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Smart Location Tracking System using FSR (Force Sensing Resistor)

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Abstract

This paper presents a smart location tracking system using FSR(Force Sensing Resistor). It is important to note that our system doesn't need to attach a sensor to human body, because we install a FSR in a floor in order to establish a smart space. Our system can track location of a person and interact with a computer through tapping behavior of person. This paper describes a smart floor for obtaining pressure data and location of person using sensor array. It is shown how sensor's response data are used in some application. Our system can be used for several areas of applications, for example, location tracking, context aware based on human gait recognition, surveillance. Our system also can be used for the automatic world modeling using pressure sensing of each object, which was not possible in computer vision system.

Key words: force sensing resistor, location tracking, world modeling

1. Introduction

Many systems have been developed to track the position of people for various applications; e.g. motion capture, security, interactive/virtual reality environments, etc.

The majority of people-sensing systems in the virtual reality community have used computer vision techniques [1], where data from a set of video cameras is processed to obtain real-time tracking information. Although this technology is continually improved as hardware and algorithms increase in capability, most current real-time vision systems still have significant drawbacks, such as slow response and limited robustness to lighting conditions.

House_n Project[2] tries to measure and recognize human behaviors by not only attaching the on/off sensor called "Tape-on" and vision sensor but also interviewing the occupants via PDA carried with them. The main purpose of the project is off-line analysis of sensor data. Our system can realize on-line applications as well as measurement of human behaviors. Aware Home[3] is a home equipped with many cameras, microphone, RFID tag sensors and finger print verifiers. The home can measure only position of persons in the home. It cannot recognize human behaviors. Easy Living[4] aims to create applications fitting habitant behaviors by means of cameras, RF position sensor, and finger print verifiers. The project mainly measures the occupants' positions in the room and how they use the computers. Our system presents a smart location tracking system using FSR(Force Sensing Resistor). The proposed system can track location of a person and interact with a computer through tapping behavior of a person. Our system is also coordinated with UPnP based light system that can be dimmed or switched according to position of persons.

2. Single Board Computer and FSR

Fig. 1 shows the total flow of our proposed smart location tracking system. Using a GPIO(General Purpose Input Output) function of the Single Board Computer which equipped Intel PXA 255 CPU, we scan sensor array to get pressure data and then process response value of a sensor every time. Size of an experiment space is 720cm x 660cm, and size of an each block is 60cm x 60cm. Fig. 2 shows size and structure of block. FSR(Force Sensing Resistor) is installed in an each block of a smart floor.

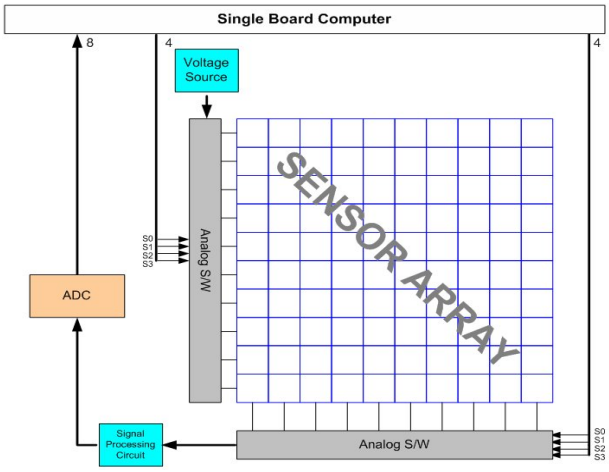


Fig. 1 Overview of our smart location tracking system

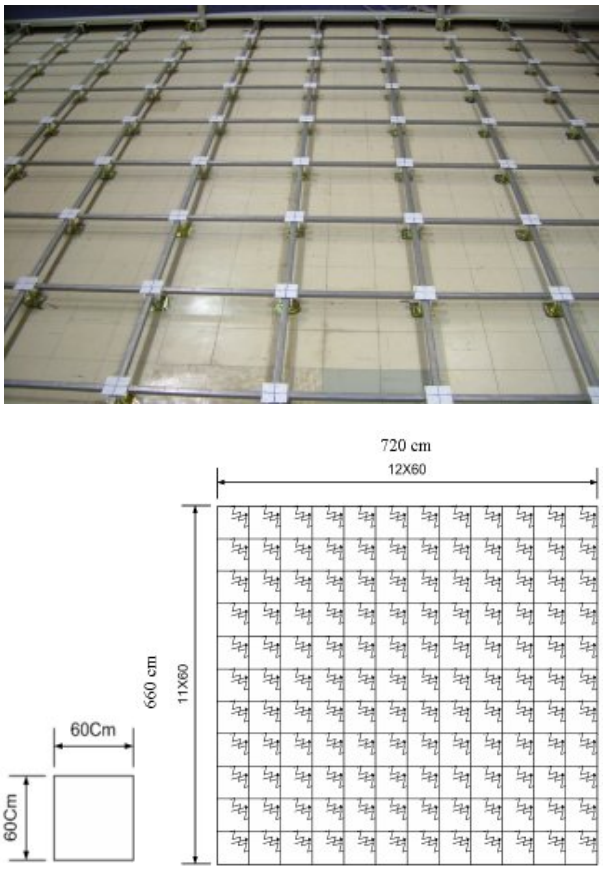
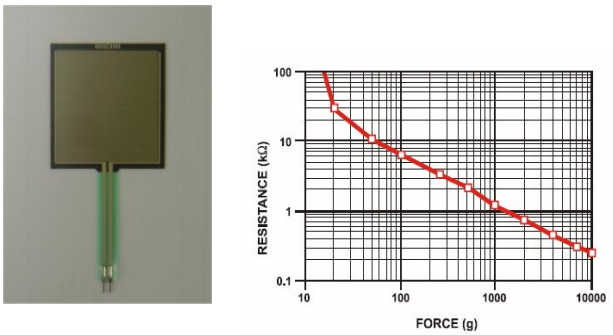


Fig. 2 Structure of the smart floor using FSR

FSR used in experiment is a PTF(Polymer Thick Film) device which exhibits a decrease in resistance with an increase in the force applied to the active surface. Fig. 3 shows the shape of FSR and the characteristics of force vs. resistance. For interpretational convenience, the force vs. resistance data is plotted on a log/log format. In general, FSR response approximately follows an inverse power-law characteristic (Roughly 1/R)[5].



(a) FSR sensor (b) Resistance vs. Force

Fig. 3 FSR shape and characteristics of force vs resistance

The PXA255 processor of a single board computer used in experiment is an integrated system-on-a-chip design based on the Intel® XScale™ microarchitecture. The PXA255 processor provides 85 GPIO pins for use in generating and capturing application-specific input and output signals. Each pin can be programmed as either an input or output.

We can use the GPIO Pin Direction Register (GPDR) to set whether the GPIO pins are outputs or inputs. When programmed as an output, the pin can be set high by writing to the GPIO Pin Output Set Register (GPSR) and cleared low by writing to the GPIO Pin Output Clear Register (GPCR). The set and clear registers can be written to regardless of whether the pin is configured as an input or an output. If a pin is configured as an input, the programmed output state occurs when the pin is reconfigured to be an output. Validate each GPIO pin's state by reading the GPIO Pin Level Register (GPLR). We can read this register any time to confirm the state of a pin.

3. System Configuration

The proposed FSR-based smart location tracking system is composed with sensor array, sensor interface board, single board computer. Sensor array is form of matrix with 22 x 20 and interface board is composed of a circuit to get pressure data from sensor array. Here, single board computer is used to process the data which got through interface board. Fig. 4 shows system configuration to get data from sensor array.

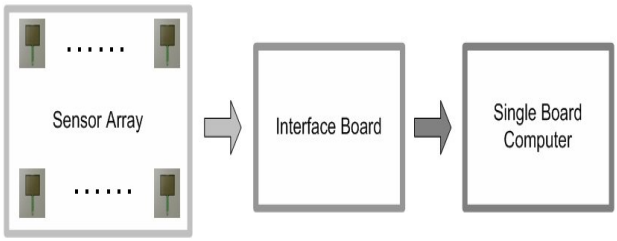
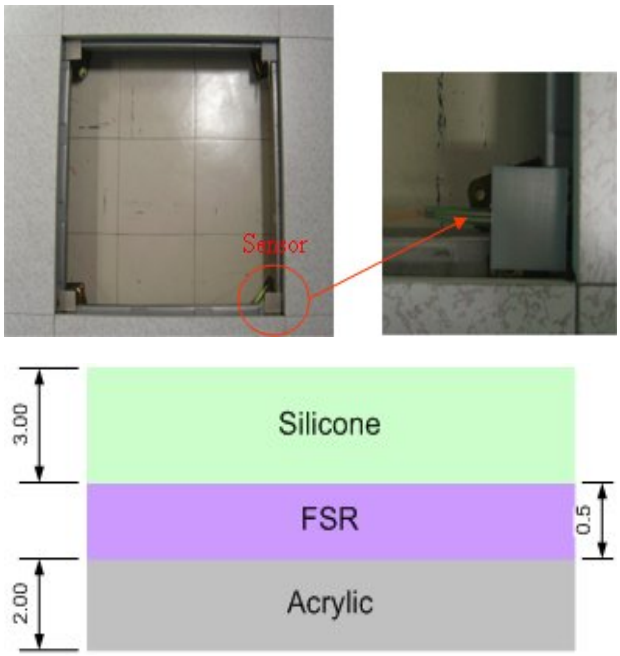
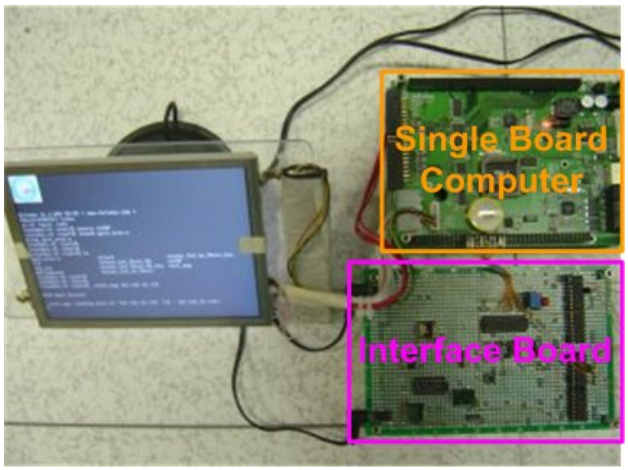


Fig. 4 System Configuration

Fig. 5(a) shows the structure of sensor array and (b) shows single board computer and interface board. We use silicone to absorb from inconsistent force distributions.



(a)



(b)

Fig. 5 Experimental devices

4. Experimental Results

We could get a pressure and position of person from smart floor. Sensor server system transmits a position and pressure data of a user to control pc. We can navigate and interact with a computer under virtual environment using position and tapping behavior of a user. Additionally, we can control mobile speed according to pace of a person. Fig. 6 shows example of application using smart Floor and Fig. 7 shows experimental environment and results.

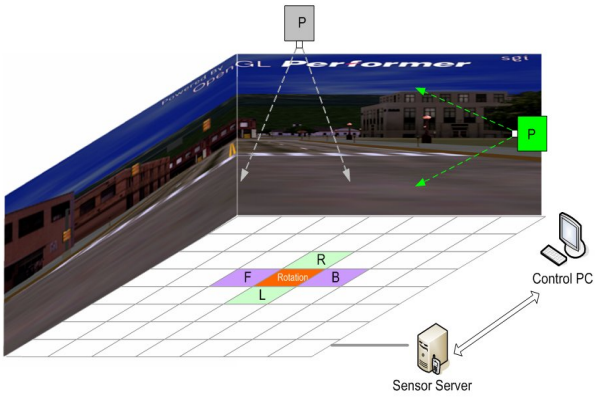
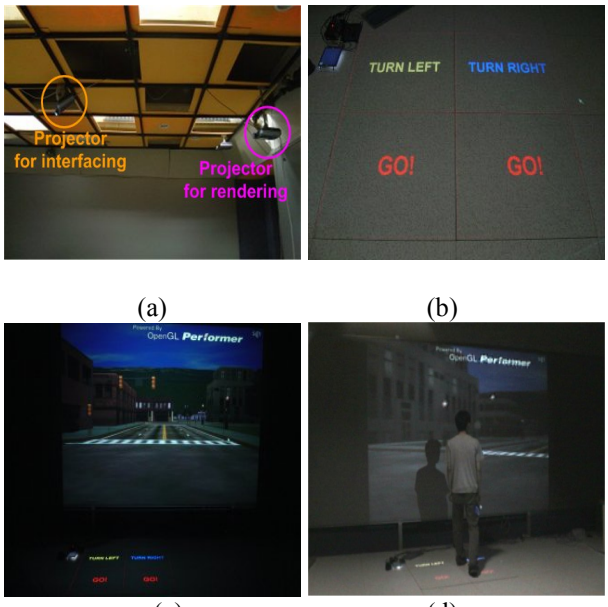


Fig. 6 Application using smart floor



(a) (b)

(c) (d)

Fig. 7 Experimental environment and result, (a) projector for user interface and rendering, (b) user interface for walking (c) contents (d) walking experimentation using FSR interface

FSR sensor array is coordinated with UPnP(Universal Plug and Play) and so can be operated such as UPnP device. Fig. 8 and Fig. 9 show UPnP action of smart floor and experimental results.

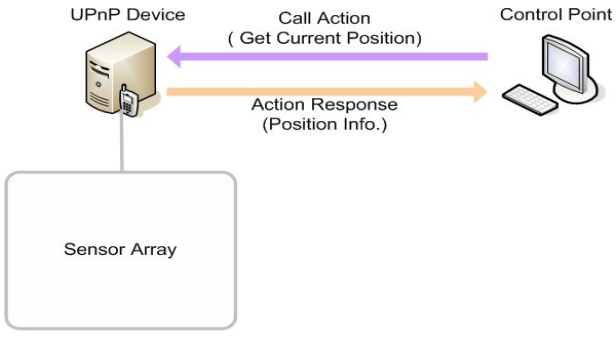


Fig. 8 UPnP action of smart floor

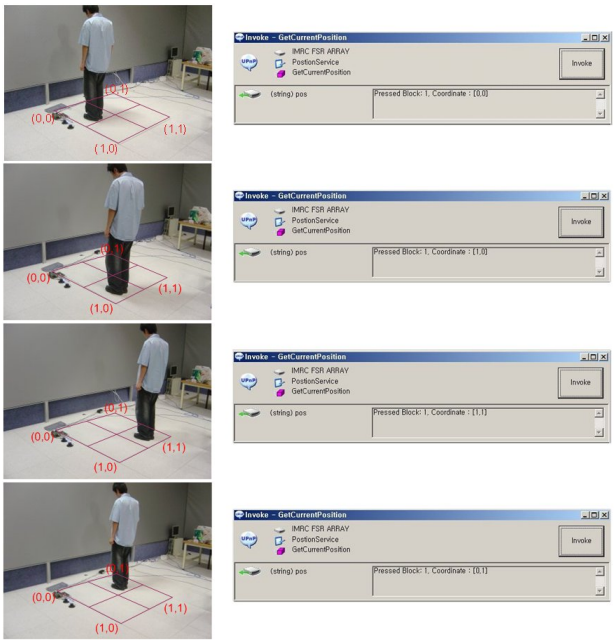


Fig. 9 Experimental results

5. Conclusion

This paper presents a smart location tracking system using FSR(Force Sensing Resistor). It should be emphasized that our system doesn't need to attach a sensor to human body unlike with the RFID tag system. Our system can be used for several areas of applications, for example, location tracking, context aware based on human gait recognition, and surveillance. Our system also can be used for the automatic world modeling using pressure sensing of each object, which was not possible in computer vision system. In the Future, we will interwork between sensor array and UPnP based light system as shown in Fig. 10. We can dim light and switch power according to position of person.

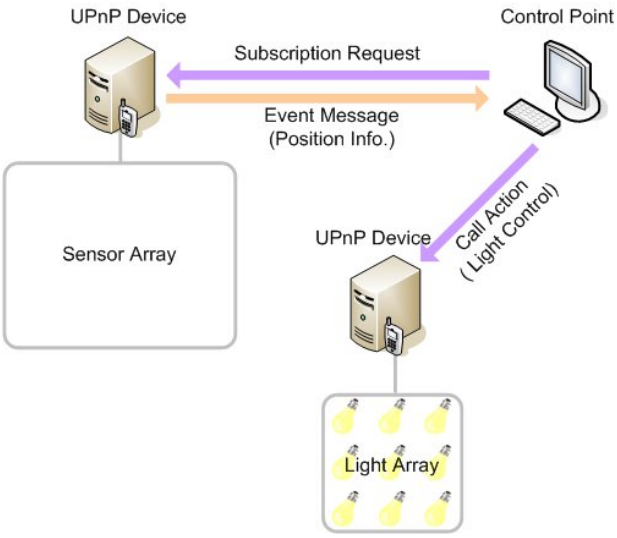


Fig. 10 Interworking between UPnP and sensor array

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