2013.8.1) under grant agreement no: 611383.

MODIFICATION CONTROL			
Version	**Date**	**Status**	**Author**
1.0	03/02/2017	Draft	E. Chaudhry
1.0	20/03/2017	Draft	X. Yang
1.0	27/02/2017	Draft	J. Zhang
1.0	16/03/2017	Draft	E. Chaudhry
2.0	22/03/2017	Draft	E. Chaudhry
3.0	21/04/2017	Draft	J. Zhang

List of contributors

- E. Chaudhry, Bournemouth University, UK
- J. Zhang, Bournemouth University, UK
- X. Yang, Bournemouth University, UK
- F. Dong, University of Bedfordshire, UK

List of Internal Reviewer's

- Diarmuid P. O'Donoghue, Maynooth University, Ireland
- Abgaz Yalemisew, Maynooth University, Ireland
- Donny Hurley, Maynooth University, Ireland

Contents

1 Executive Summary

The evaluation of the creativity performance of Dr Inventor in a designated scientific area is described through building evaluation metrics, benchmarks and baseline, the results of which have been subsequently used to establish theories and models for scientific insights into scientific creativity. Evaluation in the Dr Inventor project is aimed at evaluating the ability of the Dr Inventor tool to act in its role of creativity support. Evaluation of the technical implementation of the theoretical model of scientific creativity, including ROS generation, similarity and assessment, and analogy & conceptual blending by making use of the benchmark data created within this project in the designed scientific area of computer graphics. Qualitative feedback has formed the basis for usability testing of the system. This has identified an appropriate usability assessment scheme for use on the final system. In addition to overall system performance, we have gathered qualitative feedbacks on individual components of the system, focusing on its presentation, the identified comparisons and how well the ROS encapsulated the underlying research objects. The test has been designed to identify the success/failure of each individual key component of the system.

Evaluations contribute significantly to the understanding of the technology potentials as well as to the measurement of enhanced creative performance. The project presents a sound balance and mutual support between scientific insights, technological innovation and practical applications. The scientific insight has provided the foundation for the exploration of innovative technologies in multi-disciplinary areas for scientific creativity. The developed technologies have been integrated into a web-based system to allow evaluation of creative performance in real-world applications, which is supervised under a sound evaluation methodology and well-defined performance indicators. The evaluation has been fed back to support a spiral evolution of the scientific insights.

1.1 Summary of Novelty

The final evaluation has been carried out to assess the potential creativity of the Dr Inventor system. Evaluation of the creativity performance of Dr Inventor in a designated scientific area is described through building evaluation metrics, benchmarks and baseline, the results of which have been subsequently used to establish theories and models for scientific insights into scientific creativity. For this aim, various evaluation and user activities have been designed to seeking internal and external user feedback on individual components of Dr Inventor. The final evaluation was primarily focused on the quality of analogies that have been discovered and on the usability and effectiveness of the visualization components of Dr Inventor. Presentation and evaluation of novel scientific analogies have not been previously discussed in the literature.

2 Introduction

For the evaluation of the creativity performance various evaluation and user activities have been designed to seek user feedback on individual components of Dr Inventor. The first evaluation was primarily focused on the quality of analogies that have been discovered and then on the usability and effectiveness of the visualization components of Dr Inventor. The project stemmed from the idea that new technologies have real potential to increase scientific creativity and to overcome some human limitations. When considering ways around an issue, we often get stuck on the problem rather than solution and tend to be limited by our own perceptions, biases and memories. By harnessing the power of technology and existing research information available on the web, Dr Inventor overcomes some of these issues by acting as a personal research assistant.

2.1 Purpose of this document

This deliverable describes the results from 'Dr Inventor System Evaluation'. This deliverable covers two evaluation tasks *T8.3 'Evaluation of the outputs from the system' which include evaluation of system outputs from the system by using human raters by using the benchmark data,* and *T8.4 'Evaluation of the system usability' which include a number of specific objectives, evaluation of including the SDK toolkit and the web-based system*.

2.2 Relationship with other Deliverables

The WP8 evaluation reports are delivered in two parts D 8.5 - 'Initial version of evaluation report' and **D 8.6 - 'Final version of evaluation report'**. This report presents the final evaluation result and outputs from Dr Inventor system.

2.3 Structure of Deliverable

This document is organised in the following way:

- Section 3: Overview of Dr Inventor System Evaluation
- Section 4: Dr Inventor - Initial Evaluation
- Section 5: Creative Analogies Identified by Domain Experts *(Case-Study)*
- Section 6: Dr Inventor 'Inspire me for Creative Ideas'
- Section 7: Dr Inventor System Usability Survey Feedback
- Section 8: Conclusion
- Appendix 1. CASE-STUDY
- Appendix 2. Modelling and Simulation of Lily flowers using ODE Sweeping Surfaces *(Dr Inventor Co-Author Paper)*
- Appendix 3. Dr Inventor's System Usability Questionnaire

3 Overview of Dr Inventor System Evaluation

Dr Inventor system evaluation has carried out by following means:

USING HUMAN RATERS - *Dr Inventor system evaluation by Domain Experts (Internal users)*

The primarily focus of Dr Inventor system evaluation was to assess the outputs generated from analogy model by domain experts (computer graphics). We have involved the following computer graphics domain experts from BU and BED.

- 10 Master students from BU
- 60 Undergraduates students from BU *(Dr Inventor System Usability Test)*
- Group of 12 (Professors, Associate Professors, Senior Lectures, Lectures and PhD Research students) from BU *(Completed Topic-base Case study)*
- Group of 4 (Professors, Senior Lectures and Lectures) from BED *(Completed Topic-base Case study)*

EVALUATION PROCESS

To assess the novelty of the initiatives generated by the system. The evaluation has taken a cross-validation strategy by assessing its ability to re-discover past creative analogies. Domain experts from (BU and BED) have completed **14** topic-base case studies and have identified **204** creative analogies[3] suggested by Dr Inventor system.

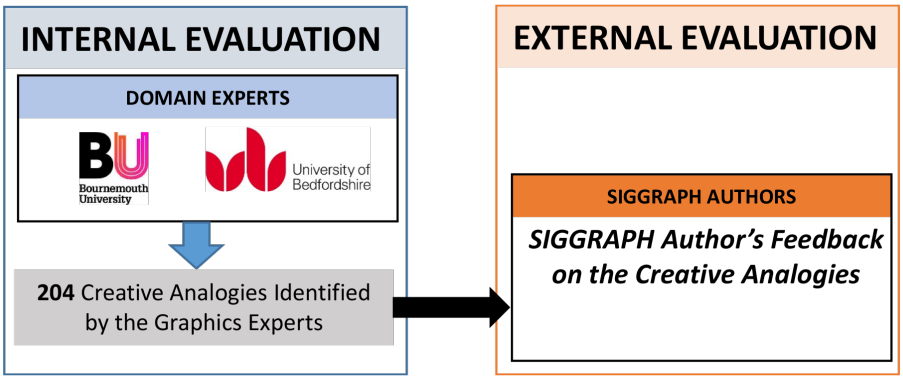

Figure 3.1 Dr Inventor Evaluation Process

As a part of Dr Invertor system evaluation, we have been contacting SIGGRAPH authors for their feedback on (**204**) creative analogies[3] that are identified by Dr Inventor system. So far, we have received **34** responses on creative analogies.

[3] *https://docs.google.com/spreadsheets/d/1PlQwshePdy94OjFsVELOWvDaF9gKpVkWuuCdnMeWI5E/edit#gid=0*

4 Dr Inventor - Initial Evaluation

During the Dr Inventor consortium meeting at Nice, France *(27-28 October 2016),* we took an opportunity to gather some initial feedbacks on a small number of creative analogies identified by Dr Inventor. This evaluation focused on the quality of the creative analogies it identified. We presented several target problems using the abstracts of selected computer graphics papers. The system generates the creative analogies, the domain experts help to interpret and elaborate.

Evaluation form (*Computer graphics domain expert*)

Analogy reviewed by:	*Prof. Feng Dong & Dr Baoquan Liu (Senior Research Fellow)*
Target paper:	***Audeosynth: Music-Driven Video Montage (2015)***
Source papers found by Dr Inventor	**Discovery of Complex Behaviors through Contact-Invariant Optimization (2012)** ***Useful Inferences:*** *The montage will be the humans* ***New Idea:*** *One can try to apply the target paper's music-driven method to the source paper's goal for a music-driven motion synthesis, where the output of the motion synthesis could be synchronized with the rhythm of the input music, rendering a symphony of audio-motion resonance. This may allow you, for example, produce a new synthesized motion of dancing (of a new figure) guided by an input music.* ***Author's Feedback: (Zicheng Liao)*** ***Yes, the identified goal of "music-driven motion synthesis" is interesting. One can apply the composition principles of the target paper to do motion synthesis. There are two points I'd like to make: first, motion synthesis already has quite a number of previous work; second, it is not clear how the source paper's CIO optimization framework could be used here.***
	Style and abstraction in portrait sketching (2013) ***Useful Inferences:*** *The we_our will analyze the data* *The surmise will sketching the face* ***New Idea:*** *The future work suggested by this analogy is as follows "The automatically generated music-driven video montages may consider styles from a variety of artists in order to achieve personalized effect. The user may choose their preferred artists in order to create montage with that style."* ***Author's Feedback: (Zicheng Liao)*** ***Artist's style only expresses in his/her music. So I'd consider it is more or less like to take the music's style and use it to drive the selection and synthesis of video motions. Then the questions are style representation, extraction from music, and how to***

	link it to video motions.

Analogy reviewed by:	*Dr Xiaosong Yang (Associate Professor) & Dr Baoquan Liu*
Target paper:	***A Reduced Model for Interactive Hairs (2014)***
Source papers found by Dr Inventor	**Fabricating translucent materials using continuous pigment mixtures (2013)** ***Useful Inferences:*** *The efficacy will allow the user* ***New Idea:*** *In order to accelerate fabricating translucent materials using continuous pigment mixtures, one may construct a reduced model (based upon precomputed simulation data) to optimally represent the appearance and characteristics of subsurface scattering for a given target material. The efficacy will allow the user to interactive explore a range of achievable appearances for interactive changing of concentration for a set of pigments.* ***Author's Feedback: (Menglei Chai)*** ***Author replied that he is not so familiar with material acquisition***
	Measurement-based Editing of Diffuse Albedo with Consistent Interreflections (2015) ***New Idea:*** *Measurement-based Editing of Diffuse Albedo may be used for realistic hair animation, so that we can change the diffuse albedo of hair strands for various hairstyles when depicting virtual characters in interactive applications.* ***Author's Feedback: (Menglei Chai)*** ***Hair is extremely difficult to capture from one image, it involves challenging albedo, shadowing, lighting and material. I am not sure if this method can be directly applied to hair.***

Analogy reviewed by:	*Prof. Feng Dong & Dr Baoquan Liu (Senior Research Fellow)*
Target paper:	***Reflectance Scanning: Estimating Shading Frame and BRDF with Generalized Linear Light Sources (2014)***
Source papers found by Dr Inventor	**Measurement-based Editing of Diffuse Albedo with Consistent Interreflections (2015)** ***Useful Inferences:*** *The difference will editing the albedo* *The result will require the pair* *The difference will editing the area* ***New Idea:*** *An inspiration could be: one may try to exploit the differences in tangent rotation between surface points to infer and edit the diffuse albedo. This will require a pair between the initial scene and the recolored result, which highlights the*

	changes in interreflections due to a change in diffuse albedo. The difference will help to edit the albedo of the area. ***Author's Feedback: (Xin Tong)*** ***Thanks for your email and analysis of my paper. The result idea looks interesting but little bit difficult to follow. For the first one, I should be frank that the idea doesn't catch the correct physics of appearance model. The tangent direction of the surface point has no contribution to the diffuse or albedo component.***
	Style and abstraction in portrait sketching (2013) ***Useful Inferences:*** *The reflectometry will use the corrective_that* ***New Idea:*** *Realtime facial animation with on-the-fly correctives (2013)* *The reflectometry will use the corrective_that: The target paper is to estimate the reflectometry (both local shading frame and BRDF) of a material surface, for which we may adopt an adaptive PCA model using shape correctives that adjust on-the-fly to the lighting patterns through incremental PCA-based learning, in order to improves the fitting accuracy of the target reflectometry.* ***Author's Feedback: (Xin Tong)*** ***It is somewhat difficult for me to follow the idea. The goal there is somehow unclear to me.***

Analogy reviewed by:	*Dr Baoquan Liu (Senior Research Fellow)*
Target paper:	***An Asymptotic Numerical Method for Inverse Elastic Shape Design (2014)***
Source papers found by Dr Inventor	**Super-helices for predicting the dynamics of natural hair (2006)** ***Useful Inferences:*** The we_our will show_predict the motion ***New Idea:*** *Inverse shape design for elastic objects may be used to accurately predict hair motion in order to get a fast convergence without thinking about elastic deformations.* ***Author's Feedback: (Xiang Chen)*** ***Dr Inventor sounds like a very interesting work. I think this idea makes sense, and actually there was a related work on it "Inverse dynamic hair modeling with frictional contact".***
	Controlling Procedural Modeling Programs with Stochastically-ordered Sequential Monte Carlo (2015) ***Useful Inferences:*** The reflectometry will use the corrective_that ***New Idea:*** *The analogy exists as below: procedural modeling =>*

	elastic shape design, so Inverse shape design for elastic objects may be extended to controlling the output of procedural modeling programs so that we can perform procedural modeling for elastic objects, by letting users focus on desired procedural target shapes without thinking about elastic deformations. ***Author's Feedback: (Xiang Chen)*** ***This idea doesn't look clear to me.***

Analogy reviewed by:	*Prof. Jian J Zhang & Prof. Gordon Clapworthy*
Target paper:	***Computational Bodybuilding: Anatomically-based Modeling of Human Bodies (2015)***
Source papers found by Dr Inventor	**Video watercolorization using bidirectional texture advection (2007)** ***New Idea:*** *The 'human body' of the target paper is analogous to the 'watercolour image' of the source paper; and 'muscle' (building blocks of the human body) is analogous to 'texture' (building blocks of the watercolour image). For the target paper, muscle shapes are modelled by controlling the atrophy, whiles for the source paper, textures are manipulated by advection following the optical flow. From an inspirational point of view, one can swap the methodologies between the target and source papers. That is, the muscles could be shaped by following/using some kind of curves or curve fields similar to the optical flow; and the textures can be manipulated by controlling features/parameters, such as stroke paths or pressure.*
Target paper:	***Build-to-last: Strength to Weight 3D Printed Objects (2014)***
Source papers found by Dr Inventor	**Transient attributes for high-level understanding and editing of outdoor scenes (2014)** ***New Idea:*** *For the target paper, it develops an (hollowing optimisation) 'algorithm', which can be used to identify an optimal structure for a 3D printed object; for the source paper, it develops a 'regressor' which can be used to predict attributes in new images. For the target paper, the algorithm is based on an explicit (well-observed) structure (honeycomb), whiles for the source paper, the regressor is based on an implicit structure which can be worked out by extracting the patterns from a (transient attribute) database. If we swap the explicit structure with the implicit structure, one may be able to create new methods for new problems.*

Analogy reviewed by:	*Dr Xiaosong Yang & Prof. Gordon Clapworthy*
Target paper:	***Robust and accurate skeletal rigging from mesh sequences (2014)***

Source papers found by Dr Inventor	**Image-based tree modeling (2007)** ***New Idea:*** *There is a clear analogy between these two papers, the skeleton links to the tree branches. One possible way of combining these two papers together is to use the rigging paper idea to solve the tree modelling problem. Because the tree modelling paper only got the images of a static tree model, it is impossible to reconstruct the full branches structure (skeleton). Current tree paper assumes the occluded branches structure is same as the visible branch structure. However, if we can have videos (instead of images) recording the movement of the tree, that will supply the example shapes of the tree, then we can directly use the rigging paper idea to reconstruct the tree branches.* ***Author's Feedback: (Zhigang Deng)*** ***Yes, I think this idea make some sense.***
Target paper:	***Hexahedral mesh re-parameterization from aligned base-complex (2014)***
Source papers found by Dr Inventor	**Removing photography artifacts using gradient projection and flash-exposure sampling (2007)** ***New Idea:*** *For the target paper, it develops an (hollowing optimisation) 'algorithm', which can be used to identify an optimal structure for a 3D printed object; for the source paper, it develops a 'regressor' which can be used to predict attributes in new images. For the target paper, the algorithm is based on an explicit (well-observed) structure (honeycomb), whiles for the source paper, the regressor is based on an implicit structure which can be worked out by extracting the patterns from a (transient attribute) database. If we swap the explicit structure with the implicit structure, one may be able to create new methods for new problems.* ***Author's Feedback: (Zhigang Deng)*** ***I do not think this is good idea, and may not work.***

Analogy reviewed by:	*Dr Baoquan Liu (Senior Research Fellow)*
Target paper:	***An L1 Image Transform for Edge-Preserving Smoothing and Scene-Level Intrinsic Decomposition (2015)***
Source papers found by Dr Inventor	***A perceptually validated model for surface depth hallucination (2008)*** ***Useful Inferences:*** *The application will use the camera* *The we_our will approximate the variation* *The we_our will impose the restriction* ***New Idea:*** *The application of L1 Image transform for surface retexturing or 3D object compositing will use the standard*

	digital camera to capture detailed surface geometry. The depth estimation will approximate the variation of surface geometry. And this variation will be used for surface shading matching or as a restriction.
	Motion graphs (2002) ***New Idea:*** *The motion graph consists of automatically generated transitions, which may be used to assist L1 Image Transform to perform edge-preserving smoothing, or to suppress surface shading variations.*
Target paper:	***Computational Hydrographic (2015)***
Source papers found by Dr Inventor	***Cardinality-constrained texture filtering (2013)*** ***Useful Inferences:*** *The high-quality will sample the system* ***New Idea:*** *The Cardinality-constrained texture filtering approach could be used in the hydrographic printing system to filter the computed color image before feed into the printing system, in order to create high-quality sampling when the computed color image has too high a resolution which does not match the final 2D texture generated for the 3D model.*
	Microstructures to Control Elasticity in 3D Printing (2015) ***New Idea:*** *Both papers are for 3D printing. The target paper is to compute a surface texture for the exterior of a 3D printing object, while the source paper is to compute some microstructures for the interior of a 3D printing object, so the two techniques can be combined in order to produce a 3D printing object with both an exterior color texture and some interior small-scale microstructures for spatially varying elasticity.*

Analogy reviewed by:	*Kun Qian (PhD Student)*
Target paper:	***Axis-Aligned Filtering for Interactive Physically-Based Diffuse Indirect Lighting (2013)***
Source papers found by Dr Inventor	***Least Squares Conformal Maps for Automatic Texture Atlas Generation (2002)*** ***New Idea:*** *The adaptive sampling technique in target paper can be used for the least square approximation of the Cauchy-Riemann equations in the source paper.* ***Author's Feedback: (Bruno Lévy)*** ***I do not think that this analogy detected by your "Dr Inventor" system is very relevant in the present case:*** **** The Cauchy-Riemann equation solved by my paper is a very***

	simple equation, and everything in the end boils down solving a linear system. **** The rendering equation solved in the other article is very different (2nd-type Fredholm), with an integration, with a difficult occlusion term, that requires several strategies to be efficiently computed (including the adaptive sampling in the cited article). The adaptive sampling for the Cauchy-Riemann equation does not make sense to me, because the difficulties solved by the adaptive sampling algorithm are not encountered with the Cauchy-Riemann equation.***
Target paper:	***Discrete Viscous Sheets (2012)***
Source papers found by Dr Inventor	***Controlling Procedural Modeling Programs with Stochastically-Ordered Sequential Monte Carlo (2015)*** ***New Idea:*** *The thickness tracking and evolving of the triangle mesh in the target paper can preserve detail and volume. Such detail and volume preservation idea can be applied as a constraint when performing the Stochastically-Ordered Sequential Monte Carlo sampling in the source paper. It may allow the procedural model generation process more geometrical aware (which means the sampling method in the source paper can be affected by the geometrical constraint, which preserve certain geometrical feature).*
Target paper:	***Subspace Fluid Re-Simulation (2013)***
Source papers found by Dr Inventor	***Suggestive Contours for Conveying Shape (2003)*** ***New Idea:*** *The Suggestive Contours in the source paper provide a good idea of motion or pattern prediction for image processing, which play the same role as "re-simulation" in the target paper. The prediction idea can also be used in the simulation area.*
Target paper:	***Planar Shape Interpolation with Bounded Distortion (2013)***
Source papers found by Dr Inventor	***An Approximate Global Illumination System for Computer Generated Films (2004)*** ***New Idea:*** *The shape interpolation technique in the target paper is to preserve details of the shape. The goal of the source paper is also to keep the detail of global illumination as much as possible. Moving the shape interpolation idea into rendering area, for example, interpolate the GI in some part of the scene may be a good idea.*
Target paper:	***Computational stereo camera system with programmable control loop (2011)***
Source papers found by Dr Inventor	***Acquiring reflectance and shape from continuous spherical harmonic illumination (2013)*** ***New Idea:*** *Computational Stereo Camera System in the target paper can be used as the capture system for the source paper. Using stereo camera system to approximate reflectance may*

	achieve more accurate result.
Target paper:	***Continuous penalty forces (2012)***
Source papers found by Dr Inventor	***A planar-reflective symmetry transform for 3D shapes (2006)*** ***New Idea:*** *Planar Reflective Symmetry Transform in the source paper may provide a good idea to capture the symmetric property of the geometry and reduce the collision detection computation cost of simple and symmetric geometric in the target paper.* ***Author's Feedback: (Min Tang)*** ***The proposed new idea by the Dr Inventor system looks quite impressive and interesting. While this idea could be useful for collision detection between rigid bodies, our paper focuses on deformable objects which usually cannot maintain their symmetric properties during the deformations. But anyway, I still believe it is an interesting idea and may be usefully for my future research.***
Target paper:	***Interactive decal compositing with discrete exponential maps (2006)***
Source papers found by Dr Inventor	***Globally smooth parameterizations with low distortion (2003)*** ***New Idea:*** *The globally smoothness parameterization in the source paper can be very helpful for reducing distortion in the exponential maps which contain holes in the target paper.* ***Author's Feedback: (Ryan Schmidt)*** ***The analogy is not very good. I don't see any non-obvious similarities, beyond the fact that they are both about surface parameterization. The method proposed in my paper is diametrically opposed to the method in that paper (geometric vs energy minimization), and the method in that paper would not work with meshes that contain holes, as proposed by the analogy.***
Target paper:	***Eigenmode compression for modal sound models (2014)***
Source papers found by Dr Inventor	***A meshless hierarchical representation for light transport (2008)*** ***New Idea:*** *Moving least square based eigen compression model in the target paper may provide a criterion for the build of the hierarchy representation in the source paper. The hierarchy function in the source paper is dependent on scatter data approximation which can be approximated using the idea of the Moving least square based eigen compression in the target paper.* ***Author's Feedback: (Jaakko Lehtinen)*** ***I'm sure it's possible to build the hierarchies in a more signal-adaptive manner.***
Target paper:	***Smoke rings from smoke (2014)***
Source papers found by	***Isosurface stuffing (2007)***

Dr Inventor	***New Idea:*** *The connection of both papers is that both papers are used to visualize volumetric data set. The source paper is based on 3D velocity field while the target paper is based on isosurface mesh.*
Target paper:	***A procedural approach to authoring solid models (2002)***
Source papers found by Dr Inventor	***Visiolization (2009)*** ***New Idea:*** *The target paper proposes a procedural approach to authoring solid models, however, the source paper is to generate novel realistic images of faces using a model trained from real examples. In the target paper, the material can be described as textures. Therefore, many textures can be generated to describe different predefined materials. Then a novel material can be produced through the method in the source paper with treating the textures as images.*
Target paper:	***Factored time-lapse video (2007)***
Source papers found by Dr Inventor	***Variance Analysis for Monte Carlo Integration (2015)*** ***New Idea:*** *The target paper describes a method for converting time-lapse photography captured with outdoor cameras into Factored Time-Lapse Video. The source paper proposes a new spectral analysis of the variance in Monte Carlo integration, expressed in terms of the power spectra of the sampling pattern and the integrand involved.*
Target paper:	***Preserving topology and elasticity for embedded deformable models (2009)***
Source papers found by Dr Inventor	***A procedural approach to authoring solid models (2002)*** ***New Idea:*** *The target paper introduces a new approach for the embedding of linear elastic deformable models. Combining with the source paper and given a mesh, we can generate its solid models. Then the deformable models in the target paper can be applied to simulate the solid models.*
Target paper:	***Coupling Water and Smoke to Thin Deformable and Rigid Shells (2005)***
Source papers found by Dr Inventor	***Diffusion Curves: A Vector Representation for Smooth-Shaded Images (2008)*** ***New Idea:*** *The vector-based primitive called diffusion curve in source paper can be used to create smooth thin solids model in target paper instead of using a lower dimensional triangulated surface in the target paper.*
Target paper:	***Radial view based culling for continuous self-collision detection of skeletal models (2013)***
Source papers found by Dr Inventor	***Leveraging motion capture and 3D scanning for high-fidelity facial performance acquisition (2011)*** ***New Idea:*** *The idea radial-view-based culling method using closed triangular meshes in source paper could be used to analyse the facial construction details which means determining*

	a minimal set of face scans on the condition that format if skeleton data (skeletal models and skeleton motion data) in both papers are similar. ***Author's Feedback: (Sai-Keung Wong)*** ***Yea, the idea is nice that the collision detection method may be good at detecting the collision events for wrinkles on facial models.*** ***Thanks for letting me know the idea generated by the system.***
Target paper:	***Interactive collision detection between deformable models using chromatic decomposition (2005)***
Source papers found by Dr Inventor	***Triangle surfaces with discrete equivalence classes (2010)*** ***New Idea:*** *The triangle surface generate from source paper is based on the discrete equivalence class clustering. The target also uses chromatic decompose for non-adjacent primitives. The discrete equivalence class clustering in the source paper actually can provide a good idea for collision detection cluster generation for the target paper.*
Target paper:	***Example-based image color and tone style enhancement 2011***
Source papers found by Dr Inventor	***Leveraging motion capture and 3D scanning for high-fidelity facial performance acquisition (2011)*** ***New Idea:*** *The only connection between both paper is the word "implicit". The source paper proposed a implicit solver to solve dynamic problem while the source paper learn implicit colour from image.*

5 Creative Analogies Identified by Domain Experts *(CASE-STUDY)*

The domain experts from BU and BED have completed **14** topic-base case studies. Table 5.1 highlights a list of all case-studies that are completed by Computer Graphic experts.

- BU 12 participants, (Professors, Associate Professors, Senior Lectures, Lectures and PhD Research students)
- BED 4 participants, (Professors, Senior Lectures and Lectures)

As a part of Dr Invertor system evaluation, we have contacted SIGGRAPH authors for their feedback on the creative analogies that are identified by Dr Inventor system[4]. Please see (Appendix 1) for the details of creative analogies.

Table 5.1 List of Topic from Computer Graphic

No	Case study topic from Computer Graphic	No of good Analogies found	No of analogies Reviewed
1	TEXTURE SYNTHESIS	7	12
2	HAIR SIMULATION	31	60
3	SKINNING	5	20
4	LIGHTING AND RENDERING	3	12
5	GPU	10	20
6	FACIAL ANIMATION	7	20
7	GEOMETRY PROCESSING	21	40
8	MOTION SYNTHESIS	17	20
9	PHYSICS-BASED DEFORMATION	13	20
10	CLOTH SIMULATION	12	20
11	SKETCH-BASED MODELING	10	20
12	FLUID SIMULATION	13	20
13	DEFORMATION	6	12
14	LOCOMOTION	1	8

As a part of Dr Invertor system evaluation, BU has selected three PhD research students who have used Dr Inventor system extensively in their research and completed the three case-studies which could lead to possible publications.

CASE-STUDY # 5,9 on GPU & PHYSICS-BASED DEFORMATION Please see (Appendix 1)

[4] https://docs.google.com/spreadsheets/d/1PlQwshePdy94OjFsVELOWvDaF9gKpVkWuuCdnMeWI5E/edit#gid=0

Kun Qian is BU's 3rd year PhD research student. His research 'Virtual Reality Based Laparoscopic Surgery Simulation' mainly focuses on physical simulation of soft tissue deformations. The virtual surgery training system he developed provides surgeons with an effective training platform before applying to real patients. This technique not only solves the ethic problem while training on animals and cadavers, but also minimises the training risk from learning and practising on real patients. Through using this system, trainee surgeons can gain vital experience quickly and safely.

Kun has complete a CASE-STUDY on the topic '**GPU**' using Dr Inventor system and reviewed more than 20 suggested analogies and found 10 good analogies; also he has reviewed topic '**PHYSICS-BASED DEFORMATION**' and found 13 good analogies. The discovered analogies have helped him to explore some new ideas on physics-based simulation on GPU. He is drafting a new publication on the topic right now.

CASE-STUDY # 2 on HAIR MODEL MODELING Please see (Appendix 1)

The CASE-STUDY on the topic **'HAIR MODEL MODELING'** was conducted by 'Wenshu Zhang'. She is a BU's 2nd year PhD research student. Her topic of research 'Hair Model Synthesis from Monocular Images' focuses on capturing the shapes as well as the rich dynamics of hair. Image based modelling techniques have been developed for reconstructing their 3D geometry and important visual features.

Wenshu has completed a CASE-STUDY on topic '**HAIR MODEL MODELING**' using Dr Inventor system and has reviewed more than 60 analogies and found 31 good analogies. The CASE-STUDY has helped her to structure a literature review for her research work and shed new light on possible future work.

CASE-STUDY # 7 on GEOMETRY PROCESSING Please see (Appendix 1)

The CASE-STUDY on the topic '**GEOMETRY PROCESSING**' was conducted Qin Yipeng. He is BU's final year PhD research student and the author of SIGGRAPH 2016 paper 'Fast and exact discrete geodesic computation based on triangle-oriented wavefront propagation (2016)'. His research focus on 'Geodesic Computation geometry and computer graphics'. Dr Inventor has analysed his paper. His comments can be found in (Appendix 1). Qin has now started using Dr Inventor system and given us very positive feedback on the creative analogies that are found by Dr Inventor system.

Kun and Wenshu have benefited considerably from Dr Inventor system. Kun has used the system and implemented the creative ideas from Dr Inventor in the final year of his research, on the other hand Wenshu has discorded a new direction and new ideas from her research through Dr Inventor. SIGGRAPH author feedbacks on creative analogies have helped her to develop new directions on possible future work.

6 Dr Inventor 'Inspire me for Creative Ideas'

The research goal of Dr Inventor is to investigate theoretical insight towards scientific creativity and to implement and evaluate novel techniques and an integrated system in support of the exploration of scientific and technological innovations. The novelty of Dr Inventor has been given a new way of exploring the problem.

INSPIRATION FOR WRITING A NEW PAPER

A research hypothesis created by Dr Inventor has led to a new publication idea. In the last review meeting, BU has presented two analogous papers which are identified by Dr Inventor system; ***'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)'*** *describes an algorithm for curve skeleton extraction from point clouds, where large portions of data are missing during 3D laser scan and* ***'Fast Bilateral Filtering for the Display of High-Dynamic-Range Images (2002)'*** *presents a technique to display high-dynamic-range images, which reduces the contrast while preserving details.*

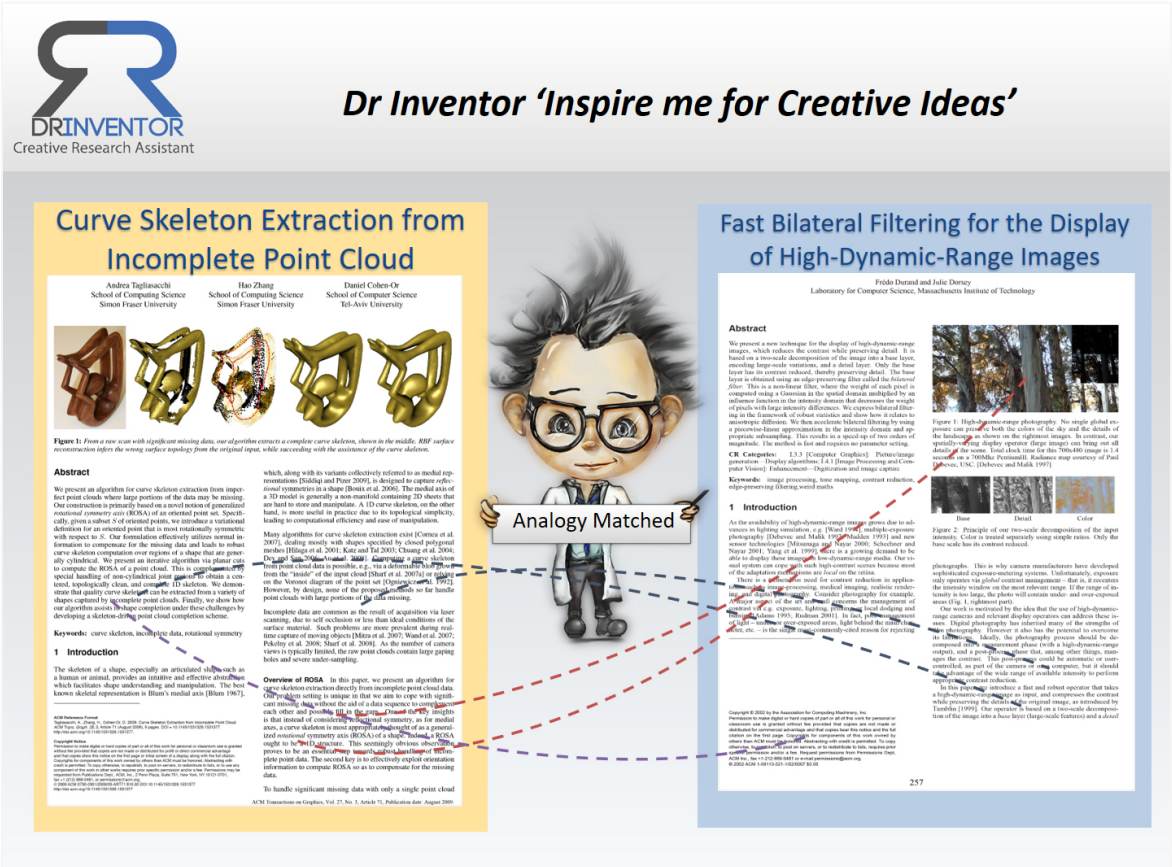

Figure 6.1 Analogous papers which was identified by Dr Inventor System in the last review meeting

INSPIRED ANALOGY

The **creative analogy** sees both papers focus on the reconstruction of **hidden structural information**. *'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)'* solves a 3D problem of incomplete vertex data containing holes (caused by self-occlusions during 3D laser scanning). 'Fast Bilateral Filtering for the Display of High-Dynamic-Range Images (2002)' solves a 2D problem in images with poor light management, with under-exposed and over-exposed areas, and light behind the main character. These two papers are from different Computer graphics domains (Modelling and Image Processing) and their methods cannot be interpolate with each other. Interestingly, "**holes**" in the problem are mapped with "**areas**" in the source paper. *'Curve-Skeleton Extraction from Incomplete Point Cloud (2009) paper has inspired us to investigate new research idea of* reconstruction of **hidden structural information** which has lead us to the following developments.

CHALLENGES: 3D scanning is the most popular technique used computer graphics for constructing 3D models, however the scanned data require a lot of work to refine the mesh structure, remove noise and fill holes. 'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)' paper solves a 3D problem of incomplete vertex data containing holes but it has following limitations.

- ROSA (generalized rotational symmetry axis) method described in 'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)' **cannot refine complex mesh structure such as (flowers leafs and trees). ROSA method can only be applied to 3D cylinder mesh that contains volume. (generalized cylinders)**

- Like other point cloud improvement papers, 'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)' **does not provide a solution for how to animated 3D reconstruction models.**

- The scanned/reconstruction **3D models have unstructured, large data size and usually not suitable for animation directly. A skilful modeller has to remodel or reduce the size of the scanned 3D models for animation. This is a relentless and tedious task.**

RATIONAL RECONSTRUCTION

We have explored new ideas through Dr Inventor and searched that how to write a new paper solving the limitations of '**Curve-Skeleton Extraction from Incomplete Point Cloud (2009)**'. The aim here was to learn how to rebuild and animate 3D models automatically and reconstruct hidden structure more efficiently for complex shapes.

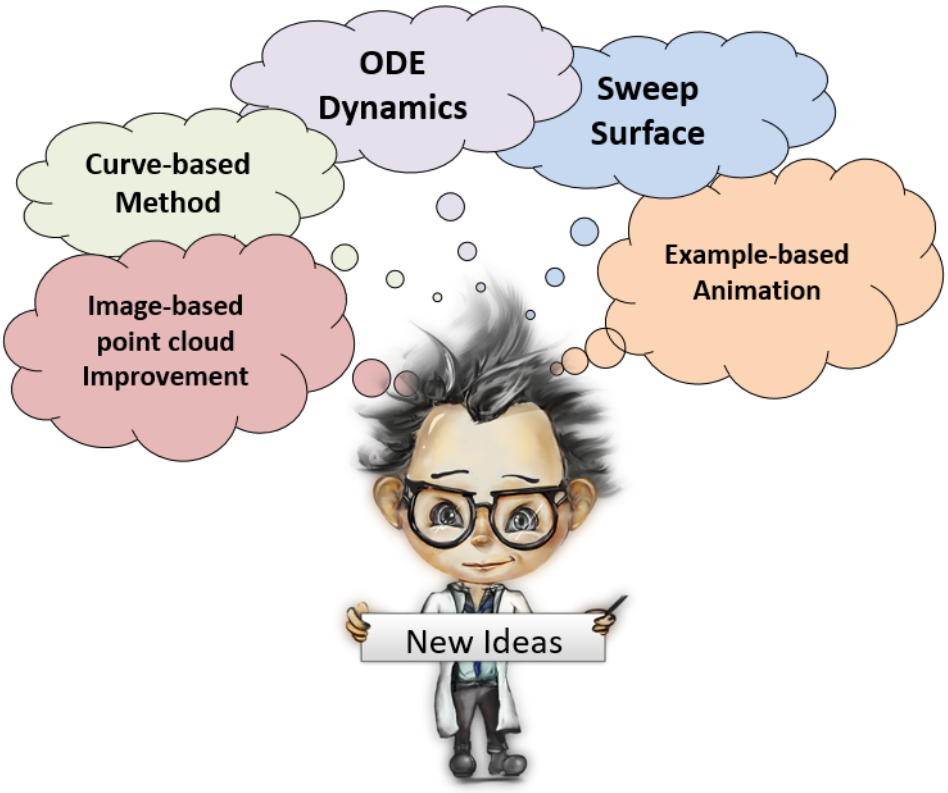

Figure 6.1 5New ideas from Dr Inventor System

Dr Inventor Suggested Ideas	
Topic:	**Image-based point cloud Improvement**
Target paper:	***Multi-aperture photography (2007)***
Source papers found by Dr Inventor	***Image-based plant modeling (2006)*** ***Useful Inferences:*** *The scene will generate the model* *The target paper proposed a computational photography method, called Multi-aperture photography, which designs and implements a prototype*

	optical system and associated algorithms to capture four images of the scene in a single exposure, each taken with a different aperture setting. If we apply, this method in the hand hold camera when collecting the point cloud information, each shot can provide four aperture images. This can actually provide a 'Level of Detail (LOD)' idea to the point cloud generation process. Each shot contains multiple resolution and feature of current object. Such LOD based point cloud generation idea can improve the point cloud generation process in the way that how LOD can improve rendering, simulation etc.
Topic:	**Image-based point cloud Improvement**
Target paper:	***Real-time motion retargeting to highly varied user-created morphologies (2008)***
Source papers found by Dr Inventor	***Image-based plant modeling (2006)*** ***Useful Inferences:*** *The the geometry of each leaf will be_use the time* *The target paper provides the idea of motion retargeting strategy based on user-created morphologies. The source paper "Image-based Plant Modeling 2006" suffers from its semi-automatic user segmentation process. The retargeting idea can be applied to optimize the source paper. Retarget technique can be used on the generation of new view images based on original view images. Those new images can provide more information for the reconstruction procedure.*

Dr Inventor Suggested Ideas	
Topic:	**Curve-based Method**
Target paper:	***Volumetric reconstruction and interactive rendering of trees from photographs (2004)***
Source papers found by Dr Inventor	***Suggestive contours for conveying shape (2003)*** *The target provides a volumetric reconstruction and interactive rendering of trees from photographs. For the photographs, it estimates the opacity values on a recursive grid, based on alpha-mattes extracted from a small number of calibrated photographs of a tree. Then attach alpha mattes results to billboard which then used for the volumetric rendering. The alpha mattes actually used to capture the outline of object, which can give a good representation of the shape rather than point cloud.* *"Suggestive contours for conveying shape (2003)" describe a non-photorealistic rendering system that convey shapes using lines. They call it "suggestive contour" line. This paper gives the idea of representing complex shape using simple curves. Combining the point cloud idea, creating feature curve and outline curve from point cloud can give a good shape and contour description of the point cloud.*

Dr Inventor Suggested Ideas	
Topic:	**ODE Dynamics**
Target paper:	***Target: Plastic trees (2012)***
Source papers found by Dr Inventor	***Projective dynamics (2014)*** *The target paper provides a dynamic tree modelling and representation technique that allows complex tree models to interact with environment. The target paper uses skeleton (curve) to represent tree shape. The biomechanically motivated transformation of the tree (skeleton) is determined by changes of environment factors (light, solid obstacles). Such method only provides a static transformation method for the tree model. If we want dynamically simulating the tree model (such as force, wind etc.). The source paper, projective dynamics, can provide a robust implicit dynamic simulation method.* *"Projective dynamics (2014)" provides local and global solution strategy for ODE based implicit integration. So the idea of descripting the curve using ODE equation is promising.*

Dr Inventor Suggested Ideas	
Topic:	**Sweep Surface**
Target paper:	***Efficient geometrically exact continuous collision detection (2012)***
Source papers found by Dr Inventor	***Projective dynamics (2014)*** ***New Idea:*** *"Efficient geometrically exact continuous collision detection (2012)" proposed a continuous collision detection method between deforming triangles. In order to capture the trail of the surface, sweeping plane testing is the mostly used operations during the collision. This idea can be extended to create sweep ODE curve to represent the object surface.*

Dr Inventor Suggested Ideas	
Topic:	**Example-based Animation *(Animated in artistic way)***
Target paper:	***Example-based elastic materials (2011)***
Source papers found by Dr Inventor	***SCAPE (2005)*** ***New Idea:*** *Example-based elastic materials (2011): propose an example-based approach for simulating a complex elastic material behavior. The core idea is deforming the object to the pose that designed by artists. This example pose idea can be used to drive the motion of the ODE curve and surface using time-dependent ODE.* *The Shape Completion and Animation for people provides a data driven method for building a human shape that varies in both shape and pose. This paper gives us the inspiration of using the example based pose to driven the*

	reconstructed shape plant. Even the provided example based pose are not complete (poor reconstruction from limited number of images), the SCAPE can generate good shape completion and finally guide the motion the plant.

NEW IDEA: Ordinary differential equation (ODE)-based surface modelling and animation can create physically based deformable curves. The great advantage of our technique is that it provides a single framework for shape modelling and simulation which uses ODE-based surface modelling technique to represent the geometry of a natural flower shape and uses time depended ODE-based solution to animate natural flower blossom and decay process.

Advantages of ODE-BASE method:

A new idea has been generated from the above case study, to represent natural flower shape, flower blooming and the decay process, using an Ordinary Differential Equation (ODE)-based surface modelling & simulation technique.

- ROSA (generalized rotational symmetry axis) method described in 'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)' cannot refine complex mesh structure such as (flowers leafs and trees). ROSA method can only be applied to 3D cylinder mesh that contains volume.

  Solution: ODE base modelling can generate complex 3D shapes.

- Like other point cloud improvement papers, 'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)' does not provide a solution for how to animated 3D reconstruction models.

  Solution: ODE base dynamics provides solution for animation 3d models. Surface of the flower shape is described by the curves and we deform the curves to obtain new shape.

- The scanned/reconstruction 3D models have unstructured large data size and usually not suitable for animation directly. A skilful modeller has to remodel or reduce the size of the scanned 3D models for animation. This is a relentless and tedious task.

  Solution: ODE base dynamics can create more realistic shapes with a small data size.

Shape representation of flowers is a challenging and interesting topic which has attracted many researchers. The shape of flower consists of a multi-layer architecture (petals, stigma, and stems). Each part of a flower involves a complex geometrical deformation such as bend, stretch, shrink and curl. Various techniques (Data-driven, Sketch-based, Point-based and Image-based) are available, but face challenges such as the geometry of high fidelity and missing-captured data.

LITERATURE REVIEW:

A new idea has been generated from the above mentioned case study, to represent natural flower shapes, flower blooming and the decaying process, using an Ordinary Differential Equation (ODE)-based surface modelling & simulation technique. We have collected all relevant papers on the following topics and processed them through Dr Inventor system.

- Flower Modelling
- Flower Simulation (Blooming and Decay)
- Plant/Tree Modelling and Simulation
- Ordinary differential equation (ODE)

18 paper were processed by NUIM. (Full paper graph match). We have selected 10 paper with good analogies.

Topic:	Flower Modelling
Target paper	***Flower Reconstruction from a Single Photo (2014)***
Source papers	***Adaptively Sampled Particle Fluids (2007)*** The source paper proposed an adaptive sampling algorithms for particle-based fluid simulation, which develops a sampling condition based on geometric local feature size that allows focusing computational resources in geometrically complex region. Such idea can also be applied to the target paper when performing the fitting (cone, surface, joint and individual). Sampling the image with importance than focusing computational resources in the higher importance region.

Topic:	Flower Modelling
Target paper	***Sketch Interface for 3D Modeling of Flowers (2004)***
Source papers	***Suggestive Contours for Conveying Shape (2003)*** *The source paper shares some similarities with the target paper. The source paper extracting suggestive contour from object to convey shape more efficiently than just using contour alone. The generation of the curve takes consideration of the radial curvature and contour. The target paper can use the inverse way. Providing the suggestive curve and then adjusting the geometry curve and contour accordingly.*

Topic:	Flower Blooming
Target paper	***4D Reconstruction of Blooming Flowers (2016)***
Source papers	***A Data-Driven Approach to Quantifying Natural Human Motion (2005)*** *The source paper developed a measure that quantify the naturalness of human motion. This idea can be used in the target paper to detect un-natural reconstruction. When reconstructing the flower shape from incomplete and*

	noisy point cloud, the measurement result can be used as a constraint during the adaptively constrained optimization process. If the reconstruction results are not natural, forward and backward track can be performed to correct the shape. If the results are natural, no need for extra track. It can improve the efficiency a lot for the target paper.

Topic:	Flower Blooming
Target paper	***Analyzing Growing Plants from 4D Point Cloud Data (2013)***
Source papers	***Fast Separation of Direct and Global Components of a Scene using High Frequency Illumination (2006)*** *The target paper and source paper using the same idea but in different area. The source paper separate the direct and global components of rendering. The target paper separate flower modelling procedures into structure and geometry modelling stage.*

Topic:	Flower Decay
Target paper	***Venation Skeleton-BasedModeling Plant Leaf Wilting (2009)***
Source papers	***Stylization and Abstraction of Photographs (2002)*** *The source paper presents a computational approach to stylizing and abstracting photographs that explicitly responds to this design goal. This provide a good idea for the target paper. In the target paper, skeleton is extracted from image and then the venation skeleton is generated from the leaf skeleton. However, the venation skeleton generated from this way are not accurate and cannot reflect the nature of the image. Using the stylizing and abstracting technique in the source paper can provide a good abstraction for the venation. Then the venation generation are also image based which is more accurate than the original one.*

Topic:	*Ordinary differential equation (ODE)*
Target paper	***Dynamic skin deformation with characteristic curves (2008)***
Source papers	***Curve Skeleton Extraction from Incomplete Point Cloud (2009)*** *The target paper introduced a framework to study plant growth, particularly focusing on accurate localization and tracking topological events like budding and bifurcation. The source paper's skeleton extraction from incomplete point cloud method can be used in the target paper. The tracking of topological event in the target paper is complex because it needs to compare with the previous and next state of flower to detect the change. If use skeleton to represent the shape of flower and perform the forward and back track using skeleton instead of flower, it will save a lot of computation resource because measure the change of skeleton is much simpler than measure the change of*

	point cloud model.
Topic:	*Ordinary differential equation (ODE)*
Target paper	***Boundary Constrained Swept Surfaces for Modelling and Animation (2007)***
Source papers	***Variance Analysis for Monte Carlo Integration*** *The source paper provides a new spectral analysis of the variance in Monte Carlo integration, expressed in terms of the power spectra of the sampling pattern and the integrand involved. The sampling pattern idea in the source paper can benefit the target paper. The boundary constraint in the target paper are user specified and seems distribute uniformly around the mesh. For complex shape, more curves should be provided in order to get a good swept surface result. If applying sampling idea into the target paper, make the curve distribution conform to certain pattern of sampling. For example, sampling the curves in the detailed area more than less detailed area, which can generate more accurate surface for the detailed area.*

The paper about the 'Modelling and Simulation of Lily flowers using ODE Sweeping Surfaces' is attached in Appendix 2 of this report.

7 Dr Inventor System Usability Test

Dr Inventor System usability test, including the system performance, usability, and the indirect output, which has indicated by the novelty of the research work created by using the system. System usability questionnaires was designed to ascertain the system functionality, efficiency, compatibility, usability, reliability and capture some general feedback. Respondents were presented with a list of 10 evaluation question as shown in (Appendix 3). The objective for this evaluation was to ascertain the system functionality, efficiency, compatibility, usability, reliability and capture some general feedback.

7.1 Initial System Usability Test

Dr Inventor first system usability test was conducted with 60 Undergraduates students from BU *(11 November 2016)*. Since we had a large number of students we conducted 'stress test' and asked student to use the system in following areas:

- Register with the system
- Login with credential
- Watch some introduction video
- Search paper from given set of terms (Various topics)
- View source and target in single document view (Explore analogies and visualisation)
- Use Dashboard and Topic Explorer
- View the result from recent history tab
- Use the 'Try your idea' search box

For the stress test large number of students accessed the system the system at the same time, the system crashed. Since then we made significant improvements to the system software and hardware and preformed a number of stress test.

7.2 Latest System Usability Results

Since Jan 2017, a new system usability test has been conduction after the major improvement to the system. The System Usability survey has gathered in total 36 responses;

THE SOFTWARE PERFORM THE INTENDED TASKS

Responses to this question were positive, indicating most of the respondent agrees that the software performs the intended task. Figure 7.1 shows the comparison of results: Strongly Agree (**12**), Agree (**21**), Neither Agree Nor Disagree (**3**), Disagree (**0**), Strongly Disagree (**0**).

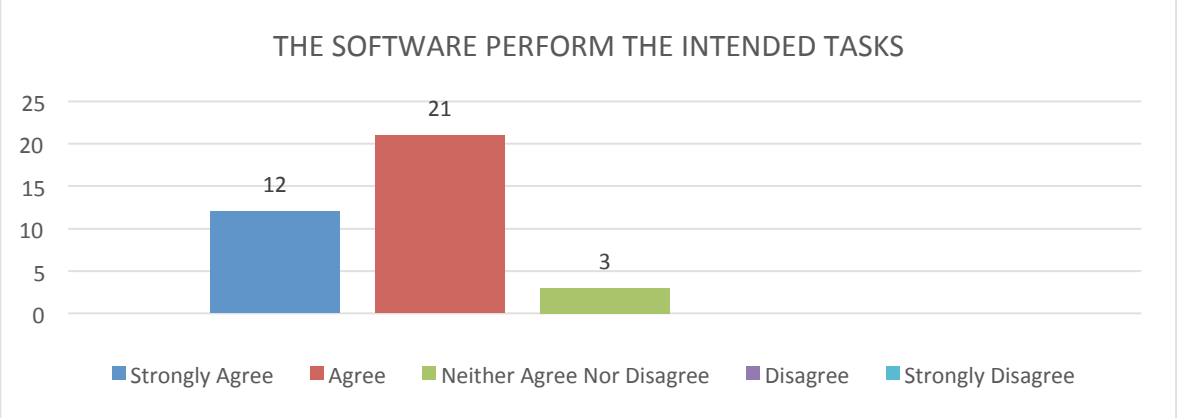

Figure 7.1 The software performs the intended tasks

THE FUNCTIONALITIES INVOLVED IN THE SYSTEM ARE SUFFICIENT

Responses to this question were positive, indicating most of the respondent agrees that the software supply sufficient functionalities. Figure 7.2 shows the comparison of results: Strongly Agree (13), Agree (15), Neither Agree Nor Disagree (7), Disagree (1), Strongly Disagree (0).

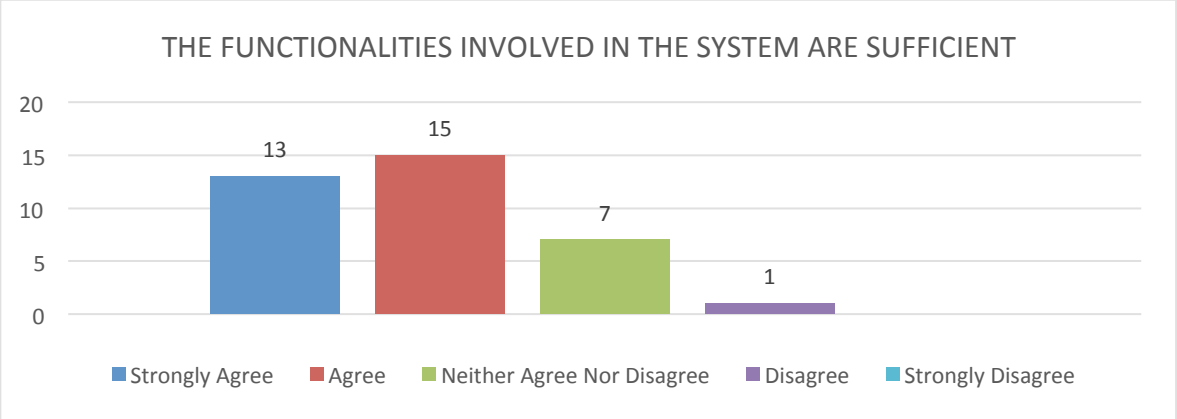

Figure 7.2 The functionalities involved in the system are sufficient

THE SYSTEM IS ABLE TO GIVE EXPECTED RESULTS

Responses to this question were positive, indicating most of the respondent agrees that the software give the expected results. Figure 7.3 shows the comparison of results; Strongly Agree (9), Agree (20), Neither Agree Nor Disagree (7), Disagree (0), Strongly Disagree (0).

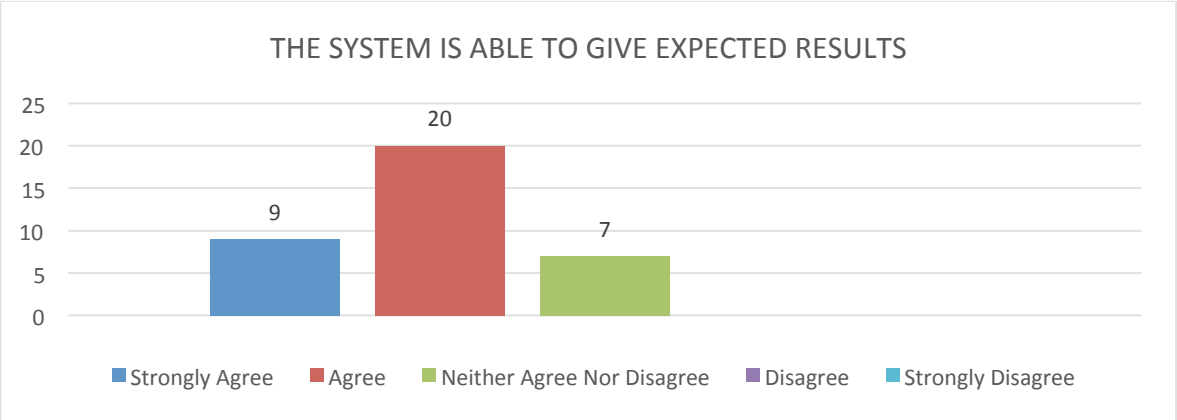

Figure 7.3 The system is able to give expected results

THE SYSTEM INTERACTS QUICKLY

Responses to this question were positive, indicating most of the respondent agrees that the system is easy to use. Figure 7.4 shows the comparison of results; Strongly Agree (11), Agree (16), Neither Agree Nor Disagree (6), Disagree (2), Strongly Disagree (0).

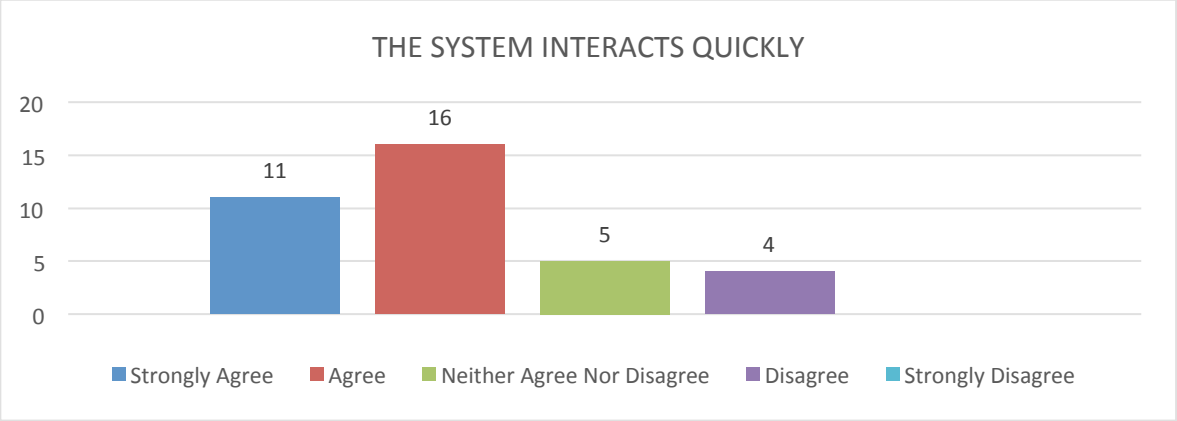

Figure 7.4 The system interacts quickly

I CAN COMPREHEND AND LEARN TO USE THE SYSTEM EASILY

Responses to this question were positive, indicating most of the respondent strongly agree the system is easy to use. Figure 7.5 shows the comparison of results: Strongly Agree (17), Agree (12), Neither Agree Nor Disagree (5), Disagree (2), Strongly Disagree (0).

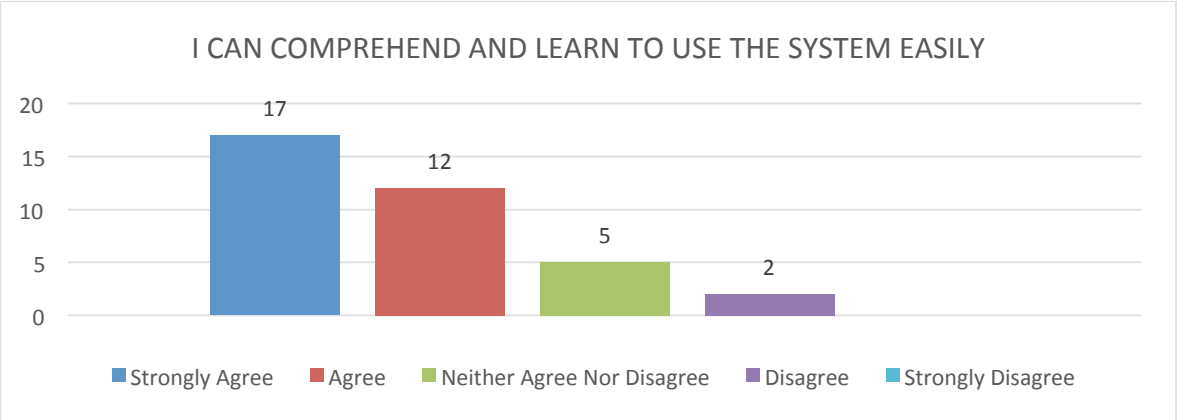

Figure 7.5 I can comprehend and learn to use the system easily

THE INTERFACE LOOKS GOOD & PROVIDES ALL REQUIRED INFORMATION

Responses to this question were positive, indicating most of the respondent agrees the Interface performs well. Figure 7.6 shows the comparison of results: Strongly Agree (11), Agree (13), Neither Agree Nor Disagree (8), Disagree (4), Strongly Disagree (0).

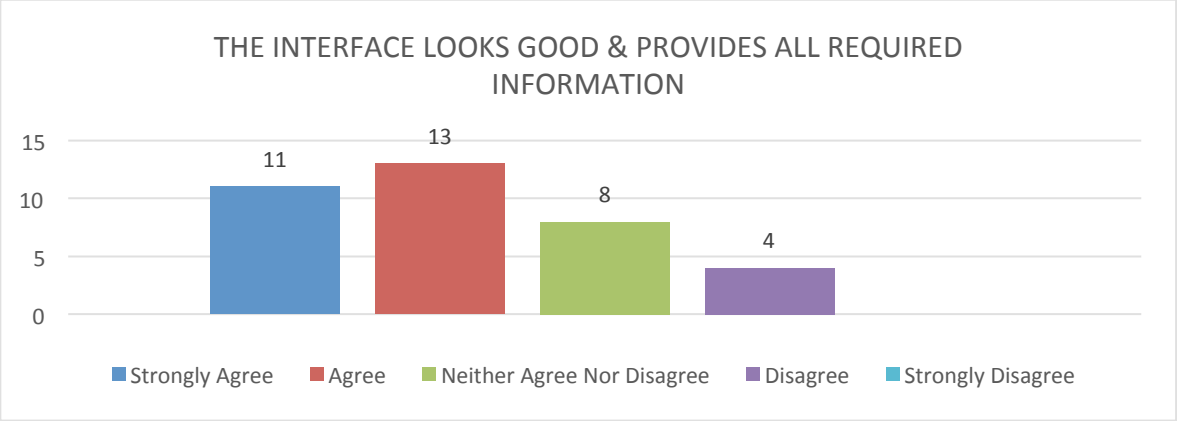

Figure 7.6 The interface looks good & provides all required information

USAGE OF THE SYSTEM IS INTUITIVE

Responses to this question were positive, indicating most of the respondent agrees that the software is intuitive for use. Figure 7.7 shows the comparison of results: Strongly Agree (11), Agree (14), Neither Agree Nor Disagree (9), Disagree (2), Strongly Disagree (0).

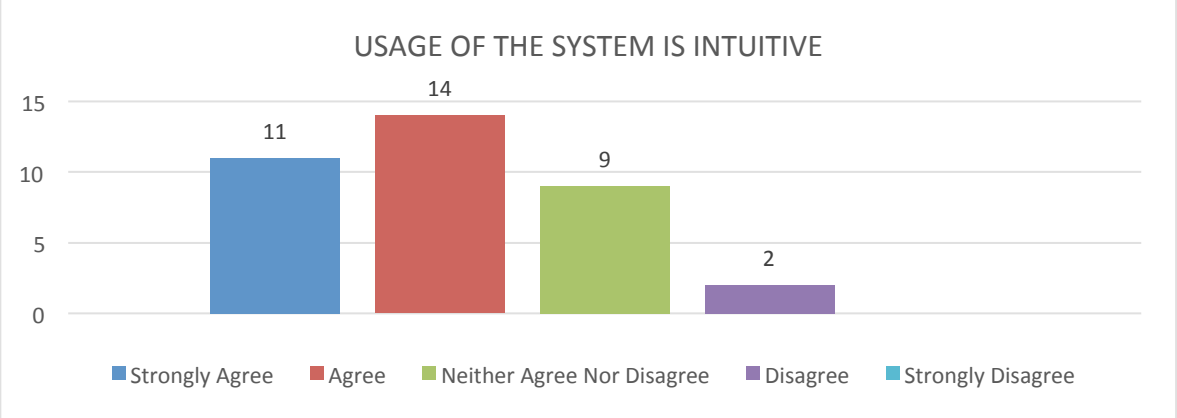

Figure 7.7 Usage of the system is intuitive

THE SOFTWARE IS CAPABLE OF HANDLING ERRORS

Responses to this question were neutral, indicating most of the respondent Neither Agree Nor Disagree that software is capable of handling errors. Figure 7.8 shows the comparison of results: Strongly Agree (11), Agree (7), Neither Agree Nor Disagree (14), Disagree (3), Strongly Disagree (1).

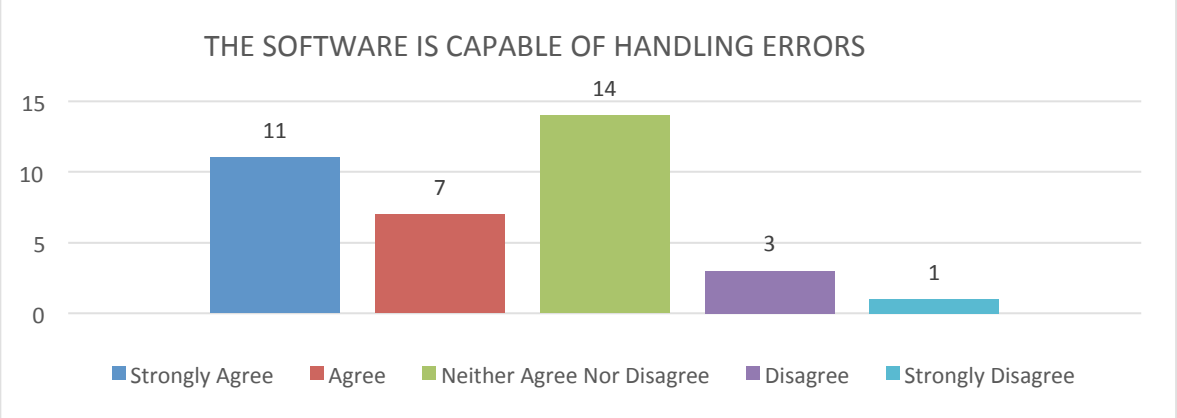

Figure 7.8 The software is capable of handling errors

Table 7.1 Do you know of other similar tools to Dr Inventor? If so, please specify:

No	Similar tools to Dr Inventor
1	Scopus
2	Academia.edu
3	Microsoft Academic Search
4	Meta.com
5	Aminer.org
6	Fastformat.co

Table 7.2 General feedback and suggestions about the Dr Inventor System

No	General feedback and suggestions about the Dr Inventor System
1	System is unique
2	Very convenient to find articles from good sources rather than simply using Google.
3	Generally the system seems very useful and can probably save me a lot of time.
4	At points the input field for the topic explorer would disappear, making it hard to reset the explorer and search for another topic.
5	It works correctly I did not discover any issues yet
6	A feature where we can view both target and source papers side by side with linked words highlighted in order to quickly compare and identify sentences relevant to the analogy, in order to get a better idea of the links the system has made.
7	The fields available to collect information from at the moment seem too limited - at present it's easier to use Google to find relevant results.
8	Its good, keep up the good job
9	I find the system pretty useful but I think it's still a little bit slow (when searching for different papers it took a little bit long to load them. However, it is a tool I will use in the future for my researches.
10	Very sufficient information provided for the investigation of interesting research topic. It would be good to include other resources into the database such as IEEE etc.
11	Software perform is unique, have not seen any system like this before.
12	Old paper as suggested as source paper. In my case, sometimes the source paper is 10 years older than the target paper, this kind of suggestion basically come out with no new idea.
13	Thanks for involved me in this interesting task, and I learned a lot when evaluating the system.
15	Mapping between the target and source papers are useful to understand the connection between papers.
16	Great info between the analogies between two papers.
17	It would be good to show more analogy papers.
18	Why some target papers don't show source papers?

19	I would like to see more detailed graph visualizations between two papers.
20	Really would like to see IEEE papers.
21	System is easy to use
22	Some of the inference does not load properly.
23	System is useful to discover new research ideas
24	Dr Inventor is a good tool for the research students. Would be more useful, if we could see the analogies from the citation of a paper.

8 Conclusion

This deliverable has summarised the evaluation work which has been carried out with regards to system creativity and usability. The results of Dr Inventor - scientific creativity survey including responses from a range of scientists, but with a focus on Mathematical and Computational Sciences. The feedbacks have shown that creativity is of great importance to researchers when writing and reviewing research papers. Reviewers expect to detect a paper's creativity from the sections addressing challenges and proposing relevant solutions. The attributes of general creativity that were found to be most associated with scientific creativity are: novel and unexpected; recognising gaps; and challenging the norms in a discipline. The attributes least associated with scientific creativity were: spontaneous and subconscious processing; communication and promotion; and emotion and self-expression. We also found that researchers deliberately seek out related work in other fields of research.

The main contributions of Dr Inventor Evaluation;

- 'Our best users are yourselves' - Dr Inventor has started with the users from Bournemouth and Bedfordshire universities whose research specialisation is within computer graphics. The system evaluation has involved a large number of users from the computer graphics domain.
- Dr Inventor is not limited to computer graphics, nor will its users be limited to this discipline. Other Dr Inventor consortium members will also commence using the system and providing both explicit and implicit feedbacks through the user interface. We have contacted SIGGRAPH authors for their feedbacks on the creative analogies that are identified by Dr Inventor system.
- SIGGRAPH Authors have provided very positive feedbacks.
- Dr Inventor evaluation has identified 204 creative analogies which could lead to new publications.
- 14 topic-base case studies have completed by domain experts. The new ideas will lead to new publications.
- BU research students have been using Dr Inventor system (Kun and Wenshu)
- We have performed a 'Rational Reconstruction' on 'Curve-Skeleton Extraction from Incomplete Point Cloud (2009)'
- We completed a publication with Dr Inventor as a co-author 'Modelling and Simulation of Lily flowers using ODE Sweeping Surfaces' Appendix 2.

Appendix 1. CASE-STUDY by Domain Experts with Author's Feedback

Case Study:	*1*
Topic:	*TEXTURE SYNTHESIS*
Conducted by:	*Prof. Feng Dong*
Target paper:	***Inverse Texture Synthesis (2008)***
Source papers found by Dr Inventor	***Simulating biped behaviors from human motion data (2007)*** ***New Idea:*** *We can carry out inverse texture synthesis on motion textures to work out a small motion patches that are representative to allow for the synthesis of larger motion texture.*
	Local, deformable precomputed radiance transfer (2005) ***Useful Inferences:*** *The a texture will extend the PRT* ***New Idea:*** *The idea suggests that precomputed radiance transfer (PRT) could be useful for textures"*
	Spacetime faces: high resolution capture for modeling and animation (2004) ***Useful Inferences:*** *The a texture will go the video sequences* ***New Idea:*** *Are we able to use a sequence of videos as the source for the texture synthesis and these textures can be captured by video cameras? In other words, can we extend the work of inverse texture synthesis by studying a sequence of images that contain textures (which may be captured by cameras).*
Target paper	***Motion texture (2002)***
Source papers found by Dr Inventor	***SCAPE (2005)*** ***New Idea:*** *In addition to motion, can the motion texture consider body shape as a part of the texture? In other words, in addition to rigid motion, can we consider body deformation in the motion texture? To do this, the linear dynamic system will incorporate deformations of non-rigid surfaces.*
	Depixelizing pixel art (2011) ***New Idea:*** *Do we consider antialiasing as an issue in motion texture and does a vector representation of the textures can help reduce the artefacts?*
Target paper	***Multiscale texture synthesis (2008)***
Source papers found by Dr Inventor	***Face swapping (2008)*** ***Useful Inferences:*** *The a technique will use the This library face library*

	New Idea: *Can we develop a library as reference for the multiscale texture synthesis in the target paper?*
Target paper	***Coherent noise for non-photorealistic rendering (2011)***
Source papers found by Dr Inventor	***Face swapping (2008)*** ***Useful Inferences:*** *The coherent noise the coherent noise will require the minimal training* *The we_our will introduce the a novel motion editing technique* ***New Idea:*** *Can we adopt a training based approach for the generation of the noise in the target paper for non-photorealistic rendering? Editing techniques (like those in the motion editing) can also be involved for the noise editing.*

Case Study:	*2*
Topic:	*HAIR SIMULATION*
Conducted by:	*Wenshu Zhang (PhD Student)*
Target paper:	***Single-view Hair Modeling for Portrait Manipulation (2012)***
Source papers found by Dr Inventor	***Learning part-based templates from large collections of 3D shapes (2013)*** ***New Idea:*** *The source paper provides a possible solution for the future work of the target paper. If 3d hair model has been fully reconstructed, learning part-based templates method will improve hair refinement as well as hairstyle editing.* ***Author's Feedback: (Menglei Chai)*** ***Yes, with part-based templates as prior, we can definitely improve 3D hair modeling. That's similar to our latest work of AutoHair: Fully Automatic Hair Modeling from A Single Image.***
	Audeosynth: Music-driven Video Montage (2015) ***New Idea:*** *The source paper could help improve hair rendering especially after portrait pop-ups with changing direction. Also the target paper prototypes hairstyle editing, a better result can be obtained by integrating more realistic rendering method.* ***Author's Feedback: (Menglei Chai)*** ***Our latest work of AutoHair: Fully Automatic Hair Modeling from A Single Image uses Deep Neural Networks to help automatically segment the hair regions and understand the hairstyle, one may think it is something similar to saliency detection.***
	Texture-lobes for tree modelling (2011) ***Useful Inferences:***

	The model will be the observation *The we_our will present the model* *The number will introduce_approximate the geometry* ***New Idea:*** *The source paper gives another way to solve the problem of the target paper. The patches (lobe-geometry) based method is also suitable for hair reconstruction somehow. Hair modelling from single-viewed image is lack of depth information. But we can still cut the hair region into several meaningful parts like the lobe-geometry in the source paper. The skeletal structure idea can be implemented in the target paper by selecting representative 2d hair strands. And if a hairstyle database is available to training, the 3d hair model reconstruction can be done by incorporating skeletal structure with hair region partition.* ***Author's Feedback: (Menglei Chai)*** ***Once again, our latest work of AutoHair represents hair as strips, similar to the so-called texture-lobes. Each strip represents a meaningful group of hair strands to serve as the skeletal structure. Furthermore, we have a database of this strip-based representation to reconstruct the 3D hair shape.***
	View-Dependent Displacement Mapping (2003) ***New Idea:*** *The source paper could help improve hair rendering especially after portrait pop-ups with changing direction. Also the target paper prototypes hairstyle editing, a better result can be obtained by integrating more realistic rendering method.* ***Author's Feedback: (Menglei Chai)*** ***Definitely, with better rendering technique we can make the results better. But I am not sure how this displacement mapping technique can improve the portrait rendering quality.***
Target paper	***A reduced model for interactive hairs (2014)***
Source papers found by Dr Inventor	***Fabricating translucent materials using continuous pigment mixtures (2013)*** ***New Idea:*** *Basically, the target paper and source paper are solving different problems within different domains. However, they still have some similar ideas to achieve their goal, using training sets/database and decoupling complex problem into several parts.* ***Author's Feedback: (Menglei Chai)*** ***Yes, the basic idea might be relevant and inspiring.***
	Measurement-based Editing of Diffuse Albedo with Consistent Interreflections (2015) ***New Idea:*** *The source paper aims to edit image albedo and recolour selected region. This method cannot help solve hair dynamics problem in the target paper. The only thing I can see is*

	that the recolouring algorithm might improve hair rendering. ***Author's Feedback: (Menglei Chai)*** ***Rendering is not the focus of this work, we use simple but efficient real-time rendering could help visualize the result only.***
	Projection defocus analysis for scene capture and image display (2006) ***New Idea:*** *In my opinion, the source paper cannot provide novel method to solve hair dynamics problem in the target paper. But it does provide a solution to hair reconstruction in hair modelling. By using different focused hair image to recover hair depth information.* ***Author's Feedback: (Menglei Chai)*** ***This work uses 3D hair geometry created by artists, it does not try to use hair models recovered from images, the quality of such models may not be appropriate for physically-based animation.***
	Reflections on simultaneous impact (2012) ***New Idea:*** *The source paper provides a possible method to solve the target paper's limitation. By introducing friction integrated by the source paper's impact solution, the target paper might generate more convincing results for hair simulation.* ***Author's Feedback: (Menglei Chai)*** ***Yes, the results can be improved by many more advanced solutions targeted at various aspects. But one key point that the new solution should be compatible with our reduced simulation pipeline and efficient enough within very limited time budget.***
Target paper	***Dynamic hair manipulation in images and videos (2013)***
Source papers found by Dr Inventor	***Biomechanical Simulation and Control of Hands and Tendinous Systems (2015)*** ***New Idea:*** *The target paper proposed a method to model, edit and simulate hair from video input, the hair dynamics is just visual plausible. The Eulerian-on-Lagrangian strands approach in the source paper should help improve hair simulation, especially on hair collision and hair interaction with human body.* ***Author's Feedback: (Menglei Chai)*** ***The reconstructed hair geometry is not appropriate for physically-based animation.***
	Practical motion capture in everyday surroundings (2007) ***New Idea:*** *Although hair motion is hard to tracking in our daily life, but a novel method of simulating hair dynamics may introduced, if integrate target paper and source paper. The*

	target paper provided a method to reconstruct hair geometry from image. According to the source paper, if something kind of marker can be placed on hair. The accurate hair motion data could be collected to generate high fidelity hair simulation. ***Author's Feedback: (Menglei Chai)*** ***Yes, if we can add some markers on the hair surface, we can get much better hair shapes.***
Target paper	***Modeling hair from multiple views (2005)***
Source papers found by Dr Inventor	***Fast frictional dynamics for rigid bodies (2005)*** ***New Idea:*** *The source paper simulates the rigid body's dynamics. This method may help simulate hair interaction with other objects like comb etc.* ***Author's Feedback: (Yichen Wei)*** ***Sorry that I am not capable of reviewing these works, as they are kind of out of my expertise.***
	Robust Epsilon Visibility (2002) ***New Idea:*** *The target paper mainly describes the hair geometry modelling from multi images, which is totally in a different domain compared to the source paper. However, the source paper could potentially help render hair shadow. Generally speaking, the method in the source paper cannot improve generate the result of the target paper.* ***Author's Feedback: (Yichen Wei)*** ***Sorry that I am not capable of reviewing these works, as they are kind of out of my expertise.***
	Triple product wavelet integrals for all-frequency relighting (2004) ***New Idea:*** *The source paper proposed a method of efficient rendering under pre-computed light transport. Their objective is to solve high dimensional representation of light direction, view direction and surface position. It provides a potential way to render large amount of hairs for real-time demand, which needs both efficiency and reasonable quality.* ***Author's Feedback: (Yichen Wei)*** ***Sorry that I am not capable of reviewing these works, as they are kind of out of my expertise.***
Target paper	***Interactive multiresolution hair modelling and editing (2002)***
Source papers found by Dr Inventor	***Circular arc structures (2011)*** ***New Idea:*** *The source paper use repeat small parts to simulate complicated architecture structures. This could help smooth hair surface but is not suitable for individual hair modelling.*
	Energy redistribution path tracing (2005) ***New Idea:*** *The source paper proposed energy redistribution*

	sampling to solve correlated integral problems, especially used in global illumination. Hair strands sampling on the scalp surface is straightforward. It is unnecessary to use such a complicated sampling method.
	Linear light source reflectometry (2003) ***New Idea:*** *The source paper used linear light source to capture object reflectance in order to reconstruct object surface. This is irrelevant with the target paper purpose. However, it reminds me of using single beam of light to reconstruct hair surface shape.*
	Nonlinear optimization framework for image-based modelling on programmable graphics hardware (2003) ***New Idea:*** *The source paper might help improve the level of detail and interactive rendering by programming on GPU.*
Target paper	***Single-view Hair Modeling Using a Hairstyle Database (2015)***
Source papers found by Dr Inventor	***Robust Moving Least-squares Fitting with Sharp Features (2005)*** ***New Idea:*** *The source paper proposed a robust MLS method to reconstruct piece-wise smooth surface. I didn't see the relation between the source paper and the target paper. To be honest, the source paper might help improve hair reconstruction from multi images, with reconstructing robust hair surface keeping detailed information. But that is a different hair modelling solution.*
Target paper	***Structure-aware hair capture (2013)***
Source papers found by Dr Inventor	***Image vectorization using optimized gradient meshes (Year 2007)*** ***New Idea:*** *The gradient mesh optimization method of the source paper may help improve ribbon mesh appearance in the target paper.*
	Motion texture (Year 2002) ***New Idea:*** *The source paper can improve or generate different results for the target paper in two aspects. First, the obtained hair model cannot preserve realistic hair movement, a learning method similar with the source paper will improve the simulation performance, e.g. video input based hair motion synthesis. Second, the hair capturing progress maybe improved by introducing hair texture. Learning and retrieving from a database will help generate full hair model, which is not precisely the same compared to the original input. But this can avoid high cost of data capture and input data clean up. This is a very useful comparison.*

Target paper	***Interactive hair rendering under environment lighting (2010)***
Source papers found by Dr Inventor	***High-order similarity relations in radiative transfer (Year 2014)*** ***New Idea:*** *The source paper proposed method may help improve dyed hair rendering, which have similar property with translucent object.* ***Author's Feedback: (Zhong Ren)*** ***It won't be quite feasible, since the similarity relation retrieval is for off-line rendering and our method is interactive, i.e. it should be computed in a framerate higher than 10fps, so the total budget is less than 0.1 second. Also, there are many specific problems in fiber volume compared with the homogeneous volume studied by that 2014 paper.***
	Light field mapping (Year 2002) ***New Idea:*** *The source paper was published on year 2002, 8 years earlier than the target paper. The hardware has been developed dramatically within 8 years, this hardware-accelerated rendering was out of date. The data partition algorithm might help accelerating hair rendering.* ***Author's Feedback: (Zhong Ren)*** ***I did not quite get the idea here, you meant using the new hardware for the 2002 method to render hair? But it is not simply about hardware, you will need to solve specific problems of shadows, interreflection in hair volume, again it is quite different with the problems in rendering general surfaces.***
Target paper	***Detail preserving continuum simulation of straight hair (2009)***
Source papers found by Dr Inventor	***Stress relief (Year 2012)*** ***New Idea:*** *The stress relief method will help optimize complicated hairstyle model. In the future, this can improve 3d printable hair quality.*
	Blue-noise point sampling using kernel density model (2011) ***New Idea:*** *The source paper's sampling method may help improve the computation efficiency when doing simulation.*
Target paper	***Dual scattering approximation for fast multiple scattering in hair (2008)***
Source papers found by Dr Inventor	***Unified particle physics for real-time applications (2014)*** ***New Idea:*** *The source paper may help improve hair simulation if treating hair as particle system with constraints, which can deal with hair-hair interactions. However, this doesn't provide a solution of approximation for multiple scattering in hair.*
Target paper	***Light scattering from human hair fibers (2003)***
Source papers found by Dr Inventor	***ShadowDraw (2011)*** ***New Idea:*** *The source paper used a learning method to solve*

	problem. If the target paper can use learning method to analyse light scattering phenomena, which may simplify the research question.
Target paper	***Robust hair capture using simulated examples (2014)***
Source papers found by Dr Inventor	***Controlled-distortion constrained global parametrization (2013)*** ***New Idea:*** *The source paper may improve ribbon connection performance.*
	Edge-preserving decompositions for multi-scale tone and detail manipulation (2008) ***New Idea:*** *The source paper decomposed input image as different detail layers which has the similar idea compared to the target paper. The target paper decomposed a hairstyle into a set of example-based guidance hairs to describe the hair model.*
Target paper	***Capture of hair geometry from multiple images (2004)***
Source papers found by Dr Inventor	***SCAPE (2005)*** ***New Idea:*** *The hair geometry capturing task can be achieved by using data-driven method mentioned in the source paper, like the research: Robust hair capture using simulated examples in year 2014.*
	High-order similarity relations in radiative transfer (2014) ***New Idea:*** *The source4 paper can help the target paper understand hair scattering information.*
	Interactive relighting with dynamic BRDFs (2007) ***New Idea:*** *The source paper can improve hair 2d orientation map by analysing the lighting for the target paper.*

Case Study:	*3*
Topic:	*SKINNING*
Conducted by:	*Dr Xiaosong Yang (Associate Professor)*
Target paper:	***Two-layer sparse compression of dense-weight blend skinning (2013)***
Source papers found by Dr Inventor	***Real-time rendering of plant leaves (2005)*** *There is one useful analogy between these two papers:* *T: dense weight => S: all frequency lighting* *T: master bones => S: low frequency environment light* *T: virtual bones => S: high frequency sunlight, direct component* ***New Idea:*** *No work on frequency analysis on skin deformation. Given a blend shape animation (or captured animation, such as facial expression capture), for all the vertices, if we analysis the frequency, the low frequency part can be represented by master bones, high frequency can be represented by virtual bones.*

	Author's Feedback: (Zhigang Deng) ***I do not think this is good idea, and may not work.***
Target paper:	***Implicit skinning (2013)***
Source papers found by Dr Inventor:	***Simulating biped behaviors from human motion data (2007)*** *There is very strong analogy between these two papers:* *T: static model shape (half, extendable to scanned deformed shapes) => S: training motion data* *T: implicit field function => S: controller* *T: result (new skin deformation) => S: result (new physically feasible motion)* ***New Idea:*** *extend the target paper by collecting deformed shapes, replace each HRBF with a small neural network for training. The implicit field function will not only depend on one input skinning shape, but also to capture the deformation from real life. It will be a dynamic implicit field.*
	Rig-space physics (2012) ***Useful Inferences:*** *The output will consist the the position of mesh vertices* *T: static model => S: simulated deformation* *T: implicit field function => S: animation curves of rig parameters* *T: result(new skin deformation) => S: result(new skin deformation)* ***New Idea:*** *Extend the target paper by collecting deformed shapes from physically based simulation, such as FEM. Replace each HRBF with a small neural network for training. The implicit field function will not only depend on one input skinning shape, but also to capture the deformation from simulation. It will be a dynamic implicit field.*
Target paper:	***Skinning mesh animations (2005)***
Source papers found by Dr Inventor:	***Responsive characters from motion fragments (2007)*** *T: vertices (follow different transformation to generate poses) => S: Player input traces* *T: cluster vertices => S: "cluster" (current frag, control) into tabular control policy table* *T: clusters => S: control bins* ***New Idea:*** *T benefit S, instead of using evenly distributed bins like Figure 4, S could use mean-shift algorithm to clustering the input in the high dimensional control space.*

Case Study:	*4*
Topic:	*LIGHTING AND RENDERING*
Conducted by:	*Dr Baoquan Liu (Senior Research Fellow)*
Target paper:	***An approximate image-space approach for interactive***

	refraction (2005)
Source papers found by Dr Inventor	***Stochastic tomography and its applications in 3D imaging of mixing fluids (2012)*** ***Useful Inferences:*** *The refraction of a distant environment the plausible refractions will demonstrate the approach* *The refraction of a distant environment the plausible refractions will show the current interactive techniques* ***New Idea:*** *The target paper introduces a simple, image-space approach to render refractions that easily runs on modern graphics cards. The source paper presents a new 3D imaging method, which is based on visible light computed tomography and is made possible by a new stochastic tomographic reconstruction algorithm. So the source paper's method can be extend to render plausible refraction effects through more than two interfaces, as done in the target paper that is through two interfaces.*
Target paper:	***A programmable system for artistic volumetric lighting (2011)***
Source papers found by Dr Inventor:	***Directable, high-resolution simulation of fire on the GPU (2009)*** ***Useful Inferences:*** *The experienced artists will be use the the wide variety of commercially available fluid simulation tools* *The non physical results will be the final simulations for rendering* ***New Idea:*** *The target paper presents a method for generating art-directable volumetric effects, ranging from physically-accurate to non-physical results, it mimics the way experienced artists think about volumetric effects by using an intuitive lighting primitive. While the source paper proposes a combination of coarse particle grid simulation with a fine refinement simulation, and the directability is achieved by allowing virtually any user-defined particle behavior as an input to the initial coarse simulation. Since both papers are to produce art-directable 3D volumetric effects using different approaches, they can borrow ideas from each other, so that more advanced and extended effects and faster performances could be achieved.*
Target paper:	***Eikonal rendering (2007)***
Source papers found by Dr Inventor:	***Global illumination with radiance regression functions (2013)*** ***Useful Inferences:*** *The an propagation technique will partition the the input space of the RRF model* *The an propagation technique will model the The RRF the RRF* *The we_our will rendering the illumination*

	New Idea: *The target paper proposes an efficient light propagation technique using adaptive wavefront tracing for real-time rendering of sophisticated lighting effects in and around refractive objects with complex spatially variant material properties, such as arbitrarily varying refractive index, inhomogeneous attenuation, as well as spatially-varying anisotropic scattering and reflectance properties. While the source paper utilizes an augmented set of attributes as input to the neural network RRF to effectively model scenes with spatially variant material properties.* *So an insight is to apply the solution in the source paper to the target paper's application: we can use the wavefront propagation technique to partition the input space of the RRF model, so that we can represent the subspaces with separate, smaller RRFs that can be evaluated more rapidly. As a result, the RRF model scales well to increasingly complex material variation, where we model the RRF as a multilayer acyclic feed-forward neural network, which provides a close functional approximation of the indirect illumination.*

Case Study:	*5*
Topic:	*GPU*
Conducted by:	*Kun Qian (PhD Student)*
Target paper:	***A realtime GPU subdivision kernel (2005)***
Source papers found by Dr Inventor	***Circular arc structures (2011)*** ***Useful Inferences:*** *The The approach will show the an extension for truly three dimensional designs* *The The approach will present the the first global approximation method for principal patches* ***New Idea:*** *The subdivision idea of the target paper can be applied to the generation of principal patches pattern. Also, the global approximation for principal patches can also be used in target paper to achieve adaptive subdivision for certain area.*
Target paper:	***Real-time GPU rendering of piecewise algebraic surfaces (2006)***
Source papers found by Dr Inventor:	***Volume contact constraints at arbitrary resolution (2010)*** ***Useful Inferences:*** *The implicit surface rendering will compute the depth images* *The implicit surface rendering will simulate the contact* ***New Idea:*** *Volume contact constraints at arbitrary resolution (2010)* *The computation of univariate polynomial coefficients at each pixel in the target paper can be used to improve the depth*

	buffer's accuracy in the target paper which can produce more accurate contact result but the efficiency probably will become the bottleneck.
	Fragment-based image completion (2003) ***Useful Inferences:*** *The implicit surface rendering will approximate the the unknown regions The implicit surface rendering will complete the roots_us* ***New Idea:*** *The source paper iterative approximate the unknown regions and composites adaptive image fragments into the image. This idea can also be applied to the target paper when approximating the univariate polynomial coefficients at each pixel.*
Target paper:	***Sparse matrix solvers on the GPU (2003)***
Source papers found by Dr Inventor:	***Linear algebra operators for GPU implementation of numerical algorithms (2003)*** ***Useful Inferences:*** *The Many computer graphics applications Realtime applications example applications of geometric flow and fluid simulation will introduce_provide the the building blocks for the design of more complex numerical algorithms* *The multi dimensional finite difference equations will apply the fx* ***New Idea:*** *The source paper provides the building blocks for the design of more complex numerical algorithms which can be used as the base for the target paper.*
Target paper:	***An efficient GPU-based approach for interactive global illumination (2009)***
Source papers found by Dr Inventor:	***Synthesis of bidirectional texture functions on arbitrary surfaces(2002)*** ***Useful Inferences:*** *The BTF synthesis the synthesis fast BTF synthesis will base the final gather* *The The irradiance values will describe the these methods* *The final gather will extract the BTF synthesis the synthesis fast BTF synthesis* ***New Idea:*** *The target paper starts with raytraced shading points and partition them into coherent shading clusters using adaptive seeding followed by k-means. This technique is similar to the surface textons procedure in the source paper which extracts*

	essential information from the sample BTF to facilitate the synthesis based on the k-coherent search. Such k-coherent search technique may be applied to the GI research to generate some new results.
	Deformable object animation using reduced optimal control (2009) ***Useful Inferences:*** *The the GPU will demonstrate the significant computational speedups The these methods will generate the shading points all points sample points* *The shading points all points sample points will use the keyframes the keyframes* ***New Idea:*** *The target paper uses the idea of adaptive sampling to the irradiance values. The source paper speed up the computational procedure by reducing the problem to a low dimension space. Those two ideas are the same, solving problem in a low dimension. Sampling based dimension reduction may be applied to the source paper.*
	Fast and detailed approximate global illumination by irradiance decomposition (2005) ***New Idea:*** *Both the target paper and source paper are in the same research topic: GI but focus on solving different problems. They can combined together (combine irradiance decomposition idea and sparse sampling).*
Target paper:	***Efficient GPU rendering of subdivision surfaces using adaptive quadtrees (2016)***
Source papers found by Dr Inventor:	***ShadowDraw (2011)*** ***Useful Inferences:*** *The the u domain of each face will guide the addition* ***New Idea:*** *The target paper subdivide the u, v domain of each face ahead of time, generating a quadtree structure, and then submit one tessellated primitive per input face. Such idea of decomposing the primitive into hierarchical structure can be applied to the shape matching user draw in the source paper. The user input can be decomposed into hirarchical structure and matching can be performed in different levels.*
	Putting holes in holey geometry (2013) ***New Idea:*** *The target paper subdivide the u, v domain of each face ahead of time, generating a quadtree structure, and then submit one tessellated primitive per input face. Such idea of decomposing the primitive into hierarchical structure can be applied to the source paper when generating wholes in the mesh. The remesh process can be performed in the hierarchical*

	style.
	Body talk: crowdshaping realistic 3D avatars with words (2016) ***Useful Inferences:*** *The the u domain of each face will guide the addition* ***New Idea:*** *The souce paper learn a model of how 3D shape and linguistic descriptions of shape are related. During the learning procedure, hierarchical ideas in the target paper can be applied. Matching of the shape is performed in different resolution level.*

Case Study:	*6*
Topic:	*FACIAL ANIMATION*
Conducted by:	*Shuang Liu (PhD Student)*
Target paper:	***Displaced dynamic expression regression for real-time facial tracking and animation (2014)***
Source papers found by Dr Inventor	***Acquisition of time-varying participating media (2005)*** ***New Idea:*** *Although the target paper is not about capturing time-varying volumertic data but the facial database acquisition step in the source paper could be useful in the database the target paper is based on. However, I fail to see an easy way to apply the techniques in either papers to each other.*
Target paper:	***3D Shape Regression for Real-time Facial Animation (2013)***
Source papers found by Dr Inventor:	***Kernel Nyström method for light transport (2009)*** ***New Idea:*** *The analysis of lighting could be somewhat useful for accounting for the light variation in facial performance from video but the setup and methodology is not appropriate.*
Target paper:	***Dynamic 3D Avatar Creation from Hand-held Video Input (2015)***
Source papers found by Dr Inventor:	***A Computational Approach for Obstruction-free Photography (2015)*** ***New Idea:*** *The method introduced in the target paper is about creating dynamic 3D avatar from hand-held video and the source paper is about photography, the source paper could help with the image acquisition process in the target paper to improve robustness and texture quality.*
	Interactive region-based linear 3D face models (2011) ***New Idea:*** *Although the new research ideas suggested is almost different but the two paper can indeed be complementary to each other. The source paper, which focus on creating linear 3D face model could help the target paper create more realistic dynamic facial model.*

	Meta-representation of shape families (2014) ***New Idea:*** *Source paper, which is about shape families could help the 3D facial model creation process in the target paper.*
Target paper:	***Realtime performance-based facial animation (2011)***
Source papers found by Dr Inventor:	***Jigsaw image mosaics (2002)*** ***New Idea:*** *I suppose the facial performance capture method in the target paper could be useful for image editing. The other way around isn't quite likely.*
	Nonlinear revision control for images (2011) ***New Idea:*** *I suppose the facial performance capture method in the target paper could be useful for image editing but it's far-fetch.*

Case Study:	*7*
Topic:	*GEOMETRY PROCESSING*
Conducted by:	*Qin Yipeng (PhD Student)* **** BU Author of SIGGRAPH 2016 PAPER***
Target paper:	**** Fast and exact discrete geodesic computation based on triangle-oriented wavefront propagation (2016)***
Source papers found by Dr Inventor	***Unified motion planner for fishes with various swimming styles (2016)*** ***Useful Inferences:*** The computation will be the graphics pipelines The computation will have the a feature The set will reproduce the variation ***New Idea:*** *(1) The main analogy between the two papers is that they both focus on a component of some applications and contains study for various cases. (2) Non-obvious/potential similarities: I think the motion planner contains some sort of path planner where the geodesic algorithm or its method may be applied. (3) Connection: I think the connection is that both the two papers are related to path planning problem.*
	Enrichment textures for detailed cutting of shells (2009) ***Useful Inferences:*** The set will be the study The we_our will adapt the computation The we_our will adapt_enrich the approximation by custom designed basis functions ***New Idea:*** *(1) The analogy between the two papers is that the source paper produces an idea of doing computation on a low-resolution simulation mesh rather than refining or remeshing to obtain a complex mesh for computation. This may suggest an*

	approximation algorithm for the target paper. (2) Non-obvious/potential similarities: The two papers both studies the problem of mesh resolution since it influences the computation performance a lot. (3) Connection: Both the two papers are related to mesh/geometry topic.
	Relating shapes via geometric symmetries and regularities (2014) ***Useful Inferences:*** The we_our will present_simulate the point The we_our will show_simulate the wrinkle ***New Idea:*** *(1) I think the geodesic result generated by the target paper can be used to identify symmetry of a model and solve the problem in the source paper. (2) Non-obvious/potential similarities: Both papers solve the problem using some geometry properties. The target paper synchronizes windows on edges and the source paper uses the symmetry and regularity of meshes. (3) Connection: Both papers are related to shapes and computation geometry topics.*
	Coupled Segmentation and Similarity Detection for Architectural Models (2015) ***New Idea:*** *(1) Geodesics generated from the target paper may be used to detect similarities between models. This may lead to a new approach other than (the one used in the source paper.* *(2) Connection: The 'segmentation' part of the source paper relates to the target paper in that geodesics can be used for segmentation.*
Target paper:	***Fast exact and approximate geodesics on meshes (2005)***
Source papers found by Dr Inventor:	***Embedded thin shells for wrinkle simulation (2013)*** ***Useful Inferences:*** The we_our will present_simulate the point The we_our will show_simulate the wrinkle ***New Idea:*** (1) The algorithm proposed in the target paper is for mesh surfaces. Thus, it may be used in the wrinkle simulation in the source paper. (2) Non-obvious/potential similarities: The geodesics generated from the target paper may be used as a measure for surfaces deformation, especially the level of wrinkle. (3) Connection: Both the two papers are related to the computation on meshes.
	Generalizing locomotion style to new animals with inverse optimal regression (2014) ***Useful Inferences:*** The shape will analyze the implementation The truth will compare the implementation

	New Idea: *I think that the source paper suggests that shapes may have influence on the performance of the geodesic computation in the target paper. In addition, the system suggests a lot of analogy on the methods used by the two papers. I think these are very valuable in general. However, they are not quite meaningful in these two papers specifically since exact geodesics may not be solved via numerical optimization.*
	Organizing heterogeneous scene collections through contextual focal points (2014) ***Useful Inferences:*** *The practice will base the an exact solution* ***New Idea:*** *I think the system provides a good link between the algorithm in the target paper and the task (focal point extraction) in the source paper. The inference suggested idea points out the logic in the target paper, I think it is very interesting.*
Target paper:	***Data-driven Interactive Quadrangulation (2015)***
Source papers found by Dr Inventor:	***A wave-based anisotropic quadrangulation method (2010)*** ***Useful Inferences:*** *The This paper will propose the The patterns The quadrangulation patterns* ***New Idea:*** *(1) The system gives a good suggestion that the source paper may produce some useful quad-mesh patterns for the target paper. I think this may enhance the contribution of the target paper by including more patterns in the database.* *(2) Connection: The two papers are closely connected since they handle similar problems on quadrangulation.*
	Stress relief (2012) ***Useful Inferences:*** *The The patterns The quadrangulation patterns will possess the greater structural integrity* ***New Idea:*** *(1) I think the system suggests a good idea. Does the mesh tessellation has any influence on the 3D printing process? If so, the remeshing techniques, i.e. the one in the target paper, will be linked with 3D printing.* *(2) Non-obvious/potential similarities: The data-driven approach used in the target paper may be used in the stress-relief 3D printing application of the source paper.*
	Frequency space environment map rendering (2002) ***Useful Inferences:*** *The The patterns The quadrangulation patterns will introduce the a new compact representation* ***New Idea:*** *(1) The system suggests a good idea on using quadrangulation patterns to generate a new compact representation. This is a novel idea and may be used to*

	decompose the mesh for rendering. *(2) Connection: The mesh tessellation and rendering is related.*
	Capturing and animating occluded cloth (2007) ***New Idea:*** *(1) Although the target paper aims at quadrangulation, its data-driven approach may also be used to fill holes in the application of the source paper. This may also be an idea.* *(2) Non-obvious/potential similarities: The source paper uses triangles as markers and mesh elements. Maybe the quadrangles can also be used and result in novel features.* *(3) Connection: Both the two papers use the data-driven approach.*
Target paper:	***Variational tetrahedral meshing (2005)***
Source papers found by Dr Inventor:	***TRACKS: Toward Directable Thin Shells (2007)*** ***New Idea:*** *(1) I think the tetrahedral mesh generated from the target paper may be used in making the animation more realistic as well as the source paper from that good tetrahedral meshes may be used to preserve the volume of a model.* *(2) Connection: Both the two papers solve the problems through the optimization approach.*
Target paper:	***Global parametrization by incremental flattening (2012)***
Source papers found by Dr Inventor:	***Handle-aware isolines for scalable shape editing (2007)*** ***Useful Inferences:*** *The Global parametrization of surfaces the parametrizations will constitute_capture the distortion metric distortion* *The the transformations will design the Global parametrization of surfaces the parametrizations* *The Global parametrization of surfaces the parametrizations will constitute the a virtual skeletal structure* ***New Idea:*** *(1) The global parameterization of a mesh may be used to calculate the isolines if the distortion is tolerable. In addition, a parameterization which makes isolines and skeletons extraction simple may be desired. (2) Non-obvious/potential similarities: The parameterization gives a 2D representation of a mesh, the isolines may be expressed in a simple manner using parameterization.*
	Robust moving least-squares fitting with sharp features (2005) ***Useful Inferences:*** *The Global parametrization of surfaces the parametrizations will use the the creation of the neighborhoods used by the moving least squares MLS computation*

	The parametrization_they will method the outlier detection *The Global parametrization of surfaces the parametrizations will classify the regions of a point set* ***New Idea:*** *(1) I think the two papers are good analogy. Sharp features or outliers may lead to large distortion in global parameterization and thus can be detected. However, this requires the input be a surface rather than point clouds. (2) Non-obvious/potential similarities: The smooth surface after MLS computation may be good for parameterization.*
Target paper:	***Making papercraft toys from meshes using strip-based approximate unfolding (2004)***
Source papers found by Dr Inventor:	***Deforming meshes that split and merge (2009)*** ***Useful Inferences:*** *The a pattern with tens of thousands of triangles will stretch the slicing* *The tracker will be the a new method for producing unfolded papercraft patterns of rounded toy animal figures from triangulated meshes by means of strip based approximation* *The the unfolded plane will use the a new method for producing unfolded papercraft patterns of rounded toy animal figures from triangulated meshes by means of strip based approximation* ***New Idea:*** *There is a good analogy between the two papers. The target paper and source paper both cut meshes in to slices. Thus, the deforming meshes technique (specifically, slicing operations) proposed in the source paper may be employed to generate papercraft toys in the target paper. In addition, the surface tracker proposed in the source paper may be adapted to the strip creation in the target paper since the strips may be found by tracking triangles. The inferences are also valuable, the isosurfaces may also be used to find strips for unfolding meshes. Both the two papers deal with operations on triangle meshes.*
	Automatic rigging and animation of 3D characters (2007) ***Useful Inferences:*** *The each part will attach the method_it* ***New Idea:*** *I think the system suggests a good analogy. The mesh processing and skeleton animation are quite different topics. However, the strip method used in the target paper may help build the correspondence between surfaces and skeletons. I think this is novel and useful analogy.*
Target paper:	***Surface compression with geometric bandelets (2005)***

Source papers found by Dr Inventor:	***Reanimating the dead (2003)*** ***Useful Inferences:*** The state of the art compression schemes will base the modeling The face will use the This new coding scheme The transform coding scheme ***New Idea:*** *There is a good analogy between the two papers. Bandelets is a general approach in representing surfaces in another basis. In the source paper, human skulls have many common features. Thus, bandelets may be used to represent them in new basis and improves the performance of reanimating.* *Non-obvious/potential similarities: Surface compression and surface representations are similar. The reanimating/reconstruction in the source paper also need to represent the surface.*
	Animating pictures with stochastic motion textures (2005) ***Useful Inferences:*** *The the corresponding basis functions will be the each layer The layers* ***New Idea:*** *I think the system suggests very good analogy. Bandelets is a general approach in representing surfaces in another basis. In the target paper, the surface is represented in multiple bandelets; while in the source paper, the image is represented in a set of layers. Thus, it may be possible to generate image layers based on the bandelets. However, it should be noted that bandelets are micro representations while the layers are macro representations.*
	Transferring color to greyscale images (2002) ***New Idea:*** *I think the connection between the two papers is the 'bandelet' method used. The 'bandelet' is from the wavelet method used a lot in image processing. Thus, it may be used in processing 2D images, like the work in the source paper. However, applying bandelet to each channel of the colored image or the original image needs further investigations.*
Target paper:	***Interactive geometry remeshing (2002)***
Source papers found by Dr Inventor:	***Real-Time subspace integration for St. Venant-Kirchhoff deformable models (2005)*** ***New Idea:*** *I think the two papers are connected since they both use some sort of dimensional reduction method (e.g. parameterization in the target paper). However, the methods used in the two papers may not be easily transferred since they deals with different objects. The remeshing is quite different from haptics or deformation.*

	Linear combination of transformations (2002) ***New Idea:*** *I think the two papers are not directly connected since the target paper focuses on remeshing and the source paper focuses on transformations. However, the idea used may be shared. The source paper proposed an easy way to implement the transformations by linear combinations. This may be used in the target paper that the uniform or ununiform remeshing may be controlled by linear combinations.*

Case Study:	*8*
Topic:	*MOTION SYNTHESIS*
Conducted by:	*Dr Zhidong Xiao (Senior Lecturer)*
Target paper:	***Rhythmic-motion synthesis based on motion-beat analysis (2003)***
Source papers found by Dr Inventor	***Suggestive contours for conveying shape (2003)*** ***Useful Inferences:*** *The an input sound signal the input sound signal will include the an algorithm* *The a novel scheme scheme scheme scheme will provide_calculate the an input sound signal the input sound signal* ***New Idea:*** *Considering the spatial-temple characteristic of the signal, the changing of curve of the line-drawing is similar to the traversing the motion transition graph. Considering the situation that some movements of characters are missing , the given suggestive sound signal could help to compensate the missing motions.*
	Learning behavior styles with inverse reinforcement learning (2010) ***Useful Inferences:*** *The a rich set of behavior variations will infer the experiment* *The a movement transition graph will describe the an adaptive process* *The a movement transition graph will show the a rich set of behavior variations* ***New Idea:*** *It is a very close analogy between the two papers and both from the same research area. The learning behaviors can be very useful to build the convincing and realistic motion transition. Transferring other characters' movement styles to the others' behaviours can be done through different signals like sound and learned behaviours.*
	Perception of perspective distortions in image-based rendering (2013)

	Useful Inferences: *The experiment will assess the an input sound signal the input sound signal The experiment will measure the magnitude* ***New Idea:*** *From the technique point of view, there is similarity between signal processing and image processing. The image can be processed from different resolution like the signal is processed from different frequency band. There is an analogy link between the two papers.*
	A fast multigrid algorithm for mesh deformation (2006) ***Useful Inferences:*** *The a novel scheme scheme scheme scheme will describe the an efficient multigrid algorithm* ***New Idea:*** *There is an analogy between those two papers. The idea of the algorithm to generate the multigrain mesh might be close to motion transitions. Styles of different data types like sound signals or motion data can be transferred between each other.*
Target paper:	***Motion synthesis from annotations (2003)***
Source papers found by Dr Inventor	***Videoscapes (2012)*** ***Useful Inferences:*** *The machine_they will use the further user studies* ***New Idea:*** *There is a strong analogy between the papers. one is applying annotation to generate smoothly motion transitions from different motion clips, and another is by analysing collections of unstructured but related video data to create a videoscape.*
	Space-time Sketching of Character Animation (2015) ***Useful Inferences:*** *The machine_they will allow the a full motion the motion of a 3 D character through projective constraints complex motions with few strokes* *The This paper will compute the a dynamic line of action DLOA* ***New Idea:*** *There is a strong analogy between the papers. one is to synthesize human motion while retaining the control of qualitative properties throughout space and time. on the other hand, the paper is to present a space-time abstraction that drive the motion of a 3D character though projective constraints.*
	Keyframe-based tracking for rotoscoping and animation (2004) ***Useful Inferences:*** *The machine_they will use the further user studies* ***New Idea:*** *There is a strong analogy between the papers. The optimisation method has been applied for developing the algorithm for solving spatial-temple concerns for the animation.*

Target paper:	***Motion graphs (2002)***
Source papers found by Dr Inventor	***Video watercolorization using bidirectional texture advection (2007)*** ***Useful Inferences:*** *The meet will simulate the a watercolor appearance* *The the video will produce the motion* ***New Idea:*** *There is an analogy between the papers. one is to abstract clip of data to build a graph for motion transition of animation, the other is to segment the input video with different quality images to produce animations.*
	Organizing heterogeneous scene collections through contextual focal points (2014) ***Useful Inferences:*** The a graph the graph will be_view the perspective The we_our will cluster the a graph the graph ***New Idea:*** *There is strong analogy between the papers. one is to abstract clips from database to build the graph, the other is apply mining to find the pattern of the scene and cluster the focal point.*
	Practical temporal consistency for image-based graphics applications (2012) ***New Idea:*** *There is an analogy between the papers. one is to analysis the motion clips and identify the characteristics of the motion. The other is to filter the input video data to recognise the patterns sequence for the final coherent output.*
	ShadowDraw (2011) ***New Idea:*** *There is strong analogy between the papers. Both focus on pattern recognitions and rebuild motion/images from the abstracted dataset. The idea from source paper proposes to match dataset data to compensate the loss or incomplete users' graphs, which will also be used for creating a new reasonable motion with different styles where the transfer motion between different styles can be automatically generated by abstracted dataset data.*
Target paper:	***Online motion synthesis using sequential Monte Carlo (2014)***
Source papers found by Dr Inventor	***Non-photorealistic camera (2004)*** ***Useful Inferences:*** *The an objective function will combine the a causal physics engine* *The parameter splines will capture the a causal physics engine* *The intensity edges the edge will feature the an objective function*

	New Idea: *There is an analogy between the papers. The idea to use multimodal and tree-based sample is similar to the method by applying multiple flashes for compositing the final rendering. Perhaps movements in real world can be modelled by depth edge detection and transferred styles into 3D certain animation motion.*
	Embedded thin shells for wrinkle simulation (2013) ***Useful Inferences:*** *The a strategy multiple different near term control strategies* *The strategies will present_simulate the high resolution surface* *The high resolution surface will wrinkle the parallel* *The a strategy multiple different near term control strategies* *The strategies will combine the high resolution thin shells* ***New Idea:*** *There is an analogy between the papers. it mainly comes from the approach of the problem solving. one is applying multimodal, tree-based sample to establish the parameter spline and another is applying C1 quadratic shape function for the algorithm development.*
	Floral diagrams and inflorescences (2005) ***New Idea:*** *The analogy between the papers. Both paper apply tree-based sample for the methodology. Generating reasonable interactive poses of objects under different circumstances is a fascinating research direction.*
Target paper:	***A deep learning framework for character motion synthesis and editing (2016)***
Source papers found by Dr Inventor	***Motion graphs (2002)*** ***Useful Inferences:*** *The network will extract the a graph the graph* *The our_we will construct the a graph the graph* *The network will walk the meet* ***New Idea:*** *There is a strong analogy between the papers. Both use large database and applying for character motion synthesis. The method in target paper automatically generating trajectories in motion graphs that could be used in the target paper 'deep learning' which will contribute to the training.*
	Inverse shade trees for non-parametric material representation and editing (2006) ***Useful Inferences:*** *The our_we will demonstrate the every type of shade tree* *The animator will estimate the leave* ***New Idea:*** *The analogy between the papers. Both papers apply dataset for further understanding of the individual characteristics representation and final editing. The editability proposed by two papers is the trend for further research.*

	Weighted averages on surfaces (2013) ***Useful Inferences:*** *The network will consider the the problem of generalizing affine combinations in Euclidean spaces to triangle meshes both the forward problem the forward problem* *The network will address_compute the averages of points on surfaces* ***New Idea:*** *There might be analogy between the paper in terms of control/transfer the parameters. The idea of transferring part of object into different styles like texture or motion under user interactions is the common key idea of both two papers.*

Case Study:	*9*
Topic:	*PHYSICS-BASED DEFORMATION*
Conducted by:	*Kun Qian (PhD Student)*
Target paper:	***Continuous capture of skin deformation (2003)***
Source papers found by Dr Inventor	***Shadow matting and compositing (2003)*** ***Useful Inferences:*** *The geometry will cast the object* ***New Idea:*** *The target paper provides a simple mechanism for solving the problems of view aggregation, occlusion handling, holling, noise removal, and deformation modeling, which can give a new idea to the source paper when deform the shadow in a new scene by taking into consideration of the above factors.*
	Blister: GPU-based rendering of Boolean combinations of free-form triangulated shapes (2005) ***Useful Inferences:*** *The depth will peel the capability* ***New Idea:*** *The boolean surface operation in the source paper can provide a good idea for the target paper when fill holes and reconstruct the surface.*
	Keyframe control of smoke simulations (2003) ***New Idea:*** *The source paper solve the problem by splitting large problems into smaller over-lapping subproblem. This idea can also be used in capture motion and reconstruct character model by dissecting the capture region into small regions.*
Target paper:	***Real-time large-deformation substructuring (2011)***
Source papers found by Dr Inventor	***Directable, high-resolution simulation of fire on the GPU (2009)*** ***Useful Inferences:*** *The timestep will utilize the deformation* *The The physical criteria will enforce the deformation* *The timestep will take the advantage* ***New Idea:*** *The simulation of fire in the source paper can also use*

	the hierarchy idea to render fire in different region in different resolution.
	Group motion editing (2008) ***New Idea:*** *The sub-region idea in the target paper can be used to classify the crowd animation into different groups.*
Target paper:	***Articulated body deformation from range scan data (2002)***
Source papers found by Dr Inventor	***How do humans sketch objects? (2012)*** ***Useful Inferences:*** *The our_we will analyze the the distribution of non expert sketches of everyday objects such as teapot or car* ***New Idea:*** *The hierarchy sub-domain idea in the target paper can provide a innovative idea to the source paper. The sketch detection can also be performed in muti-level and sub-domain fasion.*
	Wavelet importance sampling (2005) ***Useful Inferences:*** *The a parameterization of all the scans using a posable subdivision surface template will match the the wavelet representation* ***New Idea:*** *The importance sampling idea can be used to determine and classify the sub-region in the target paper.*
Target paper:	***Controllable conformal maps for shape deformation and interpolation (2010)***
Source papers found by Dr Inventor	***Embedded thin shells for wrinkle simulation (2013)*** ***Useful Inferences:*** *The shear will use the quadratic shape functions* ***New Idea:*** *The Conformal Maps method in the target paper can be directly used in the source paper when computing the relation between the coarse cage and embedding thin shell.*
	An L1 Image Transform for Edge-preserving Smoothing and Scene-level Intrinsic Decomposition (2015) ***New Idea:*** *The image transform method in the source paper can combine the conformal mapping method to generate more interesting effect. Also, transforming the source paper method into target paper can preserve geometry local details.*
Target paper:	***Semantic Shape Editing Using Deformation Handles (2015)***
Source papers found by Dr Inventor	***Beady: Interactive Beadwork Design and Construction (2012)*** ***Useful Inferences:*** *The a set of semantic attributes a large set of pairwise comparisons between the semantic attributes and geometry a set of user studies will construct the the user* ***New Idea:*** *The process of adjusting edge lengths by considering*

	the physical constraints among neighboring beads in the source paper can combine the semantic idea in the target paper to make the adjusting more semantical based.
	Real-time Eulerian water simulation using a restricted tall cell grid (2011) ***Useful Inferences:*** *The method on large datasets using two different user interaction modes will allow the real time simulations of large scale three dimensional liquids* ***New Idea:*** *The semantic driven deformation in the target paper can provide a good idea for the source paper when generating semantically based structure of grid for fluid simulation.*
Target paper:	***Image deformation using moving least squares (2006)***
Source papers found by Dr Inventor	***Thin skin elastodynamics (2013)*** ***Useful Inferences:*** *The an image deformation method will be_simulate the fast deformations* *The fast deformations will work the the surface* *The the impression of manipulating real world objects will simulate the fast deformations* ***New Idea:*** *The semantic attribute collect idea in the target paper can be applied to the source paper to generate more semantically based feature when correct raw stretch input.*
	Lapped solid textures (2008) ***Useful Inferences:*** *The method on large datasets using two different user interaction modes will allow the real time simulations of large scale three dimensional liquids* ***New Idea:*** *The filling process in the source paper can be combined with the target paper to make the texture filling conform to the mesh surface well by adjusting the filling using handle based deformation.*

Case Study:	*10*
Topic:	*CLOTH SIMULATION*
Conducted by:	*Tao Jiang (PhD Student)*
Target paper:	***Untangling cloth (2003)***
Source papers found by Dr Inventor	***Piko: A Framework for Authoring Programmable Graphics Pipelines (2015)*** ***Useful Inferences:***

	The This paper will present the a history free cloth collision response algorithm The algorithm ***New Idea:*** *The source paper proposed a programmable graphic pipeline, allowing programmers to build load-balanced parallel pipeline implementations, to exploit spatial and producer-consumer locality in a pipeline implementation. The exploitation of spatial and producer-consumer locality share the same idea of the target paper which mentioned history based collision detection. The source paper and target paper both want to narrow the searching scope for the target. The spatial locality search idea is good and can be exchanged between those papers.*
	Upright orientation of man-made objects (2008) ***Useful Inferences:*** *The This paper will introduce the set* *The tangle_that will use the function* ***New Idea:*** *The source paper infer object's upright orientation by analyzing its geometry, which introduce a set of discriminative attributes linking shape to function and earn an assessment function of these attributes from a training set. Such discriminative attributes linking shape to function can be useful when perform the collision detection task in the target paper. Apply shape function to collision can significantly accelerate the collision detection phase because of its simple intersection test cost.*
	Scene completion using millions of photographs (2007) ***Useful Inferences:*** *This paper will demonstrate the superiority of our algorithm over existing image completion approaches* ***New Idea:*** *The source proposed a data-driven image completion method. The data-driven idea in the source paper can be useful in the target paper. Combine data driven technique with collision detection, can significantly improve the performance of collision detection because the possible collision tests have already been trained in the dataset. The training of collision detection dataset is similar to the image data set in the source paper. When perform the collision detection, it can dive into the dataset to find similar collision situation and provide plausible response.*
Target paper:	***A deformation transformer for real-time cloth animation (2010)***
Source papers found by Dr Inventor	***Physical face cloning (2012)*** ***Useful Inferences:*** *The transformation will capture the D facial expressions for a*

	given target subject the target expressions *The transformation will use the simulation* *The transformation will demonstrate the this computational skin design* ***New Idea:*** *The source paper presents a novel optimization scheme that determines the shape of the synthetic skin as well as the actuation parameters that provide the best match to the target expressions. The target paper can also consider the similar optimization that match the low resolution cloth simulation to the high resolution training data set result.*
	Perceptually Based Downscaling of Images (2015) ***New Idea:*** *The source paper proposes a perceptually based method for downscaling images which formulate image downscaling as an optimization problem where the difference between the input and output images is measured using a widely adopted perceptual image quality metric. Such idea can be applied to the target paper perform the matching between the low resolution simulation cloth and the high level detailed model in training set. The downscale idea can be used to improve the accuracy of transformation between low-quality simulated deformations and high-resolution cloth deformations with dynamically introduced fine details.*
Target paper:	***Physics-inspired upsampling for cloth simulation in games (2011)***
Source papers found by Dr Inventor	***Invertible motion blur in video (2009)*** ***New Idea:*** *The source paper proposed an invertible motion blur technique which can remove the motion blur effect caused by hardware device. The source paper address the problem of automatic deblurring of objects moving with constant velocity by solving the four critical components: preservation of all spatial frequencies, segmentation of moving parts, motion estimation of moving parts, and non-degradation of the static parts of the scene. Such idea of deblurring is actually a process of removing noise. In the target paper, the motion matching between low resolution simulation mesh and high resolution pair also has noise. So the deblurring technique can be applied to the target paper to preserve more physical details of the high resolution pair.*
	Perceptually Based Downscaling of Images (2015) ***New Idea:*** *The source paper proposes a perceptually based method for downscaling images which formulate image downscaling as an optimization problem where the difference between the input and output images is measured using a widely adopted perceptual image quality metric. Such idea can*

	be applied to the target paper perform the matching between the low resolution simulation cloth and the high level detailed model in training set. The downscale idea can be used to improve the accuracy of transformation between low-quality simulated deformations and high-resolution cloth deformations with dynamically introduced fine details.
	A theory of locally low dimensional light transport (2007) ***New Idea:*** *The source paper proposed a theory of locally low dimensional light transport. The reason to use low dimension is to use the low dimensional representation to approximate the original object to save computation time. Such idea can be also applied to the target paper by attaching priorities to different regions of the simulated object. Higher accuracy should be achieved for high priority areas when perform the upsampling between the low resolution object and high resolution pair.*
Target paper:	***Robust treatment of collisions, contact and friction for cloth animation (2002)***
Source papers found by Dr Inventor	***Lagrangian vortex sheets for animating fluids (2012)*** ***Useful Inferences:*** *The dynamics will cause the obstacle interaction The we_our will propose the any technique for simulating the internal dynamics of the cloth* ***New Idea:*** *The target paper and source paper share some resemblances. The source paper demonstrates a re-sampling scheme to remove surfaces that are hidden inside the bulk volume. In this way it is able to achieve highly detailed simulations of turbulent plumes efficiently. In the target paper, they show how their simulation data can be post-processed with a collision-aware subdivision scheme to produce smooth and interference free data for rendering. Their goal are the same: better rendering result.*
	Controlling Procedural Modeling Programs with Stochastically-ordered Sequential Monte Carlo (2015) ***New Idea:*** *The source paper viewing a procedural model as sampling from a probability distribution allows for the application of Bayesian inference techniques: the prior is the procedural model itself, and the likelihood is some high-level control expressed as a scoring function. Treating collision detection as a probability distribution problem play the same role as the collision history in the target paper. The target paper can also apply probability distribution techniques and design useful scoring function to predict collision.*
Target paper:	***Data-driven elastic models for cloth (2011)***

Source papers found by Dr Inventor	***3DFlow: Continuous Summarization of Mesh Editing Workflows (2015)*** ***Useful Inferences:*** *The techniques a data driven technique new measurement techniques for studying the elastic deformations for both stretching and bending in real cloth samples will take_output the visualization* *The elastic models with manually selected stiffness parameters a elastic model will be_allow the artist* *The techniques a data driven technique new measurement techniques for studying the elastic deformations for both stretching and bending in real cloth samples will require_mesh the snapshot_their* ***New Idea:*** *The source paper proposed 3DFlow, an algorithm that computes continuous summarizations of mesh editing workflows. The output of the workflow can be enhanced using the target papers' data driven method. The training data can be setup using the target paper's easy and inexpensive way which test simple object's physical property. Such data driven enhanced workflow visualization can produce more realistic result.*
	Physically based modeling and animation of fire (2002) ***Useful Inferences:*** *The elastic models with manually selected stiffness parameters a elastic model will allow the most materials* ***New Idea:*** *The source paper proposed an invertible motion blur technique which can remove the motion blur effect caused by hardware device. The source paper address the problem of automatic deblurring of objects moving with constant velocity by solving the four critical components: preservation of all spatial frequencies, segmentation of moving parts, motion estimation of moving parts, and non-degradation of the static parts of the scene. Such idea of deblurring is actually a process of removing noise. In the target paper, the motion matching between low resolution simulation mesh and high resolution pair also has noise. So the deblurring technique can be applied to the target paper to preserve more physical details of the high resolution pair.*

Case Study:	*11*
Topic:	*SKETCH-BASED MODELING*
Conducted by:	*Li Wang (PhD Student)*
Target paper:	***A sketch-based interface for detail-preserving mesh editing***

	(2005)
Source papers found by Dr Inventor	***Image-based rendering for scenes with reflections (2012)*** ***New Idea:*** *The source paper presents a system for image-based modeling and rendering of real-world scenes containing reflective and glossy surfaces. The source paper implement view interpolation using ma multiple layers that are combined in an additive fashion. Such multiple layer idea can be applied to sketch based shape editing. Perform editing in multiple layer is a new idea in this area.*
	Precomputed local radiance transfer for real-time lighting design (2005) ***New Idea:*** *The source paper introduces an method for real-time relighting of scenes illuminated by local light sources. They use use simplification of lights, and clustered PCA to obtain a compressed representation of light. Such technique can be applied to extract the compressed representation of the user sketch in the target paper. User's sketch may vary a lot. So the cluster PCA is useful in this process.*
Target paper:	***Learning to simplify: fully convolutional networks for rough sketch cleanup (2016)***
Source papers found by Dr Inventor	***Cardinality-constrained texture filtering(2013)*** ***New Idea:*** *The source paper presents a method to create high-quality sampling filters by combining a prescribed number of texels from several resolutions in a mipmap. The target paper proposed a novel technique to simplify sketch drawings based on learning a series of convolution operators. The source paper may provide an innovative idea to perform the target paper's task in a LOD style. The convolution operators learned in the target paper can be learned from the mipmaps of different resolution in the source paper, which can be quite efficient for operator learning using low resolution mipmaps. This multi-resolution operators can provide more choices for users to generate user specific effect.*
	Embedded thin shells for wrinkle simulation (2013) ***New Idea:*** *The combination of the ideas from the source paper and target paper can generate interesting effect. The source paper applies frequency based wrinkles onto coarse lattice controlled deformable thin shell, which is actually a post processing mesh operation. Such post processing mesh operation can be used in the target paper when learning the convolution operators. The trained convolution operators can then differentiate user specific details and decide filter them or not. The combination of both method can generate a user specific and stylized sketch generation system.*

Target paper:	***Sketch-based shape retrieval (2012)***
Source papers found by Dr Inventor	***Time-varying surface appearance (2006)*** ***New Idea:*** *The source paper time varying surface appearance rendering method. The source paper relies on a time-varying data base and derive overall temporal appearance variation characteristic curve of the specific process. The time vary concept can be useful for the target paper. In the target paper, it needs huge amount of sketch training data. By taking into consideration of the time varying factor feature of sketch, it may generate more meaningful result because the sketch is a time varying process, which contains lots of useful geometry information.*
	Shading-based Refinement on Volumetric Signed Distance Functions (2015) ***New Idea:*** *The target paper is about sketch based shape retrieval. The source paper focus on shading based refinement. The techniques in both paper can be combined to generate sketch based shape but with fine details on the shape surface. The details on the shape surface can come from image. The shading based refinement can be used as a second pass to the sketch based shape retrieval, making it more realistic.*
Target paper:	***How do humans sketch objects? (2012)***
Source papers found by Dr Inventor	***Transient attributes for high-level understanding and editing of outdoor scenes (2014)*** ***New Idea:*** *The source paper study "transient scene attributes" – high level properties which affect scene appearance. The transient scene attribute can be a novel idea in the reorganization of human sketch. By taking into consideration of the transient attribute, the recognition process can be more accurate by using different sketch of the same object made by the same person. By analyzing the transient attribute of those sketches, more features will be added to the process of recognition.*
	Fluid Volume Modeling from Sparse Multi-view Images by Appearance Transfer (2015) ***New Idea:*** *The source paper proposed a method of modeling volumetric fluid phenomena from sparse multi-view images. Such modeling concept can be extended to the sketch recognition process. Instead of analyzing 2D sketch, approximated or trained transformation can be applied to the 2D sketch and turn it into other view. Then analyze the 2D sketch in multi-view is possible, which can add more features to the recognition process to reduce errors.*

Target paper:	***Image-based tree modeling (2007)***
Source papers found by Dr Inventor	***All-frequency interactive relighting of translucent objects with single and multiple scattering (2005)*** ***New Idea:*** *The target paper proposes an approach for generating 3D models of natural-looking trees from images They use the shape patterns of visible branches to predict those of obscured branches. Such shape pattern based prediction can be used to the translucency approximation in the translucent object rendering in the source paper.*
	Putting holes in holey geometry (2013) ***New Idea:*** *The target paper proposes an approach for generating 3D models of natural-looking trees from images They use the shape patterns of visible branches to predict those of obscured branches. Such shape pattern based prediction can be used to provide a prediction mechanism for the topology change of same pattern geometry. That is to say using similar topology change strategy for similar pattern geometry which can save a lot of computation time.*

Case Study:	*12 (USER A)*
Topic:	*FLUID SIMULATION*
Conducted by:	*Richard Southern (Senior Lecture)*
Target paper:	***Matching fluid simulation elements to surface geometry and topology (2010)***
Source papers found by Dr Inventor	***Adaptive image synthesis for compressive displays (2013)*** ***Useful Inferences:*** *The Recent years will generate the the Voronoi diagram of a potentially unorganized collection of pressure samples* ***New Idea:*** *The application of an adaptive optimization method based on Voronoi diagrams looks directly applicable, although possibly relatively small research outcome.*
	Cubic mean value coordinates (2013) ***New Idea:*** *The application of mean value deformation / interpolation methods to fluid boundary extraction sounds like something that should be explored (if it has not already). However I would add that this sort of analogy could be described as obvious.*
	All-frequency interactive relighting of translucent objects with single and multiple scattering (2005) ***New Idea:*** *The connection here is between sampling methods*

	from rendering and the sampling method for the fluid boundary mesh. Exploring the broader area of sampling when applied to the boundary method seems plausible, although I'm not convinced that the referenced sampling method is the most appropriate.

Case Study:	*12 (USER B)*
Topic:	*FLUID SIMULATION*
Conducted by:	*Min Jiang (PhD Student)*
Target paper:	***Fluid animation with dynamic meshes (2006)***
Source papers found by Dr Inventor	***Line drawings via abstracted shading (2007)*** ***New Idea:*** *Both the target and source paper share the same idea. The target paper focuses on computation in the visually important parts of the simulation domain. The source paper focused the computation on the tone boundaries or thin dark areas. Using the method in the source paper, a tone shading region can be extracted. Such kind of region extracting technique can be used as the visually important area in the target paper and generate some interesting effect.*
	Jigsaw image mosaics (2002) ***New Idea:*** *The source paper fills an arbitrary shape image with arbitrarily-shaped image tiles. This packing problem is solved by minimizing a mosaicing energy function. This idea can be extended to the re-mesh area. In the target paper, the shape of the object can also be filled with certain types of tetrahedral element or other forms of elements by minimizing similar mosaicking function.*
Target paper:	***Two-scale particle simulation (2011)***
Source papers found by Dr Inventor	***Wavelet importance sampling (2005)*** ***New Idea:*** *The target paper proposed a two scale fluid simulation, which allocates computing resources to regions of the fluid where complex flow behavior emerges. The source proposed a novel hierarchical importance sample warping algorithm that generates high-quality point distributions. Such hierarchical importance sampling can be used to generate an importance area distribution, which can be used to determine the importance area for simulation in the target paper.*
	Fast exact and approximate geodesics on meshes (2005) ***New Idea:*** *The source paper focus on fast exact and approximate geodesics on meshes. If apply the idea of the target paper to the source paper, the geodesic distance computation on the meshes can be computed in two-scale. For the high detail area, more computational resources can be used. For the less*

	important area, coarse geodesic distance can be computed.
Target paper:	***Modular bases for fluid dynamics (2009)***
Source papers found by Dr Inventor	***Augmented MPM for phase-change and varied materials (2014)*** ***New Idea:*** *The target paper a new approach to fluid simulation that balances the speed of model reduction with the flexibility of grid-based methods. This method is suitable for the grid based simulation such as the MPM in the source paper. The MPM simulation can also utilize similar idea which constructs a set of compostable reduced models, or tiles, which capture spatially localized material behavior.*
	Keyframe control of smoke simulations (2003) ***New Idea:*** *The source paper describe a key frame based smoke control method which formulates an objective function corresponding to how well a simulation matches the user's keyframes. The corner stone of this approach is a method to efficiently compute exact derivatives through the steps of fluid simulation. Such exact derivative computation idea can be applied to the target paper. When making model reduction in the target paper, the important area can use exact derivative computation to increase accuracy and make the simulation more guidable.*
Target paper:	***Subspace fluid re-simulation (2013)***
Source papers found by Dr Inventor	***Suggestive contours for conveying shape (2003)*** ***New Idea:*** *The target paper proposed an idea of re-simulation when there is a need of subtracting dynamics from an existing high-resolution fluid simulation. If use the source paper's technique in the image processing software, such as photoshop, dynamic showing of suggestive contours with user input is challenging. When the object is occluded by object, the suggestive curve cannot well represent the shape of the object. The re-simulation idea can be applied to such situation. When object is occluded by user draw object, subtracting this area and discover a efficient reduced approximation to re-represent the suggestive contours.*
	Learning behavior styles with inverse reinforcement learning (2010) ***New Idea:*** *The source paper presented a method for inferring the behavior styles of character controllers from a small set of examples. It designs a reward function in the reinforcement learning framework, and show that the discovered reward function can be applied to different environments and scenario. This idea can also be extended to the target paper, when subtracting certain area from the high*

	resolution simulation, a reinforcement learning framework can also be created and the reward function can infer surrounding behavior of particle. This can provide useful information for re-simulation.
Target paper:	***Animating sand as a fluid (2005)***
Source papers found by Dr Inventor	***How do humans sketch objects? (2012)*** ***New Idea:*** *The combination of the target paper and source paper can generate a new idea: sketch driven simulation. The target paper abstract away the individual grains and think of the sand as a continuum. By taking into consideration of the sketch input, the area covered by the sketch can be treated as a continuum body. The rest of the object can flow the guidance of the movement of sketch.*
	Triangle surfaces with discrete equivalence classes (2010) ***New Idea:*** *The source proposes a technique that takes a triangulated surface as input and outputs a surface with the same topology but altered geometry such that each polygon falls into a set of discrete equivalence classes. They begin by describing an error function that measures how close the polygons are to satisfying these criteria. This pre-computation for clustering similar polygons can provide a good idea of cluster the simulation sand into different continuum objects. The output of each cluster also fall into a set of discrete equivalence classes. This is similar to the example based simulation. The simulated object will be moving towards the guided or example results. This idea will generate user-specified simulation results.*

Case Study:	*13*
Topic:	*DEFORMATION*
Conducted by:	*Jian Chang (Associate Professor)*
Target paper:	***Volume conserving finite element simulations of deformable models (2007)***
Source papers found by Dr Inventor	***Computational Hydrographic Printing (2015)*** ***Useful Inferences:*** *The issues in enforcing multiple possibly conflicting constraints will use the variety* *The the difficulty of handling complex surfaces will handle the errors in volume* ***New Idea:*** *It is possible to apply deformation and texture mapping for manufacturing as demonstrated in the targeted paper.*
	Suggestive contours for conveying shape (2003)

	New Idea: *Yes. The suggestive contour line may be important in studying deformation and could improve the result of target paper.*
	A meshless hierarchical representation for light transport (2008) ***Useful Inferences:*** *The oscillation will induce the data approximation* ***New Idea:*** *Source paper present a hierarchical function basis induced by 'scattered data approximation'. Such Hierarchical representation to accelerate deformation computation. Light transportation vs. incompressibility*
Target paper:	***Animating deformable objects using sparse spacetime constraints (2014)***
Source papers found by Dr Inventor	***Color images visible under UV light (2007)*** ***New Idea:*** *Superimpose light of fluorescent ink to create new picture will analogy to impose a new phase of deformation to create new dynamic behavior.*
	Simulating biped behaviors from human motion data (2007) ***New Idea:*** *Measure the physically-feasibility to improve the deformation modelling.*
Target paper:	***Interactive editing of deformable simulations (2012)***
Source papers found by Dr Inventor	***Toward evaluating material design interface paradigms for novice users (2010)*** ***New Idea:*** *Dynamic data structure for deformation computing is useful of target paper.*

Case Study:	*14*
Topic:	*LOCOMOTION*
Conducted by:	*Gabriel Notman (PhD Student)*
Target paper:	***Generalizing Locomotion Style to New Animals With Inverse Optimal Regression (2014)***
Source papers found by Dr Inventor	***Data-Driven Modeling of Skin and Muscle Deformation (2008)*** ***New Idea:*** *The source paper also uses a data-driven approach to synthesizing a component of the animation (specifically the secondary motion and deformation of the actor's skin and muscles). The methods used here may also be beneficial to the problem addressed in the target paper.*

Appendix 2. Modelling and Simulation of Lily flowers using ODE Sweeping Surfaces (Paper)

Appendix 3. Dr Inventor's System Usability Questionnaires

Evaluate Dr Inventor's Usability

Rate the Dr Inventor System from 1 to 5 in the following: (where 5 is high)

	Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
The software perform the intended tasks.	○	○	○	○	○
The functionalities involved in the system are sufficient.	○	○	○	○	○
The system is able to give expected results.	○	○	○	○	○
The system interacts quickly.	○	○	○	○	○
I can comprehend and learn to use the system easily.	○	○	○	○	○
The interface looks good & provides all required information.	○	○	○	○	○
Usage of the system is intuitive.	○	○	○	○	○
The software is capable of handling errors.	○	○	○	○	○

Do you know of other similar tools to Dr Inventor? If so, please specify:

Your answer

Please give general feedback and suggestions about the Dr Inventor System

Your answer

Do Not Edit these Fields. For Internal Use Only.

Your answer

SUBMIT

Never submit passwords through Google Forms.