Investigating Inertial Measurement Units for Spatial Awareness in Multi-Surface Environments

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ABSTRACT
In this work, we present an initial user study that explores the use of a dedicated inertial measurement unit (IMU) to achieve spatial awareness in Multi-surface Environments (MSE's). Our initial results suggest that measurements provided by an IMU may not provide value over sensor fusion techniques for spatially-aware MSE's, but warrant further exploration.

Author Keywords
Inertial tracking systems; indoor navigation systems; gestures and interactions; HCI; multi-surface applications.

ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: User Interfaces, Input devices and strategies.

INTRODUCTION
We present a user study that examines the challenges with sensor-fusion based approaches [1], by evaluating an IMU to determine its accuracy for location and orientation tracking within spatially-aware MSE's. In MSE's, this type of information is important in using gestures to transfer content, a common task in MSEs [1][3] Specifically, we evaluated the applicability and usability of the SmartCube IMU, developed at the Alberta Center for Advanced MNT Products (ACAMP). Our initial work explores two major questions: How accurate are the position and orientation measurements returned by the SmartCube? And whether it is a feasible alternative to sensor fusion techniques?

EXPERIMENT
Ten volunteers participated in our study. We developed a specialized application to display a set of targets on a large wall-display connected to a PC. A Microsoft Surface tablet application was created to communicate spatial data from the SmartCube, and act as a device to send content.

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Users were instructed to stand at certain locations in the room (fixed and randomized), and send content [2] from the tablet, to a number of visual targets that were shown on the display - one target at a time, by rotating the device in the 3D space.

RESULTS
Sending content from a fixed location, without visual feedback, showed a success rate of 7%, deviating 21.4 cm from the target on average. Performing the same task with visual feedback of the position on the large wall-display had a higher success rate 21%, with target deviation averaging at 20.6 cm. Tasks that depended on location measurements showed negative results, with a success rate of 0%, deviating from the target by 1 to 3 meters. Feedback received from the study participants indicated that attaching an external module to the tablet reduced the tablet's mobility. Participants, also, thought that the visual feedback was crucial to understand the system's perspective and understanding of the room.

CONCLUSION
Our limited initial study highlighted the inaccuracy of the SmartCube for providing spatial-awareness in a MSE. An interesting observation revealed from the study and comments from participants was the use of visual feedback to offset sensor inaccuracy. This may suggest that providing visual feedback for multi-surface interactions is valuable and will allow users to compensate for inaccurate tracking technologies or MSE's that require constant calibration.

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