The Fastest Route from A to B

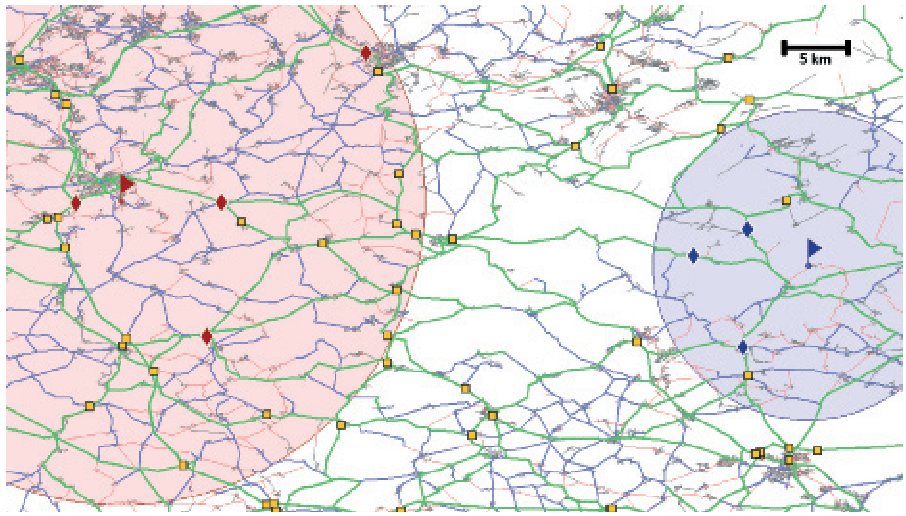
Max Planck scientists accelerate navigation aids one-hundred-fold

MISSING AN INSTRUCTION from an in-car navigation system may not only lead to the driver getting lost, it may well confuse the GPS, too. Current navigation programs can sometimes take up to a minute to find a new route that will take drivers to their destinations as quickly as possible. However, there is a much quicker way – scientists at the Max Planck Institute for Informatics came up with an idea that accelerates these navigation aids one-hundred-fold.

Working with colleagues at the University of Karlsruhe, the Max Planck researchers calculated a relatively small number of transit nodes – prominent points, such as highway entry ramps or roundabouts, that drivers regularly pass by on their way to more remote destinations. There are around 11,000 of these points in the Western European road network. The navigation system searches for the transit nodes closest to the starting point and destination – there are generally fewer than two dozen. Using tables, the system then calculates the distances between these nodes in a few millionths of a second.

If the starting point and destination are close together – say, from one city suburb to the next – the wide-meshed network of nodes won't do. Depending on the distance, the navigation system then uses some 300,000 to 3 million nodes. "By using this hierarchical procedure, we can calculate the optimum route between any two points extremely quickly," says Hannah Bast, who, together with Stefan Funke, developed the new navigation system at the Max Planck Institute for Informatics.

Previous systems have groped their way through the road network from node to node, of which there are 20 million in Western Europe alone. For shorter journeys, the principle works well, but it takes much more time to plan longer trips than is the case with transit nodes – even though conventional systems take only major highways into account when traveling between places that are far apart.



Current route planners weave their way from point to point through the maze of streets. In the future, they may be able to identify the shortest route between starting point and destination (flags) using pre-calculated data on the nearest transit nodes (diamonds).

Photo: Max Planck Institute for Informatics/University of Karlsruhe

"Some commercial navigation aids can calculate quickly, but they don't always calculate the fastest route," says Hannah Bast. Her new method, in contrast, always provides the optimum route, a feature that is particularly valuable to logistics companies. Calculating the shortest distances with speed and reliability cuts costs. The new system also helps Internet route planners cope more effectively with the thousands of inquiries they receive every second of the day. PH

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Some Like It Hotter

With coatings made of new ceramic materials, aircraft turbines and engines can operate more economically and at higher temperatures

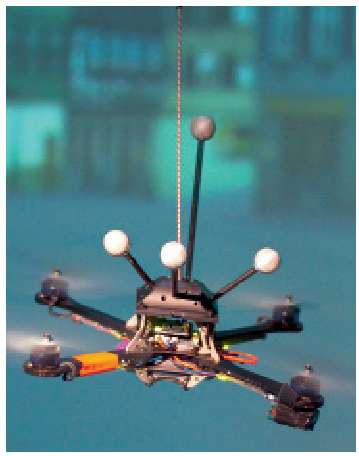
WHEN THINGS GET REALLY HOT, ceramics are the material of choice. Ceramic coatings protect the components of aircraft engines or power station turbines from heat. Yet until now, the limit has been, at best, 1,200 degrees Celsius – even the most durable protective coating fails at temperatures above this mark. Turbine manufacturers, however, want more, in order to increase operating temperatures even further – because the higher the temperature, the more efficient the fuel usage. This wish could soon become reality.

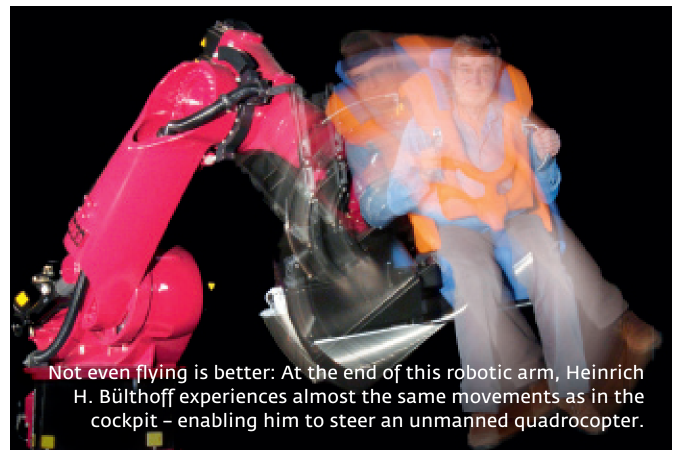
Researchers working with Martin Jansen, Director at the Max Planck Institute for Solid State Research in Stuttgart, have developed a new type of lightweight and very stable ceramic that can withstand even temperatures above 1,400 degrees Celsius. Ceramics are commonly crystalline, which means that the atoms are neatly aligned to form a symmetrical lattice. Such a crystal can be extraordinarily stable.

Flying by Robotic Arm

Simulated motion makes unmanned aircraft safe to fly by making pilots aware of their sense of balance

FLYING AN UNMANNED aircraft is safe enough for the pilot – but less so for the aircraft. At least 20 of the 60 unmanned US reconnaissance aircraft deployed in Afghanistan have crashed – although not one of them was shot down. With a control system developed by scientists at the Max Planck Institute for Biological Cybernetics in Tübingen, these drones without a cockpit might well still be flying. Researchers there developed a motion simulator that allows pilots who fly the aircraft by remote control to also use their sense of balance.





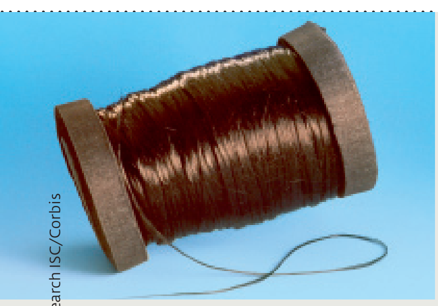
Not even flying is better: At the end of this robotic arm, Heinrich H. Bülthoff experiences almost the same movements as in the cockpit – enabling him to steer an unmanned quadrocopter.

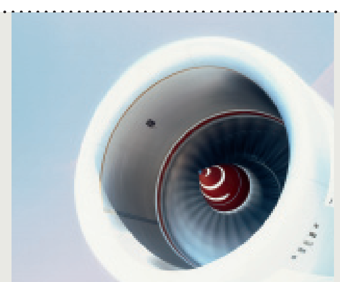
Photos: MPI for Biological Cybernetics – Martin Breidt/MPI for Biological Cybernetics – Theresa de Maddalena

Currently, a pilot operates the flight controls by observing flight instruments and a camera view from the plane on a display screen. The pilot has no immediate sense of the plane's attitude and no feeling for turbulence or wind gusts. Not so in the motion simulator: here, too, the pilot sits in front of a display screen, but is strapped into a seat mounted on a robotic arm that could have served the Colossus of Rhodes as an artificial limb. The arm movement is controlled by data from sensors in the plane that monitor its attitude and acceleration.

"With this information, the motion simulator replicates the flight as accurately as possible," explains Paolo Robuffo Giordano, who heads the motion simulator study. He and his colleagues are currently investigating ways to use the system to pilot miniature drones.

"What we essentially want to study with the robotic arm is how the brain combines data from various sensory organs, so for example the eyes and ears and the sense of touch and balance," says Director Heinrich H. Bülthoff, in whose department the work is taking place. The system could, however, also have practical applications, including Earth observation, pipeline inspections, remote-controlled space missions and pilot training. PH | MI 0107-4065-BC-JK





Ceramics from the reel: SiBNC ceramics can be made into fibers. Coatings manufactured from a fused web of these fibers could make jet engines more heat resistant.

Photos: Fraunhofer Institute for Silicate Research ISC/Corbis

If the load is too high, however, it suddenly breaks. One of the reasons for this is that, starting from a lattice defect, a crack runs along the periodic lattice planes through the whole crystal as fast as lightning.

In Jansen's ceramics, in contrast, the atoms are in total disorder – the ceramic is amorphous. There are no lattice planes and thus no 'highway' along which the crack can propagate. Jansen uses silicon, boron, nitrogen and carbon for his ceramics, elements that form particularly strong chemical bonds with each other. Moreover, these atoms bond to at least three neighboring atoms, making the amorphous network especially stable. The research project has found support through the Federal Ministry for Research and the German Research Foundation (DFG).

The present level of development, which is aimed at the industrialization of the new material, involves several partners from industry and other research institutes, like the Fraunhofer Institute for Silicate Research in Würzburg. A pilot plant has been installed there to manufacture large quantities of the precursor for the ceramic and to process it into ceramic fibers – an important step toward industrial use. "The material will certainly be a success," says Martin Jansen. Not least because the ceramics can be shaped into a variety of products, such as coatings for aircraft, power station turbines and combustion chambers, as well as solid components and ceramic fibers for composite materials.
Tim Schröder | MI 1201-2758-BC-WA