Walking Motion Recognition System by Estimating Position and Pose of Leg Mounted Camera Device Using Visual SLAM

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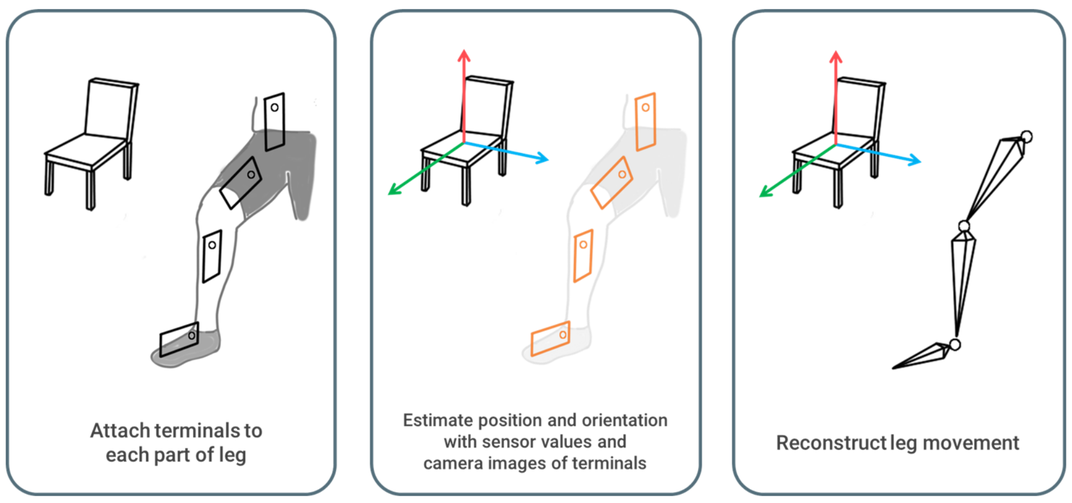
Introduction



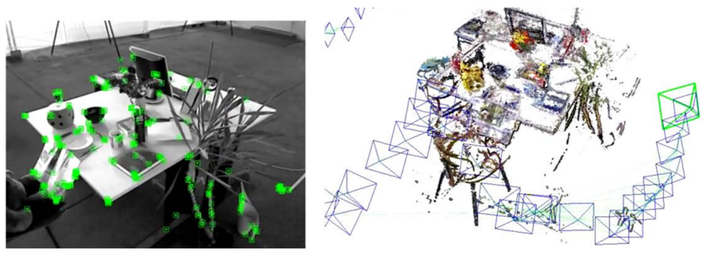
We present the method for recognizing the walking motion of the user with estimating position and pose of leg mounted camera devices by employing Visual SLAM. Approximate displacement of the position and orientation of the sensor terminal can be estimated using output values of the acceleration sensor, the gyro sensor, and the geomagnetic sensor. It is also considered that the position and orientation of the terminal can be estimated by the image captured by the camera mounted on each terminal. The system records surrounding scenery of the user with each camera device attached to each part of the user's leg, and estimates the 3D position and orientation of each camera device by using Visual SLAM. Although conventional optical motion capture system requires a special environment such as an expensive camera, our method enables easy motion sensing in daily environment.

Hardware Setup

We employ Android smartphones (ASUS ZenFone 2 ZE 551 ML) as terminal for recognizing the walking motion of the user because it is relatively easy to realize the hardware requirements required by the system. Total of eight smartphones is attached to each part of both of the user's legs. In order to fix each smartphone to the user's legs, we made dedicated wearing belt. This wearing belt is made up of a nylon material belt and a flip cover for fixing the smartphone.

Visual SLAM

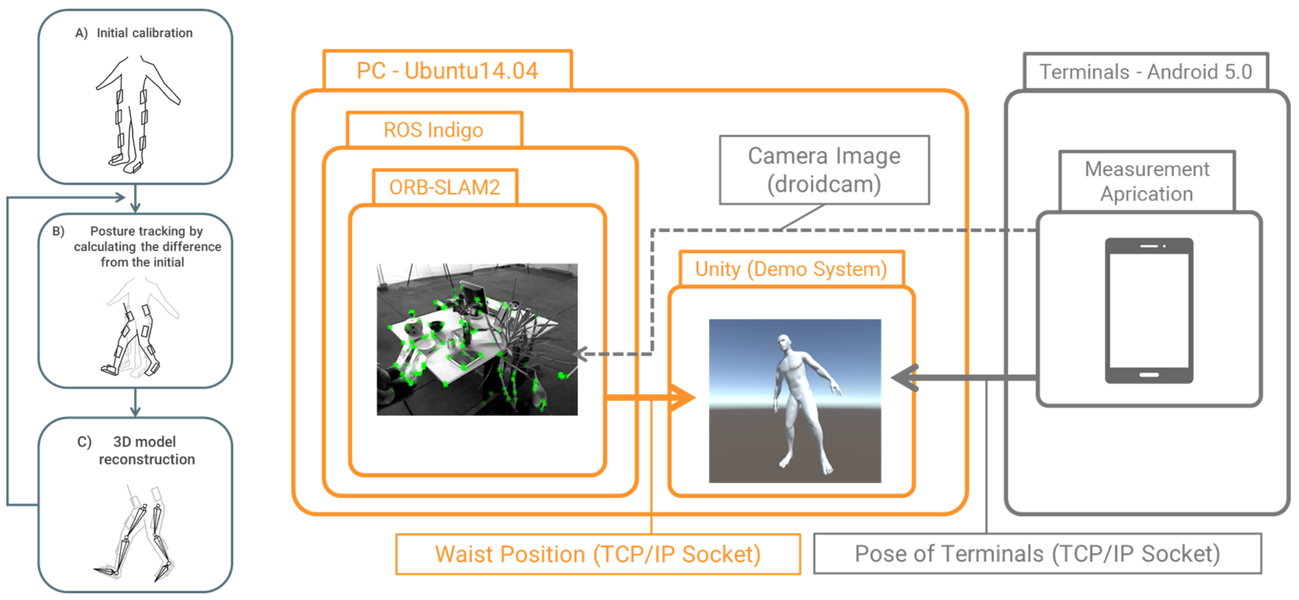
Visual SLAM is used to estimate the position of the camera from the images captured by the terminal attached to the user's right waist. SLAM (Simultaneous Localization and Mapping) is a general term for technologies that realize high-precision and high-speed self-location estimation by simultaneously performing environment map creation and self-location estimation. We use ORB-SLAM by Mur-Artal et al. to estimate the position and orientation of the camera. The ORB-SLAM is a feature point-based Visual SLAM that operates with a monocular camera and it adopts ORB feature detection as a method of detecting feature points in images.



"ORB-SLAM: A Versatile and Accurate Monocular SLAM System"
Raúl Mur-Artal, J. M. M. Montiel and Juan D. Tardós
IEEE Transactions on Robotics, vol.31, no.5, pp.1147-1163, October 2015

Demo System

The motion of the leg is output as a 3D model by the demonstration system implemented on the PC. This demonstration system is implemented by Unity. The PC prepares a virtual socket for wireless communication for the number of installed terminals, and orientation information of the terminal received from each socket is reflected on each part of the leg of the 3D model. On the PC, Linux is installed as a virtual OS, and ORB-SLAM is operated on a tool called ROS (Robot Operating System). Then, the position of the waist of the user is estimated by applying ORB-SLAM processing to the received camera image.



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