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A NEW INTERACTIVE VIRTUAL AND PHYSICAL MANIPULATIVES (VPM) EDUCATION TECHNOLOGY FOR SPATIAL TRAINING

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A New Interactive Virtual and Physical Manipulatives (VPM) Education Technology for Spatial Training

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Abstract

Spatial skills are important in learning a variety of subject matters in science, technology, engineering, and mathematics (STEM) disciplines. For example, engineering students often need to draw free-hand sketches, or review and understand computer graphics of complex machines, components, and structures. Math students often need to deal with planar and solid geometry, pattern recognition, and computational visualization. Geology students often need to construct geologic maps or work with a Global Positioning System. Solid spatial skills are required in all these circumstances.

The U.S. National Science Board has identified spatial skills as one of the three core cognitive skills, along with mathematical and verbal skills, that students should have if they pursue STEM careers. Training of students' spatial skills, however, has not received adequate attention in STEM education. This is because spatial skills are not explicitly tested for and often get lost among the contents and skills specified in STEM education programs.

This presentation focuses on the demonstration of a new interactive virtual and physical manipulative (VPM) education technology. This new form of education technology was recently developed by our project team to enhance spatial training. This technology consists of both hardware and software. The hardware includes ten 3D concrete physical objects (i.e., physical manipulatives) as well as an Inertial Measurement Unit (IMU) board 9DoF Razor IMU M0. Each physical manipulative has authentic engineering applications, such as a Geneva wheel, spinner flasks, and a component grip. The software includes a computer software package called Processing, which is a new version with P5 Serial Control written with JavaScript. When using VPM technology, a student (trainee) holds a physical manipulative in his/her hands while sitting at a computer. The IMU board captures the physical movement of the object and sends orientation signals to the computer for real-time image processing of the corresponding virtual manipulative. Virtual and physical manipulatives provide trainees with two simultaneous visual and haptic channels during spatial training.

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