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IMU Mobile Positional Tracking

Project Inspiration: The concept of mobile positional tracking is inspiring to our team from an egalitarian and technical standpoint. We are excited by the potential for low-cost positional tracking to further democratize the VR space. Imagine if a Google Cardboard could not only provide an individual a first view of VR, but also the freedom to physically explore new spaces using tracking on par with hardware such as the HTC Vive. Then, we would be much closer to the promise of VR for all. We have personally seen that while Cardboard-type devices bring VR to the average person, they give no indication that it's only a low-fidelity version of what's really possible. Most people don't realize that haptics, binaural audio, hand-, eye- and positional tracking, etc. are already being rigorously researched and developed. Without this context, it's difficult upon first exposure to VR to imagine applications outside of entertainment and gaming (where the user stationary and at best, using a joystick/game controller as input). Positional tracking at the lowest end of VR is crucial to showing mass markets how powerful and far-reaching a tool this technology will be.

As much as our interest in a mobile positional tracker is driven by idealism, we are also driven by the project's technical rigor. Our team understands on a surface level that positional tracking is difficult, but we are excited to dive into the problem and learn more firsthand. We envision gaining a stronger understanding of why positional tracking is hard as well as potential directions for future work. We are also eager to survey the numerous past attempts to solve the problem of positional tracking. In the future, we're interested in exploring solutions like SLAM, but felt that this approach would a) best take advantage of the knowledge and skills we've gained in this course and b) give us the opportunity to understand the details of why accelerometers are insufficient for high-fidelity positional tracking (as Gordon mentioned, it's common knowledge and oft-discussed that double integration of accelerometer data isn't "good enough," but we want to understand what that means and be able to qualify that statement).

A low-cost solution is important to our team, so we particularly plan to explore positional tracking through use of a constrained model or additional hardware such as Estimote Beacons.

References:

- Sensor Fusion on Android Devices: A Revolution in Motion Processing:
https://www.youtube.com/watch?v=C7JQ7Rpwn2k
- Head tracking for the Oculus Rift:
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6906608&tag=1
- Ambulatory Position and Orientation Tracking Fusing Magnetic and Inertial Sensing:
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4155012

- Method and apparatus for determining position and orientation of a moveable object using accelerometers: https://www.google.com/patents/US5615132
- Self-contained Position Tracking of Human Movement Using Small Inertia/Magnetic Sensor Modules: http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4209463

Outcome & Milestones:

Week 7 - Survey existing techniques for positional tracking and determine implementation
Week 8 + 9 - Implement positional tracking -- work on double integration, confirm limitations of this approach that have previously been described, observe additional limitations, and observe limitations we might want to constrain or mitigate
Week 9 - Continue implementing positional tracking, hopefully experimenting with ways to add constraints and additional information to make accelerometer-based tracking more reliable
Week 10 - Polish

By the end of the project we plan to have at least a rough implementation of low-cost positional tracking which enables users to walk through a Unity scene, as well as directions for future work.