PORTABLE SENSOR ATTACHMENT

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PORTABLE SENSOR ATTACHMENT

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ABSTRACT

The rapid development of technology is placing an enormous demand for smart phones and similar devices as we are requiring more and more from these mobile devices. One of the major products which are becoming increasingly popular is the mobile phone. There are many sensors that may be used in such applications and some of which are: the accelerometer, digital compass, gyroscope, temperature, camera, etc. These sensors help enable new applications such as guiding systems, social network, health, gaming, entertainment, education, transportation, and many more. This paper presents the design, development and implementation of a portable sensor attachment that includes several sensors. The device includes sensors such as accelerometer, gyroscope, light level, atmospheric pressure, temperature and compass that may be used for human gait analysis, indoor/outdoor localization and navigation. This device can be coupled with any Bluetooth enable host device and data will be transferred to the host for further processing.

***Key words*:** Sensors, Mobile Devices, Smart Phones, Sensor Attachment, Bluetooth, Accelerometer, Gyroscope, Locomotion Analysis, Localization, Navigation

1. INTRODUCTION

The tremendous growth of sensor technology has replaced personal computers as well as sensor modules with smart phones; the primary advantage of smart phones is embedded sensors for a variety of applications. These applications interact with people's lives in many areas such as global environment monitoring, transportation systems, games and sports, and many more. Using this large scale of sensing data helps to analyze lots of useful information which can be used in any field. Researchers have come up beyond the boundaries of traditional scale of research and have introduced new technology which contributes sensing devices with new models, applications, algorithms & systems [1].

This project consisted of many sensors needed for locomotion/ gait analysis, localization and guidance systems. Locomotion monitoring is a study of biomechanics involved in human locomotion and gait development. Human performance on information dependant tasks can be improved by sensing which provides information (e.g. position, orientation) & environment cues via the use of appropriate sensors & sensor fusion algorithms [2].

With the use of this localization aid, guidance and navigation, algorithms can be implemented which will greatly increase the safety and overall mobility of its user.

There are many sensors used in locomotion analysis, localization, guidance systems and navigation systems; but all these sensors are currently not available even in high end portable devices; and a very few sensors or not at all are available in low end devices. If this gap can be fulfilled by a device, any smart device may be used for processing [3].

The only device which has sensors related to locomotion analysis, localization and navigation is the Smart phone.

The main problem with those devices is the higher cost. The other problem is that those phones have features such as touch screen, soft outer covers and therefore they cannot be used in a harsh environment [4].

Due to the rapid development of technology, people are increasingly interested in products which have multiple uses and ultimately sensor attachments have become a requirement, which engineers are searching for.

2. METHODOLOGY

2.1. Hardware Implementation

Microcontroller and the sensing data are the heart of this project. The raw data of all sensors are manipulated through microcontroller. Bluetooth is the data transferring method and all manipulated data is stored in SD card for further analysis [5]. Figure 1 shows the block diagram of the entire system.

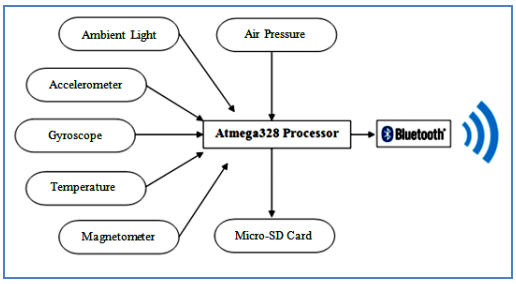

Figure 1: Block diagram of the system

Table 1: Sensor Specifications

Sensor	Part Number	Resolution	Ranges	Interface
Accelerometer	ADXL345	10-bit	up to ±16 *g*	Digital- I²C
Gyroscope	ITG3200	16-bit	14.375 LSBs per °/sec	Digital- I²C
Magnetometer	HMC5883L	12-bit	1° to 2° Accuracy	Digital- I²C
Air Pressure	BMP085	19-bit	300 - 1100hPa	Digital- I²C
Temperature	TMP102	12-bit	–25°C to +85°C	Digital- I²C
Light Level	TEMT6000	10-bit	Sensitivity $\phi = \pm 60°$	Analog

Table 1 shows the most important specification of sensors which are used in the device such as resolution, data range and interface.

2.1.1. Data Transmission Rate

Figure 2 illustrates the sequence of data rate of each sensor. The Maximum data is 100 Hz of each sensor.

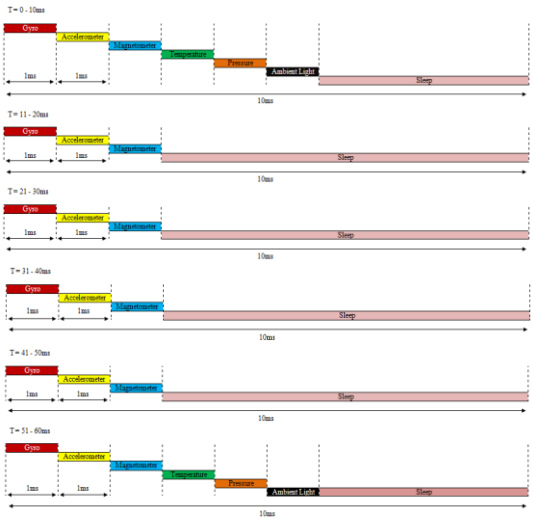

Figure 2: Data transmission sequence

Figure 2 shows data transmission sequence. The fluctuation of data changing is higher in gyroscope, accelerometer and in magnetometer. So the transmission frequency is higher as 100 Hz whereas temperature, pressure and light level data transmission sequence is at 20 Hz.

2.2. Software Implementation

The user can understand the sensing data separately. The data is converted to information and displayed in PC interface or using android application.

A. Implementation of PC Application

The .NET framework version 2.0 (beta) provides features for serial communication. The framework provides *System .IO .Ports* namespace. The new framework provides classes with the ability to access the serial ports on a computer, and to communicate with serial I/O devices [6].

PC application is designed to analyse the data sequence of sensors. All the data gathered to PC and send to further processing. Simple data receiving interface for the accelerometer in shown in Figure 3.

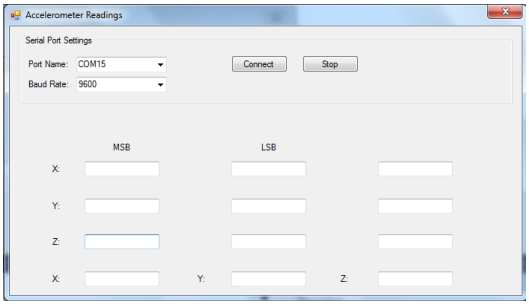

Figure 3: Interface of PC accelerometer readings

Figure 3 shows the display of a single sensing data. The final interface is display of all sensing data as accelerometer, gyroscope, magnetometer, air pressure, ambient light, and temperature sensing data. And all the data will be stored in SD card for further analysing purposes.

B. Implementing Android Application

The interface for Bluetooth Sockets is similar to that of TCP sockets: Socket and *Server Socket*. On the server side, use a *Bluetooth Server Socket* to create a listening server socket [7].

Figure 4 shows a simple data receiving interface

for the raw sensor data via Bluetooth. When a connection is accepted by the Bluetooth server socket, it will return a new Bluetooth socket to manage the connection. On the client side, android application use a single Bluetooth socket to both initiate an outgoing connection and to manage the connection.

The important feature of the application is user can chose the data rate as his desires.

Figure 4: Interface of Android Data Readings

3. RESULTS

Surface mount level PCB was designed as the final product without modules and kits. Figure 5 shows the final product with twenty pence to contrast the size of the product.

Figure 5: Final Device

The basic interface is the PC data receiving interface. The Maximum data rate is 100 Hz. Since the user can select the data rate as 1 Hz, 5 Hz, 25 Hz, 50 Hz and 100 Hz.

Figure 6: PC Data Receiving Interface

The Figure 6 shows the receiving data of the transmitter. The upper half shows the raw data and the lower half shows the converted information of the data.

Figure 7 shows a demo box which is enclose of the software for demonstration purposes. Box is rotated according to sensor data.

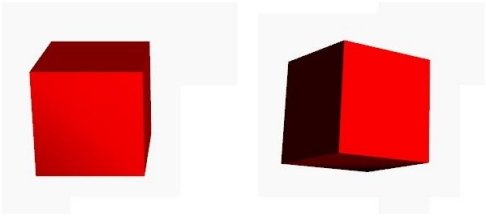

Figure 7: Demo Box

The raw data of Accelerometer and Gyroscope is shown in Figure 8 as a graphical interface.

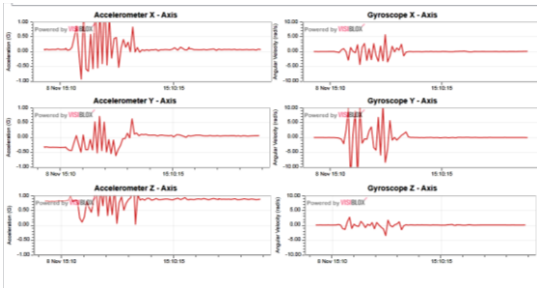

Figure 8: Received Data in Graphical Format

Through these graphical interfaces the data variation of accelerometer and gyroscope can be analysed.

4. CONCLUSION

The paper presented a Bluetooth embedded sensor attachment that consist of many sensors needed gait analysis and localization.

For human motion analysis, sensors such as accelerometer and gyroscope are used while for localization; sensors such as light level sensors, air pressure sensors, temperature sensor are used.

For navigation purpose compass is used. This device can be coupled to any Bluetooth enable host device and data is been transferred to the host for further procession. The raw data of all sensors are manipulated through micro controller. Bluetooth is the data transferring method and all manipulated data is stored in SD card for further observations. One major improvement that can be done is using Wi-Fi instead of Bluetooth. So then the user can analyse the data without distance barrier which will be effective in guidance systems.

The data rate can also be used in more accurate ways using efficient signal processing techniques. In addition, the saved data can be converted into valuable information in real time though software applications and this may be low cost and more effective way of manipulating data. In mobile communications this type of device may be coupled with all smart mobile devices, and may merge with several industries such as electronics, automation, weather forecasting, and robotic control etc. In addition, researchers on guidance systems, locomotion analysis and navigation will also be benefited.

5. REFERENCES

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