

Inside-Out Tracking Sensor Suite for Virtual Reality Applications

The aim of this project is to understand and implement the basics of an inside-out tracking system for virtual reality applications. Unlike traditional methods that depend on external sensors, inside-out tracking systems eliminate the need for dedicated play spaces or complex installations. Comprising onboard cameras, sensors and virtual reality headsets, these systems allow users to interact with their surroundings naturally, enhancing immersion and realism.

The inside-out tracking system to be designed in this project must have the following features:

- The 6-degree-of-freedom head pose of the user must be estimated via the selection of proper sensors mounted on the headset to enable "accurate" real-time tracking. The sensor suite must be composed of a single camera and IMU, at minimum.
- The head pose must be transmitted (via a wired connection or wirelessly) from the user module to an external computer.
- A synthetic head model must be rendered on the external computer in order to visualize the estimated head pose in real time.

The project team must show the effect of sensor fusion on the accuracy of pose estimation and make a minimum viable product analysis in terms of user satisfaction and sensor cost. The design should also comply with the following constraints:

- The system must operate in indoor environments.
- The sensor suite must be compact enough to be carried on the user's head. The processing unit may be carried on the user's body as a belt pack.
- External sensors (such as a camera facing the user's head) are not allowed.
- The processing unit must be a battery-powered single-board computer.
- The user should be able to move in at least a 2m by 2m area.

The design may have the following optional features:

- The transmission of the first-person camera view to the external computer and inclusion of artificially added objects in the user view via augmented reality
- Gaze tracking via an additional sensor to monitor user's eye
- Operation at low-light conditions
- 3D scene analysis and detection of external objects for collision avoidance, warning, and interaction
- Local rendering of the user view, displayed on the headset's integrated screen