DEVELOPMENT OF A LOW-COST INTERACTIVE GRAPHICAL TACTILE DISPLAY CAPABLE OF DISPLAYING TEXTUAL AND GRAPHICAL INFORMATION AS ADVANCED USER INTERFACE FOR THE VISUALLY IMPAIRED

Berichterstattung

Projektinformationen

TACMON

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Projektwebsite

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Final Report Summary - TACMON (DEVELOPMENT OF A LOW-COST INTERACTIVE GRAPHICAL TACTILE DISPLAY CAPABLE OF DISPLAYING TEXTUAL AND GRAPHICAL INFORMATION AS ADVANCED USER INTERFACE FOR THE VISUALLY IMPAIRED)

Executive Summary:

The main focus of the TACMON project was technological development with the objective to enable the realization of low-cost large-area tactile displays. The innovative TACMON technology is based on an electrostatic-pneumatic-hybrid concept realized with high-end Micro-Electro-Mechanical-System (MEMS) technologies in combination with conductive elastomer technologies. The MEMS technologies enable to produce a large matrix of tactile dots using cost-effective bath-processing technologies. The pneumatic support is used to achieve the required rise and keep up forces for the tactile dots.

The TACMON concept required the highly interdisciplinary cooperation of 16 partners. The system specification has been agreed in detail based on the expertise of the consortium partners, as well as on a thorough market survey and discussions with experts in the field both from an end user and a technological point of view.

The TACMON system consists of three main modules, the novel tactile actuator chip with a matrix of actuator dots, the dot driver electronics including supportive high voltage electronics, and the pneumatic support system. The hardware development was backed-up with appropriate software development.

For the end user validation and demonstration activities 5 integrated prototypes have been built up with the display size of 8x12 dots achieving with reproducible functionality the most important specifications set at the beginning of the project featuring >0.5 mm off-plane amplitude and up to 0.25 N keep up force for the dots. The demonstration of the prototype can be seen on a video available on the project homepage.

Beside the hardware support software also a TACMON training application has been developed in order to make end users familiar with the concept of a graphical tactile display. A significant part of the software development was dedicated to support the future exploitation of this novel technology by developing a software module specifically supporting the graphical nature of the proposed product. The specifications for this module were specified in synergy with associated parallel running projects, such as HyperBraille (www.hyperbraille.de). Within TACMON a universal image conversion module has been developed with the aim to convert different charts and maps containing mixed textual and graphical content into tactile perceivable format. The developed algorithm is able to convert with a success rate of about 90%. The partners intend to further develop and exploit this algorithm also as a standalone software, as its output can also be used for the preparation of paper based tactile Braille documents.

The TACMON project successfully finished with a small scale functional prototype demonstrating the

viability of the actuator technology as well as of the technologies required for scale-up. A modular set-up has been realized by the assembly of 6 4x4 dot prototype chips forming an 8x12 dot combined matrix.

The result owner established a start-up company (TACMONCO Ldt.) holding the jointly owned TACMON IPR as a common platform for the further development and market introduction of the TACMON technology. The current technology enables already a significant cost advantage (factor 4) compared to state-of-the-art, but the consortium is eager to further develop the technology to further decrease the costs to be able to market graphical tactile displays at a comparable prise to current Braille display lines which would make it accessible to a larger market segment.
Project Context and Objectives:
The aim of the TACMON project is to increase SME competitive advantage in the special needs sector by offering an innovative and cost-effective technology to help the visually impaired to have access to graphical and text-oriented information.

There are 12 million visually impaired people in the European Union. High unemployment amongst the disabled is a serious social and economic problem for the EU, as continued exclusion from productive activity requires increasing state-funded support for social programs. There is a need for effective assistive technology to facilitate employment of the visually impaired and for industry to better be able to meet anti-discrimination legislation.

The main scientific/technical objective of TACMON was to develop an innovative and cost-effective, MEMS-based (Micro Electro-Mechanical System) tactile display technology that can provide the visually impaired with interactive access to both textual and graphically-oriented electronic information.

The main objective of this project is to develop a technology enabling the realization of an Interactive Graphical Tactile Display as a computer periphery, by realizing a matrix of electronically refreshable tactile dots making electronic textual and graphically-oriented information accessible for the human touch sense on a dynamically reusable surface.

The scientific objective of this proposal is to develop a novel combination of approved MEMS actuator technologies for the realization of large area interactive tactile displays. The objective of the proposed combination is to achieve off-plane displacement amplitudes perceivable statically by touch (> 0.5 mm) using cost-effective MEMS and polymer MEMS production technologies.

The TACMON technology is intended -

+ to provide a replacement for the common visual screen for the visually impaired in a design similar to a digitizer board, featuring a USB interface using a standard interface.
+ to enable graphical tactile displays able to display multi-line text in Braille as well as simplified images and diagrams.
+ to be demonstrated with prototype matrix size of 8x12 dots.
+ to be compatible with current Braille text display lines, setting the minimal requirements to a dot spacing of 2.54 mm (1/10 inch).
+ to achieve a targeted off-plane displacement of more than 0.5 mm.

+ to achieve a cost price target of around 1500 Euros for a matrix size corresponding to A6 paper size, featuring approximately 60 x 40 dots in standard Braille dot-density.

The research and development work of the TACMON technology, including scientific and operational methodologies, which were defined by distinct Tasks grouped in Workpackages, and addressed the required technological development steps and the functional needs of the project in terms of market research, validation, dissemination, training and exploitation.

Project Results:
An overview of the main scientific and technological results is presented below connected to the to the single modules of the developed TACMON technology.

>> MEMS chip with membrane used for actuating the tactile pins
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The MEMS tactile actuator chips are the most innovative part of the TACMON concept and can be considered as the key TACON technology. Currently a patent is pending to protect this part of the results which can be considered as the core of the TACMON technology. Even though most resources were dedicated to the research on this part only a short overview can be presented to the public now.
The TACMON actuator concept uses a common external pneumatic pressure as supportive force to achieve the desired displacement and force, while electrostatic clamping is used to individually control the state-of-the single actuator dots. The tactile actuator chip is built on a micro structured silicon substrate combined with conductive elastomer realizing macroscopic actuators.
The core MEMS technology was first proven at laboratory scale with small sized prototypes, focusing the resources to the improvement of fabrication technologies. After successfully improving the yield and fabrication process of the chip assembly, and achieving reproducible functionality the research was focused on scaling up issues to open the way for the realization of large area low-cost graphical tactile displays. The project ended successfully with the realization of 8 x 12 dot sized integrated prototypes realized by the seamless integration of 6 individual actuator chips. The process of the fabrication was supported by a new auto-alignment method for the assembly of the 4 x 4 dot prototype actuator chips which were used to build up the 8x12 dots display setup. In future it is planned to increase the size of the single chip modules to 10x10 dots and to realize a large-area 80x120 dot display setup.

>> Multichip assembly and chip holder with electrical connection between the chip and electronics
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To deal with the modular scale-up issues a multi-chip setup has been realized. The final design and procedure of a multichip assembly were developed that includes six 4x4 dot chips that are split in two rows, forming thus a matrix of 8 x 12 pins with a total of 96 Braille pins. Special care was taken in obtaining a good pneumatic sealing while keeping proper electrical contacts with the gap less assembled chips. Under the tactile surface there is a sandwich structure which contains the movable tactile pins, the actuator chips, the electrical connection support layer, the electrical connection printed circuit board and pneumatic connection base-plate. The movable tactile pins are same as pins used in state-of-art METEC actuators. The alignment of the pins is ensured by an top-plate with through-holes for the pins and screws for the proper fixation. The following layer is the electrical connection layer with the pogo-pins where the control electronics is connected to the chips. An intermediate clamping system was added between the

chips and electrical connector printed circuit board, called pogo pin connection. Each pogo-pin is touching the chip surface and pushing it with a light force on one side while the other side the pin is touching the golden pad of the printed circuit board that is wired out to the ribbon cable connector. Finally, a machined block of aluminum that contains a pit for each chip and a hole for the pressure connector is at the bottom of the sandwich structure, called base-plate. The chips are sealed leak tight to the block by an O ring and by the precise placement next to each other. This mounting block also contains mounting holes and alignment pins for the pogo-pin plastic piece that holds the chip down. At the side of the base-plate there is a connection point for the pump unit. When applying pressure from the pump unit the pins are come out except those which are clamped with the electronics by high voltage.

>> Tri-state multichannel switching circuit for individual dot actuation and matrix drive
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The individual control of 96 dots is handled by four stacked up dot-driver electronics. Each of them has 24 channels and a controller on board that is connected to the master controller within the system. The on-board controller can store the display data and handle the control individually; however the present version is working in latch mode which means a converting function between serial communication and channel control. Since the driving channels have equal properties without dedicated channel purposes the dot driver electronics can also be used for passive capacitive matrix drive which was the research focus in the last project year to achieve further cost and size reduction for the scale up.
One dot driver channel realizes a decoupled current limited tri-state switching channel. There are three output values: high, logic low and high impedance when the output is floating. The voltage rating of the final version's channels is 500Vdc and the switching time is less than 1 ms. Special care was taken during the design and development in order to minimize the size of the electronics. Due to the high voltage range the applied switching transistors of the channels are through-hole devices with significant physical size. The finally results imply that the driving voltage can be kept below 300V, which would allow to use smaller transistors or even ASIC components to achieve significant savings in cost and build space.

>> Power supply with simplified voltage regulator circuit

The power supply had the most versions besides the dot driver unit due to the large variation in required voltage range during the research on the actuator chips technology. In time series: a linear transformer based power supply, a switching power supply, a voltage multiplier, and an integrated power supply were developed, fabricated and tested. The challenge in the power supply development was the balance in size, weight and voltage amplitude. During the development there were versions for +/-250Vdc, +/-800Vdc, +/-600Vdc, +1200Vdc, and finally +400Vdc which is the integrated power supply in the final system. The voltage output of the power supply in each version was connected to the custom designed voltage regulator which is a simple, , low-cost, discretely built high voltage regulator with limited number of components and optimized for pricking power consumption that raising when the channels are changing their states. The final version is an integrated and compact power supply capable of regulating its output between 0 and 400Vdc with the maximum power of 40W. The regulator has a charger and a discharger branch that regulates the voltage on the output capacitor. The accuracy of the regulation has 1-5% voltage oscillation that depends on the desired voltage level. At higher levels the performance is better due to the smaller difference between the source and the regulated voltage level. The ripple on the regulated output is less than 1% at the maximum of the range.

>> Controller unit and distributed control method for larger area displays

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The control unit itself is a general purpose controller board with connections to the most of the peripherals of the applied microcontroller supplemented with an USB emulated serial communication port. The main result in this topic, on the one hand is the controller board together with the control firmware that can be used for either controlling the TACMON device or emulating the TACMON device as it is connected to the PC. For the emulation only the controller should be used facilitating the software developers' work.
On the other hand, a distributed control method was developed for larger area matrix control and test software for matrix drive control. The distributed control is a double handshake communication with master slave relation that is developed for the 96 dots. The slaves are the on-board controllers on the dot driver electronics. They receive the addressed packet from the master and handle the dot control individually, so the master does not spend process time by calculation and conversion of byte data to the bitmap of the dots but handles higher level processes, like PC communication pump control etc.
The firmware of the slaves can be used for the matrix drive control as well. PC software was developed to upload the byte data to the slaves that converts it to bitmap arrays. The controller than rotates the bitmap arrays cyclically by adjustable time base. With this test software the passive matrix drive can be optimized to the tactile matrix area and to the chip properties.

>> Pneumatic pump unit

The pneumatic unit is used for applying pressure to the system, making the membrane inflate and the pin lift; afterwards, the pneumatic system provides a negative pressure to support the activation of the electrostatic clamping of the selected membranes/pin. The concept of the pneumatic support system is the use of a closed pneumatic system with an actuated volume changing part, for which a two way pneumatic cylinder was used.
From the functional point of view, the unit meets the following requirements:
i) Refreshing time: cycle for a pressure/vacuum loop with 1 seconds each, in total approx. 2 seconds;
ii) Providing the possibility to adjust the pressure levels in the range of +0.5 bar to +2 bar relative pressure while achieving vacuum levels below 0.8 bar (-0.2 bar);
iii) Having a pressure sensor in order to adjust the clamping pressure based on pressure measurement.
The movement of the pneumatic cylinder is supported with end-position reed-switches directly added in the cylinder and a squared shape to avoid turning during the movement.

>> Integrated system, and housing

The above listed components were tested separately and integrated together into one single box, the external dimensions of the box are 350 (W) x 442 (L) x 80 (H) mm. The pneumatic pump and the electronics share a common power supply of 12V and the high voltage is generated directly from the mains power. The bottleneck of the integration was the size, hence all the subunits are still prototypes only not optimized for building size.
The standby power consumption of the prototype was measured as 25 W. Higher power consumption was measured during the refresh cycle especially when changing the voltage on all dots and simultaneously moving the pump. These peaks could reach the 40 W peaks.

The working parameters of the final prototype:
+ 8x12 pin matrix tactile surface that can display graphical and textual data;
+ 2 sec refreshing time of total refreshing cycle (means 1 sec vacuum creation and 1 sec pressurizing) with audible feedback;
+ Immediate actuation for pin pop-up supporting drawing applications;
+ USB interface with auto-connect and communication recover feature; and
+ 25W average power consumption.

>> Tutorial and training application software

The training content is intended to train the end-users how to use a tactile display, as well as to make the user familiar with reading and interpreting of tactile presented graphics. Many of the potential end-users have never got the chance to try even a Braille display, so it is needed to teach them how to use a graphical tactile display. Usually, visually impaired persons have met with the graphical representation of basic shapes, like square, triangle, and so on. However, only a very few of them know how to interpret more sophisticated figures, like charts. Charts are visual representations of some data, information, or tendency; hence they can help people to get the most important properties of the current dataset even without knowing the exact measured values. This method is also suitable for visually impaired persons when it is 'visualized' on a tactile display, but first they should be taught to the way of interpreting it.
The aim of the training application is to give a quite short, but comprehensive introduction to the shapes from very basic ones to some more advanced figures, as well as to the handling of the software and the display system. This application is a framework program for the presentation of the training material to the end user, including all necessary interactive and control functions, supporting the ergonomics and use for the end users.
Application interface consists of two panels and navigation buttons. The left panel is used for displaying all presentation slides. The right - main panel is used for displaying current slide display on the tactile device. Training materials are provided in form of presentation slides. Slides can contain lessons from many areas - mathematics, science and engineering. The training materials have mainly been created by the end-user partners.

>> Data-converter module

The aim of the Data-converter module is to provide a tool for visually impaired people to convert usual bitmap figures and images into such format which can be shown on tactile display (especially on TACMON device). Due to the two main specialties of these tactile displays, namely binary information and very low resolution the conversion of images are quite challenging.
Binary information means the tactile display lacks shades of colors. Compared to the typical 24 or 32 bit color depth of PC displays and digital images the delivered information is extremely small. Tactile displays usually have lower resolution than 100x100 pins (the TACMON prototype is an 8-by-12 one) compared to the commonly used at least 800x600 pixels for visual images.
Due to the above mentioned issues the TACMON data conversion handles separately graphics and text. Graphics parts recognized and simplified into a proper low resolution representation while preserving its relative size to the whole image by drawing only the contour of the homogenous areas.
Text images are rendered forms of letters (glyphs) of some alphabet (including punctuation symbols).

Many of the visually impaired people are unable to read plain letters, and the resolution of the display is not large enough to show them properly. For text conversion an OCR (optical character recognition) algorithm is used which can convert the text images into alphabetical symbols. These symbols can be converted into braille letters or presented in audio using text-to-speech engines. In combined images where Braille text would comprise the readability of the graphical information text-to-speech was preferred by marking the text positions by single dots on the display allowing the user to select specific labels in the region of interest for voice output. The user can initiate the voice output by double clicking of the marker in a specific location, thus being aware about the relative location of the text heard within the image.

>> Drawing application software

Although this application is a quite simple one for presenting the capabilities of an interactive graphical display, but it was said by the end user partners that it was probably the most interesting one. It gives the ability to the user to draw on the surface of display by touching it with his/her fingers. It is also possible to freeze the image, in which state no drawing can be performed, so the whole image can be read by touch using the fingers. The drawn image, of course, can be erased, and there is also an option to save it in most common formats (the generated image is going to have the same resolution, and the pixels are going to be either black or white). These three operations can also be accessed via double clicking on special control areas on the display.

>> Test and demo application

The test and demonstration software was developed to provide full control about all setting and functions of the prototype through the PC on a graphical user interface. The final demo software is able to handle 96 dots individually, convert and visualize text to Braille on the GUI, upload braille patterns to the device, control the pump with variable pressures and run automated test sequences on the 8x12 display. This software was mainly made for testing and evaluating the chips and the integrated device and has less features and functionality for the end-users.

On the user interface of the software all the features of the TACMON device can be handled and parameters can be modified by single clicking. Text to braille conversion is also supported and basic shapes are implemented that can be added easily into textboxes by lower case and uppercase letters, respectively. The letters that can be converted are from the lower case 'a' to 'z'. The upper case letters from 'A' to 'Z' are reserved for symbols.

The demonstration software contains ATS (automated test sequence) feature. This feature allows automatic sequence of refresh cycles with different displayed symbols which is useful for fatigue test and in case on-line demonstrations as well as testing of different system components and functions such as tactile feedback on different pressures for the end-users. The automatic sequence feature of the demo software was also used to conduct durability tests of the system.

>>Device driver

A simple dynamic-link library (dll) was made from the first version of the test application, called TACMONLib.dll. The library represents a class that can automatically connect the TACMON device and has the variables and methods to monitor its status and upload new Braille pattern. The dll should be

added to the software project as a reference. The driver has the functions to move the pump, get the system parameter, like pressure, send bitmap to the device in byte format, set up connection and shutdown the device; moreover gives the number of rows and columns of the device display and can update the device firmware which permits the usage for further applications.
Potential Impact:
Final Result

The TACMON project successfully arrived at the proof of technological concept demonstrated on integrated standalone prototypes featuring a graphical tactile display size of 8x12 dots. The final prototype included also proof of concept for the scale up strategy, by the seamless assembly of multiple tactile chips which could be controlled and operated as a single display. The technology has already been tested and validated by visually impaired end users. The second main results of the project were the software TACMON modules which are also marketable by their own, such as the training application, as well as the chart conversion algorithms. The advanced image conversion module can also be utilized for the preparation of tactile figures in paper based Braille materials.

The aim of the TACMON project was to provide an innovative and cost-effective technology that can provide the visually impaired with interactive access to both textual and graphically-oriented electronic information, thereby contributing to their inclusion in conventional training programmes. Furthermore, this technology will provide European SMEs not only a highly marketable product, but will open larger markets in software for learning, leisure and Internet communication for use with TACMON.

Economic and EU wide impact

According to a recent EC report assessing the potential market size for Braille readers there are 12.5 million visually impaired people in the European Union and estimated to be 45 million worldwide. With the exception of some countries such as Spain and Sweden, there is generally a significantly high unemployment rate among the visually impaired in the EU ranging from 30 % to more than 70 % of the working age population. As per the i2010 Annual Information Society Report, the need for access to e-learning to function successfully in employment has increased significantly and is predicted to increase substantially in the coming years. Nevertheless, the visually impaired are locked out from information and communication because these technologies are heavily oriented to visual user interfaces and provide increasing amounts of information graphically. There is a critical and timely need to develop technologies that contribute to the inclusion of the visually impaired in terms of employment training.

The TACMON technology will help them to have access to general information needed for proper quality of life, have chances to be educated on higher level and integrate to market of labour and society. There are 12.5 million people with visual impairment, although the reality is that only a relatively small group (10%) of people actually able or have been taught to use a Braille display, although the proposed Graphical Tactile display also enables applications which do not need Braille reading skills.

The permanent demand for innovation of novel technology and software customized to Braille readers is induced by rapidly growing ICT field, especially referred to electronic agendas, laptops, mobile devices, etc. The aim is that Braille users can stay compatible with all these new tendencies. Due to the new

developments market for assistive technology (AT) is predictably stable.

The additional business opportunity can be exploited by adapting the TACMON device for the market of Virtual Reality. By economic sectors the solutions of Virtual Reality can be used in education, health care, training and maintenance, design, military, information processing and entertainment with the market size up to approximately $810 billion in 2012.

Social Impact

The significant cost reduction, compared to existing products, will open up a larger market, including industry and educational institutions required to meet EU standards. TACMON research meets EU policies set out in the Council Directive 2000/78/EC of 27 November 2000 establishing a general framework for equal treatment in employment and occupation that "recognises the importance of combating every form of discrimination". TACMON will help industry adherence to the Directive that employers must provide reasonable accommodations to adapt working environments to people with disabilities.

TACMON technology will also facilitate the inclusion of the visually impaired to the experiences of e-learning. Within the last decade, the use of e-learning has been a priority in most European countries for all segments of education (primary and secondary, higher education, lifelong learning and workplace training). As indicated in the EC's 2010 Annual Information Society Report, the need for access to e-learning to function successfully in education and employment in the 21st century is predicted to increase substantially in the coming years. Another EU-wide project (eTwinning) encourages the pairing of schools across the EU through ICT to promote the collaboration and sharing of learning experiences and the development of ICT skills. The visually impaired, however, have been largely excluded from this resource as e-learning, similar to most internet experience, is graphically-based. The TACMON product will address this exclusion and help open the resources and knowledge of e-learning to the visually impaired.

Today visually impaired people hardly can afford to buy an expensive tactile device due their limited financial situation. The unemployment statistics implies a correlation between visual impairment and poverty rate. Due to this fact the government pay regular allowance, which will be eliminated in case of giving job to the disabled person. In the 21st century the potential areas of electronic applications are growing fast (e-government, e-libraries, e-learning).

A study conducted in 2004 estimated that approximately 60%-70% as average of visually impaired people are unemployed in each European country. TACMON technology presents an opportunity for the development of SMEs as providers of innovative products for the visually impaired as businesses are gaining acceptance of the need and benefits of hiring the disabled. In this manner the employability will be increased considerably. In EU many governments legislated that companies have to employ certain percentage of disabled or have to pay subsidy to a State Fund. This way the governments strive to reach a higher employment of disabled people.

The benefits of TACMON technology are evident from both an economic, and, in particular, a social sense. Better access to education and life-long learning of new technologies is critical for the visually impaired as

they currently only have a very limited number of books available to them. The novel access to graphically oriented electronic information through a Graphical Tactile Display will facilitate a new dimension of access to information, in particular to Internet Web pages. Innovative applications for tactile diagrams, technical Braille, and electronic books will create new opportunities for the visually impaired, with important implications in terms of employability, professional development and learning.

Dissemination Activities

The dissemination actions of TACMON project aimed to spread non-confidential information as well as results about the project to the widest audience possible in order to improve the knowledge of large communities of SMEs. The dissemination activities were ranging from editing of dissemination materials for dissemination channels, such as 6 monthly newsletters, flyers, leaflets, brochures, poster presentations, and electronic bulletins. A CD-ROM has been prepared containing training documents and the documentation of all project results.

Apart from the prepared materials listed in the deliverable D9.3 attendance at different conferences and exhibitions were the other significant part of the dissemination activities. During the reporting period the most significant event was the SightCity 2011 (in Frankfurt, Germany) conference where METEC and TECHREADY manned a stand by giving special priority to spread broad information on the project and its current results. The TACMON consortium meeting was connected to this exhibition. The second main event was the Braille21 World congress 2011 (in Leipzig, Germany), where TACMON was represented on the stand of METEC.

In line with the dissemination plan each partner contributes to disseminating the project and its findings by keeping the corresponding rules of confidentiality. By exploiting the broad networks and partnering of the consortium members the project awareness has significantly grew during the present reporting period.

Most of the dissemination actions were realized in accordance with the plan. However the scientific publications have been postponed by the management board in order to avoid infringement of the planned patent application. As the patent application could only be submitted with end of October 2011, the submission deadline for the planned scientific papers has been missed for this year. Never-the-less an appropriate number of scientific publications is planned to be realized in the post project phase from the own effort of the concerned partners.

The plan of the dissemination activities and the detailed description and materials of the dissemination actions, e.g. leaflets, brochures and presentations, can be found on the webpage.

A new project website has been constructed with improved design and functionality. The news section has been extended in functionality turning it into a publication platform, allowing to publish beside project events also non-confidential information about the project, as well as related material and conferences. Also the restricted area for access and storage of technical information by consortium partners has been considerably improved. The Document section includes all deliverables and all reports, as well as meeting information and meeting minutes, as well as public information and videos about results achieved within the project.

The project web page is accessible over the "tacmon.eu" domain name.

Exploitation of the results

As reported in the Plan for the Use and Dissemination of the Foreground (PUDF) the project participants'

plan for dissemination and for exploitation of their results, including expected results of the project in relation to specific potential applications, the progress of the development of results, the commercial, social or scientific background of the results, a record of the potential role of each partner in the dissemination and the market launch, planned main dissemination actions, exploitation agreements between the consortium members in relation with the utilization of the project results, IP rights and business plan. The major steps in exploitation of the results were the followings.
1) After taking into consideration the possibilities, the non-RTD partners decided to set up a new company which owns the foreground IPR, calling it TACMONCO Ltd. The company under number 7686178 was registered on the 23rd June 2011 in the UK for any licensing and/or transferring the technology to third parties.
2) The shareholders of TACMONCO initiated a patent application process in Hungary in late July and managed to secure the priority date under the patent number P1100601 on the 28th October 2011.
3) The company strives to get other funding, public or private involved to further developing the TACMON technology. For this aim, the follow-up project of TACMON was successfully submitted in FP7 research for the benefit of SMEs funding scheme wherewith the consortium partners hope further subsidization for their success story.
4) In order to find the widest possible audience and possible users of the TACMON technology all the partners were eager to propagate the non-confidential project results on different conferences where further application fields and possible investors could be discovered.

List of Websites:
Project website: www.tacmon.eu

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