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A Literature Survey on

**Android based Monitoring Human Knee Joint Movement Using Wearable Computing**

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**INTRODUCTION**

The aim of this project is to monitor the human knee joint movement on an Android application, by using two accelerometer sensors and a Renesas RL78 microcontroller with a Bluetooth module. The accelerometer sensors generate an analog voltage output depending on the orientation of the sensor along x, y and z axis i.e. three dimensional accelerometer sensors [1]. This output is then converted into a digital value by using an ADC and displayed on a LCD interfaced with the microcontroller. Later this value is sent via Bluetooth to an Android application which generates a pie chart indicating the various users’ physical activities such as walking, sitting, running etc. [1]. We found that the accelerometer sensors suit our requirements [3][6][7].

We propose this system as this idea was brainstormed by referring to various IEEE papers and by using suitable ideas from them and also we have added some additional attractive features to the system such as providing an emergency button which when pressed triggers a buzzer and also ensures that the Android Application sends an Email alert with the location of the user by using the user’s phone’s GPS.

The field of Body Sensor Network (BSN) is very useful in constantly monitoring the body’s movements in rehabilitation activities [2]. In our case we consider that the user might want to recover quickly after a knee operation and user along with the doctor needs to constantly monitor the different activities performed by them to ensure that there is not much of stress/strain applied on the knee due to excessive activity. Thus this data is very crucial for the physiotherapists who ensure that the effectiveness of the rehab program is quite high and user achieves a timely recovery [2].

The Android application also provides persistent storage by keeping a history of previous readings that it received via Bluetooth. This makes sure that ADL i.e. activity of daily living [1] is monitored on a long term basis. Further Bluetooth has been used as the mode of communication between Renesas RL78 and the Android application as there’s no dependency on the availability of internet connection. Renesas RL78 is a 16bit microcontroller widely used in various industrial and medical applications [4][5]. Thus we have chosen it for our system.

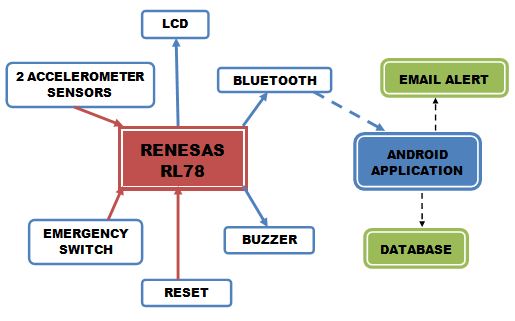
**MAIN BODY**

As our concentration is on monitoring the movements in the knee joint we have used a 3-axis accelerometer which gives more precise readings [1]. The first reference paper uses a 2-axis accelerometer sensor with a ATmega8 microcontroller as this paper aims at fall detection thus the readings of the sensors need not be very accurate and thus they have used a 2axis variant. However, in our system the readings need to very accurate as it is used by the Android application to determine whether the user is sitting, standing, walking etc. Thus the aim of [1] is to estimate fall detection but the idea of using accelerometer sensors has been quite efficient and we would thus be using it in our system too.

The aim of [2] is to determine the knee joint angle using gyroscope and flex sensors for rehabilitation purposes. From this paper we got the idea of monitoring body joints as Body sensor networks (BSN) is a field which is rapidly growing and needs relatively easy to use and comfortable wearable computing to monitor the body. Thus we are concentrating on monitoring the knee joint movement rather than the angle as the angle wouldn’t be an effective way to monitor the user’s movements. Instead we would be using a pie chart that attractively displays the data and yet effectively monitors the user’s knee to ensure quick recovery.

Further [3] gives an overview of the advantages and characteristics of using accelerometer sensors. This was a motivation for us to use this sensor in our system too. Also we wanted the user to actively monitor his knee by providing him with a very efficient GUI. Thus we came up with idea of an Android application which communicates with the Renesas Microcontroller [4]. This is feasible by interfacing a Bluetooth chip with the microcontroller and thus it transfers the sensors data via Bluetooth and hence it’s not dependent on internet connectivity. Also we have used an emergency button which when presses trigger a buzzer which can be deactivated by pressing the reset button. This ensures that if the user is in tremendous pain he can gather the attention of the people around him and also an Email alert is sent to the doctor from the Android application along with his/her GPS location.

The system that we have proposed is shown in Figure1. It efficiently takes ideas from different papers and integrates them to achieve maximum benefit and also ensures that the design is cost effective but at the same time efficiently solves the problem at hand. Thus the tradeoff between performance and cost has been effectively managed.



**Figure1. Proposed Architecture for monitoring Knee Joint Movement**

**CONCLUSION**

The system that we have proposed is light weight and can be used on a daily basis and will help in quick recovery. This is quite different from other knee joint monitoring systems as most of them that are available in the market are quite sophisticated to understand and use. Further we are developing an Android application which communicates with the microcontroller via Bluetooth and thus doesn’t need internet connectivity. Also persistent storage is provided by the app. The 3-axis accelerometer sensors give precise information when there’s a knee movement. The UI is simple and yet performs all the functionalities efficiently. In case of any unforeseen events an emergency button and a buzzer has also been provided along with the LCD which constantly displays appropriate messages to keep the user informed if there are any technical glitches. By sending an Email alert to the doctor along with the GPS position of the user it ensures that the user receives immediate care.

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