Puckish robots pull together: Air hockey helps joint techniques for work in space.

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The frictionless conditions of space are being simulated by air-hockey tables, as a new generation of intelligent robots is trained to build space stations and solar arrays. The construction workers of the future look like oversized hockey pucks and float on a cushion of air while they pick up girders and assemble them into frameworks. These prototypes could lead to robots capable of building space systems such as giant arrays of solar panels.

NASA has speculated about constructing arrays up to 10 km long.

Wei-Min Shen of the University of Southern California and his colleagues described the robots at the International Conference on Complex Systems, held last week in Boston, Massachusetts. Given the hazards of human space travel, they believe robots are the best bet for building structures in space.

"Assembly performed by astronauts would be too expensive and risky," says Shen. His group is collaborating with NASA to develop intelligent robotic systems that can coordinate their own activities, so that they do not have to be precisely monitored and controlled by humans.

The prototype robots practice docking manoeuvres on an air hockey table. © Polymorphic Robotics Laboratory

Group intelligence

Several research groups have demonstrated that teams of mobile, communicating robots can perform complex tasks: for example, they can collaborate to push objects over a surface. This is reminiscent of the way ants show group intelligence when carrying out collective tasks such as foraging.

In space, however, there is the added complication of a weightless, friction-free environment, which can make movements harder to control. Two robots carrying separate components for assembly might easily collide, or career past...
To explore such difficulties, Shen and colleagues have created a two-dimensional analogue of space... better known as an air-hockey table. Jets of air blow through a mesh of tiny holes on the table's surface, so that puck-shaped robots float in a virtually friction-free environment.

The robots, each about 30-cm wide, move around using four onboard fans. Their movements are remote-controlled by a wireless transmitter and they are tracked by a video camera that acts as the robots' eyes. Ultimately the researchers hope to replace this centralized control system with autonomous sensing and control mechanisms on each robot.

It takes two

A key attribute of the robots is that pairs are linked by a cord. This helps to stop individual pucks from flying out of control and brings them together to assemble the components that they carry. When the tether is extended, each puck can wander independently, looking for building components.

So far the experiments have involved long, rigid girders with connectors at each end, which can be joined into flexible chains. Once each robot in a pair has found itself a girder, they pick them up using mechanical docking units and the tether is reeled in to pull the two pucks and their cargoes together.

Shen's robots have mastered this process. They have no problem finding two girders and snapping them together. The next step is to add a third girder and link all three into a triangle.

"We are now working on this final step," says Shen, who anticipates that they will be able to make such shapes very soon. Triangular elements would act as rigid structures that could be assembled into larger frameworks such as trusses.