Virtualization of Real Flows for Animation and Simulation

Results in Brief

Teaching neural networks to go with the flow

From aircraft wings to Hollywood movies, a better understanding of how fluids move can find many applications.

FUNDAMENTAL RESEARCH

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Understanding how fluids move in three-dimensional space is central to a range of industries from medicine to engineering, and even creating convincing special effects in film. The EU-funded realFlow project sought to improve the connection between fluid models and the real world, using a machine learning approach.

Typically, fluid models are constructed to mimic real-world physics, giving researchers the ability to run simulations that are quicker and cheaper to carry out than physical experiments. realFlow was attempting the inverse. The project set out to create a system that could capture the underlying physics of real-world examples.

“For example, we’d like to have a cloud of smoke rising somewhere, and be able to predict what the underlying air movements are doing,” explains project coordinator Nils Thuerey, who is based at the Technical University of Munich. The goal was to be able to do this only from two-dimensional images.

To achieve this, Thuerey and his colleagues decided early on to pursue a machine learning approach. Neural networks were fed data on fluid movements such as smoke density and flow velocity, and allowed to come up with their own descriptions of the physics involved.

Wings, weather and blood

“The original proposal was to work with data, observational and simulated, to figure out what happens,” says Thuerey.

“Naturally we harnessed development in AI over recent years. We developed machine learning based on data sets, to be able to solve these different problems.” Thuerey adds his team is among the first to connect these physical problems with machine learning algorithms.

Being able to understand the underlying physical processes affecting a fluid, from footage of its movement, has a range of applications, such as analysing airflow over aircraft wings, or the forces generating weather systems.

Another application is in medicine, notes Thuerey. “You have the case of a marker injected into veins, where you can see the motion of a known quantity in an unknown field,” he explains.

“If doctors get immediate feedback about pressure distributions in a patient’s vein, they could adjust what they do in real time.”

Smoke signals

Thuerey’s team also sought to improve the speed and quality with which smoke effects could be simulated by using a library of pre-generated data.

By taking the starting positions and velocity of smoke particles, a neural network builds a simplified model of the expected flow. It then searches the database for high-quality footage corresponding to those conditions.

The work was supported by the European Research Council. Thuerey says: “The grant was extremely effective, enabling us to work without spending a lot of time on grant writing and worrying about immediate deliverables shortly after.”

He adds that the ERC grant also helped with his professional development, making a strong argument for his tenure at the Technical University of Munich.

The team has since secured a consolidation grant to further pursue their research. “This field, a combination of deep learning and physical simulation, has grown a lot,” concludes Thuerey. “Now we’re ready to take the next big step forward and go into practical applications. There are many exciting challenges to resolve.”

Keywords

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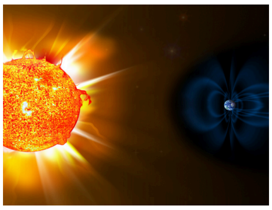

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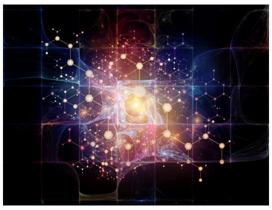

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realFlow

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