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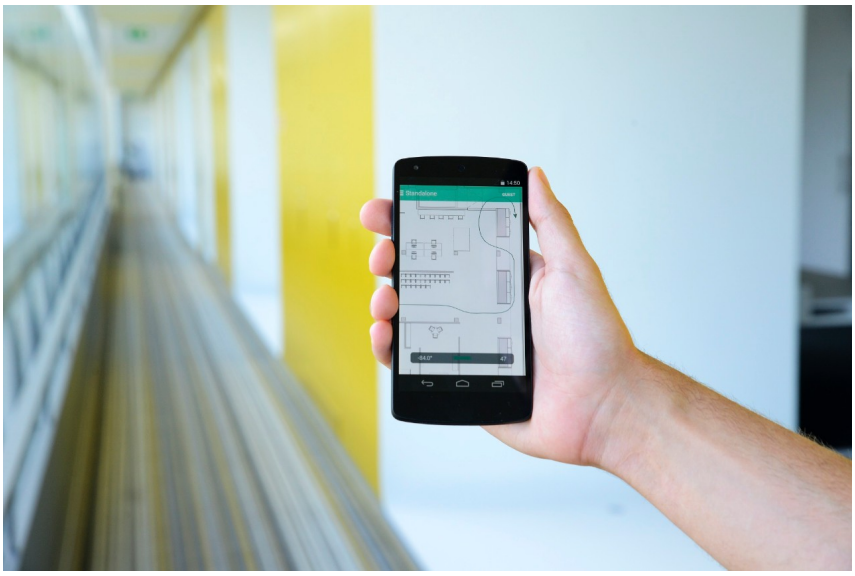

Fig1. Precise Indoor Location.

PressureRef4PIL

POSITION REFERENCE WITH DIRECTION ESTIMATOR FOR INDOOR LOCATION SYSTEMS

The main objective of this project is to improve Indoor Location Systems accuracy by using a smart floor that will be gathering data and calculating in real-time the user's direction.

Motivation

According to the U.S. Environmental Protection Agency (EPA), people spend more than 90% of their time indoors and for that reason effective technologies are demanded for indoor human/object localization.

Most recent smartphones are equipped with several sensors (e.g.: accelerometer, gyroscope, magnetometer) that provide the necessary hardware for indoor navigation systems based on inertial sensors. On the other hand, these systems rely on low-cost sensors that can be extremely noisy. Noisy sensors will introduce position errors due to noise itself but also drift (from gyroscope) and magnetic interference (from magnetometer). Eventually, these cumulative errors will lead to an erroneous estimation of the actual position.

Description

This works aims to study and develop an intelligent surface that detects person's walking direction and send this information to the indoor location system that runs in the user's smartphone. It was purposed a scalable and low cost solution that should allow an increase of the active area.

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Features

We used four FSR 402 sensors, which are low cost force sensitive resistors that exhibit a decrease in resistance when force is applied to the surface of the sensor. The Raspberry Pi 2 is used for gathering and processing all the data.

Our approach is based on Fuzzy Logic. The system detects the heel striking and toe push-off. The final solution uses Fuzzy rules to detect 4 different directions. It also differentiates on each side foot hits the smart floor. This information will be useful to avoid false positives.

Outputs

- Qualitative weight estimation
- Exact time that a footstep is detected
- Time on heel to time on toe
- Direction estimation

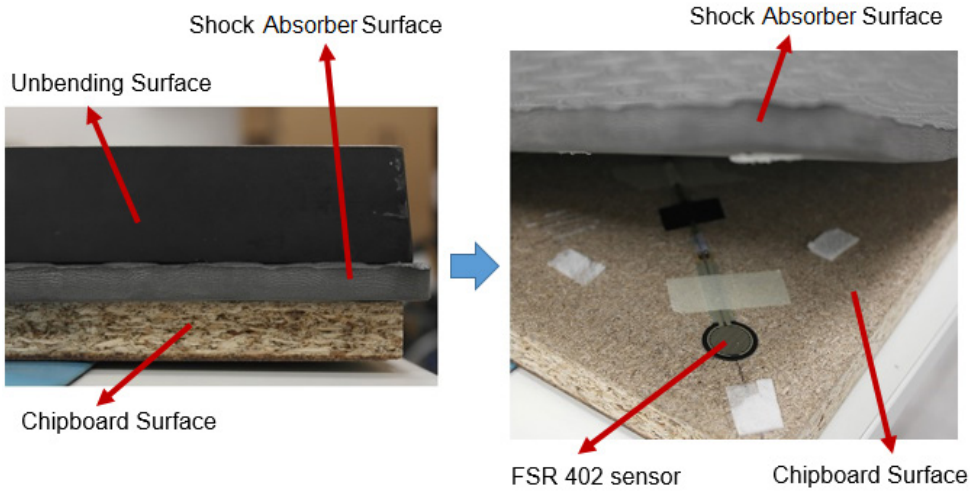

Fig2. Smart floor prototype.

The final prototype size is 60x60cm and has 3 different layers. The top layer is a rigid surface that ensures the pressure is evenly distributed across the active area. At the bottom we added a chipboard surface for fixing FSR 402 sensors at each corner. A shock absorber surface was installed to protect the sensors and increase the force range.

The system uses Fuzzy Logic to analyze the human gait and distinguish the two main events of a footstep: heel striking and toe push-off. Afterwards, the algorithm applies a set of Fuzzy rules to estimate the user's orientation and direction.

Tests

At this point the system is capable of detecting four different directions: north to south or south to north and west to east or east to west.

7 individuals, with weights between 65 to 95Kg, tested the system. The tests were performed under previously known directions. At the end the system successfully identified the user's direction in more than 100 tests.

More tests are necessary in order to evaluate the algorithm performance in a real case scenario (walking randomly).

Future Work

As for future work, the system could expand for detecting 8 possible directions.

A Bluetooth communication is also needed in order to transfer to the smartphone the absolute user's position and direction.

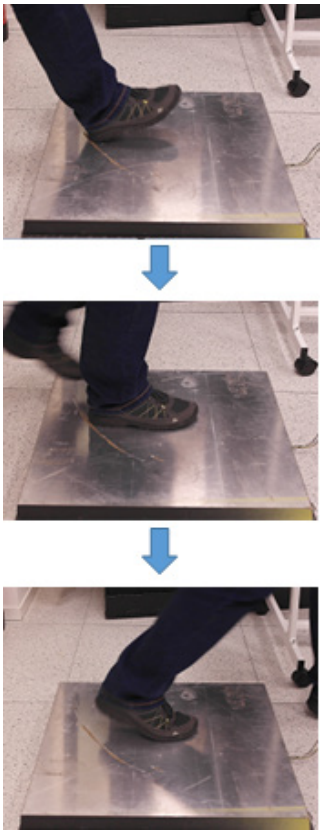

Fig3. Heel striking (top) and toe push-off (bottom).