TU Wien Informatics

Foot Tracking in Virtual Reality

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Motivation and Problem Statement

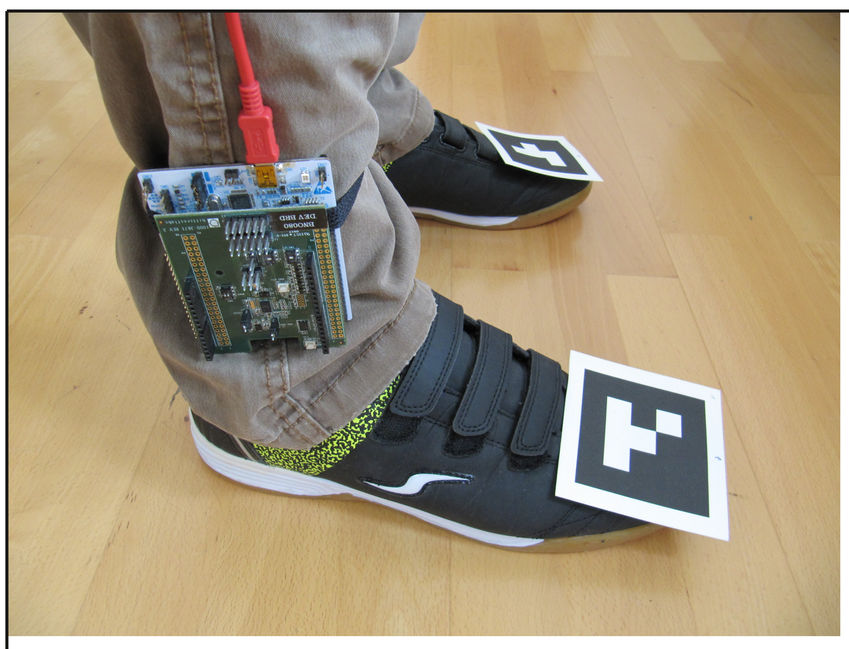
- Visualisation of limbs helps to get a better immersion in Virtual Reality (VR)
- A lot of VR applications omit limbs visualisation due to technical difficulties
- Hard to implement with large scale VR environments and outside-in tracking
- Developers don't want to exclude parts of the userbase due to expensive hardware

Aim of the Work

- Generate a lightweight tracking system that only relies on tracking of the head position
- Can be used either in inside-out or outside-in tracking
- A headmounted RGB depth camere is used together with inertial sensors to track the feet
- These signals are then fused to get one reliable signal
- The foot position can be used to animate an avatar with the usage of an inverse kinematic algorithm

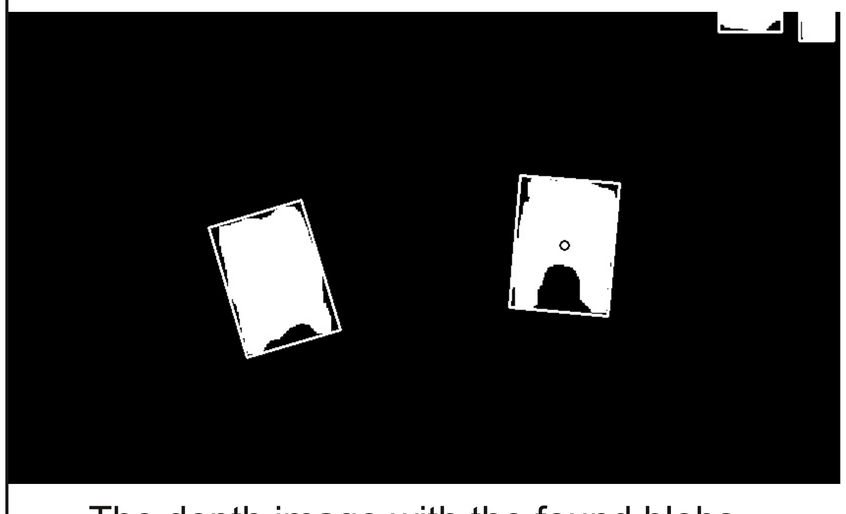
Components

- Intel Realsense Depth Camera D435
- ArUco Fiducial Markers
- Bosch BNO080 IMU
- Extended Kalman Filter (EKF)
- Forward And Backward Reaching Inverse Kinematics (FABRIK)



The IMU calculates the foot position from the measured acceleration and rotation

The RGB image with the found marker



The depth image with the found blobs
The chosen blob is marked with a dot

Approach

- ArUco markers are used to track the user's feet
- The depth camera is used to track the feet when the markers are occluded
- The IMU is used to track the feet when they are not in the field of view of the camera and to get a higher tracking frequency
- These three signals are fused with an EKF
- FABRIK is used to animate the user's avatar with the fused foot position signal

EKF

FABRIK calculates the missing knee and hip positions of the avatar

Results

- A technical evaluation and a user study were done to evaluate the proposed tracking system
- It was tested against the HTC Vive tracking by mounting both on the user's feet
- The distance between the two tracking systems shows the performance of the proposed system
- Works well when standing still
- 2 to 10 centimetres difference to HTC Vive while walking due to system latency of 0.3 seconds
- Bigger gaps are possible due to wrong marker detection at low light and due to wrong positions when the marker leaves the field of view
- Has no time related drift
- IMU is an important part of the system as it prevents the biggest errors from the marker tracking