**M S Ramaiah Institute of Technology**

(An Autonomous Institute, Affiliated to VTU)

MSR nagar, MSRIT post, Bangalore-54

A ***SRS*** on

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

**Wearable Computing**

Submitted by

Sanjana K. S 1MS12CS098

Vidit Jain 1MS12CS127

Vignesh P 1MS12CS128

Vishal H 1MS12CS132

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**M.S. RAMAIAH INSTITUTE OF TECHNOLOGY**

**(Autonomous Institute, Affiliated to VTU)**

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**SOFTWARE REQUIREMENT SPECIFICATION**

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9. **PRODUCT OVERVIEW**

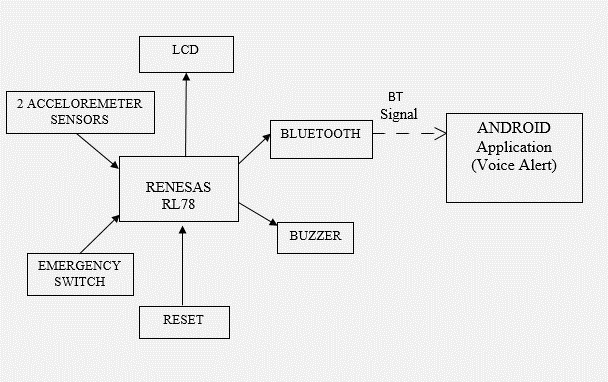
If an individual, say an athlete, is injured in the knee utmost care has to be taken in-order to recover as soon as possible. For thispurpose, the amount of bending around the knee due to an athlete’s day-to-day activity, needs to be monitored at every instant of time. If the athlete bends his injured knee too much accidently, then chances of damage to the injured knee would increase and the speed of recovery would take more time.

To facilitate proper correction for speed recovery from damage caused at joints, in this case knee, we propose a system which uses accelerometer sensors placed on both the side (one above the joint and the other below the joint) of the joint. Whenever the bends around the joints is more, the athlete is alerted and hence can make the necessary correction. In this case the speed of recovery around the joints will be much faster. Also a pie chart will be maintained on an Android based Smartphone. This chart can provide an insight to physician or doctor regarding the amount of bending around the joints.

The acceleration readings are provided by accelerometers on different axis – x, y and z. These readings are obtained by monitoring changes in the positions of two accelerometers, placed on either side of the joint of an individual. Any movement that occurs at particular joints where accelerometers is placed will cause the accelerometer to generate an output voltage corresponding to the change in gravity. These voltages are fed as input to the microcontroller. The microcontroller further processes this information and delivers an output which is transmitted via Bluetooth to an Android based application mobile. The Android application converts incoming messages into voice output. The microcontroller located at the center of the block diagram in Figure1. forms the control unit of the entire project. Embedded within the microcontroller is a program that helps the microcontroller to take action based on the inputs provided by the output of the sensors.

An emergency switch is included in this project demonstration. If there arises a scenario, wherein the individual may require assistance of another human being who is not present in that particular room, pressing emergency switch would cause the buzzer to buzz, thereby drawing the attention to another human being.

In the below block diagram LCD is utilized to demonstrate the working of the entire unit. Further a web application with cloud storage for monitoring the values of sensor from anywhere along with Gmail alerts has been planned to be implemented.

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**Figure 1. Block Diagram**

**2. EXTERNAL INTERFACE REQUIREMENTS**

**2.1 User Interfaces:**

The user interface includes an Android Application and a LCD screen. The android application will be highly interactive, efficient, and attractive but would yet be simple and possess a sleek look. Also this interface will be highly user friendly and will perform two important tasks. One of them is that it would produce an audio message after the Bluetooth signal has been received from the wearable computing kit. Another task is that it would enable the user to keep a track of the angle of bend in the knee joint and this would be helpful for analysis and speedy recovery. The LCD screen displays the voltage value that is produced as the output by the microcontroller for the corresponding sensor inputs. The user interface shall be implemented using Java and a framework like Android Studio. A web application to can be implemented where alerts are triggered to keep the relatives informed in case of emergency events.

**2.2 Hardware Interfaces:**

The hardware interfaces will include the need of wireless internet connectivity to send Gmail Alerts in case of unforeseen emergency events and also to update the Web Application. Rensas RL38 Microcontroller is the hardware device which is responsible for co-coordinating various activities with respect to the project and is the core component. Further accelerometer sensors are used to measure the change in position of the knee and its output is fed to the input of the microcontroller. A Bluetooth module must also be interfaced. The LCD screen displays the output voltage of the microcontroller. A buzzer is triggered when the knee bends beyond a threshold angle and an emergency switch is provided.

**2.3 Software Interfaces:**

The values are sensed from the accelerometer sensors which is then fed to the microcontroller. An assembly language program is written and embedded into it to covert the sensor value to a corresponding voltage value as its output. Further Java and a framework like Android Studio will be used to develop the Android Application and also to send the intended Gmail Alerts to the doctor. Further CSS, HTML5 etc. can be used to develop the Web Application which runs on an Apache Tomcat Server.

**2.4 Communication Interfaces:**

SMTP is the communication protocol used to send Email Alerts to the doctor which uses port number 25. Further for the Web Application HTTP protocol is used which runs on port number 80. Also a Bluetooth signal is used as the communication interface between the wearable computing kit and the Android Application running on the mobile device of the user. Also a voice message is played out to the user upon the receipt of the Bluetooth signal indicating the angle of bend in the knee joint and serves as another type of communication interface between the Android Application and the user.

**3. FUNCTIONAL REQUIREMENTS**

**3.1 Functional Requirement 1.1: Tracking of the angle of Bend in the Knee joint**

The angle of bend in the knee joint can be constantly monitored by the user in the android application and thus can take preventive measures and ensure that he/her recovers quickly from the surgery/injury.

**3.2 Functional Requirement 1.2: Email Alert**

In case if the angle of bend in the knee joint exceeds drastically due to some unforeseen event and when the user is in pain an automated Gmail Alert is sent to the user’s doctor.

**3.3 Functional Requirement 1.3: Online Monitoring**

The values sensed by the accelerometer sensors can also be monitored online with the help of a web application. This is particularly helpful when the user is alone and others want to monitor his/her status.

**3.4 Functional Requirement 1.4: Handle Emergency Events**

The user is provided with an Emergency button to trigger the alerts and also to activate the buzzer.

**3.5 Functional Requirement 1.5: Attention of Surroundings**

Once the buzzer has been activated by the user and he/her has drawn the attention/help of the people in the surroundings, it can be turned off with the help of reset button.

**3.6 Functional Requirement 1.6: Maintaining History**

The Web Application also maintains a log/history of the sensed values which be accessed at any time.

**3.7 Functional Requirement 1.7: Voice Message Alert**

The Android application also has the functionality of converting the Bluetooth signal into a corresponding voice signal in order to provide a voice alert.

**3.8 Functional Requirement 1.8: Usage of LCD**

The LCD screen displays the voltage output produced by the microcontroller corresponding to the angle of displacement.

**4. SOFTWARE SYSTEM ATTRIBUTES**

**4.1 Reliability:**

The reliability of the product depends on the lifetime of the accelerometer sensors and the accuracy of the measurement. As lifetime and accuracy is high the system is reliable. Further the android application would be rigorously tested to ensure that the application does its intended tasks in real time and doesn’t generate fake alerts due to some bugs.

**4.2 Availability:**

The basic functionality of the system except the Gmail Alerts and Web Application is always available as long as the device is worn by the user. For Gmail Alerts and Web Application updates internet connectivity is needed.

**4.3 Security:**

The scope for security in this product is more over concerned with privacy. Only the authorized phone of the user must be capable of receiving the alerts and more over the data readings stored in the web application must be kept safe and thus authentication and authorization can be added. The system shall not leave any cookies on the customer’s computer containing the user’s password. The web browser shall never display a user’s password. It shall always be echoed with special characters representing the typed characters.

**4.4 Portability:**

One of the features of Java is that it is architecturally neutral i.e. the code is machine/platform independent. Thus the same application can run on different Android phones and its backward compatible with respect to a specific Android phone version. Also the Web application can be accessed from a variety of browsers.

**4.5 Maintainability:**

The Android application needs to maintained and updated in case of any bugs. Updated applications will be free from bugs and also some design oriented changes can be incorporated to make the interface more user-friendly and attractive.

**4.6 Performance:**

The product’s performance is measured in terms of responsiveness, efficiency and user experience. A product with high performance will be delivered. Performance is high if the throughput is high, latency is low, response time is less and system dependability exists. The changes in the angle of the knee joint must be measured with accuracy and also in real time. Performance is also affected by the speed of internet connectivity for updating the web application and also for sending Email Alerts.

**5. PERFORMANCE REQUIREMENTS**

The only way in which systems will meet their performance targets is for them to be specified clearly and unambiguously. It is a simple fact that if performance is not a stated criterion of the system requirements then the system designers will generally not consider performance issues. In order to assess the performance of the product the following are clearly specified:

* **Response Time**- It depends on the microcontroller used as it needs to execute the embedded program to convert the sensor value into a voltage signal and then needs to transmit the Bluetooth signal. The response time needs to be low.
* **Workload**- Even if the workload on the system is increased the performance doesn’t degrade as Rensas RL78 microcontroller has a 16bit CISC architecture. RL78 is designed specifically for ultra-low power applications enabling customers to build compact and energy-efficient systems at lower cost.
* **Scalability**- The product is highly scalable as it can be worn by various users if they have any problem in their knee and all that they need to do is to install the Android application on their phone.
* **Platform-** The microcontroller is Rensas RL78 that uses 16bit CISC architecture and the Android application is built using Java and a framework like Android Studio.

**6. DATABASE REQUUIREMENTS**

A database is used to provide persistent offline storage as it keeps a log of the values sensed by the accelerometer sensors along with the date and time. The database used needs to be a relational database, for example MySQL can be used.

**7. DESIGN CONSTRAINTS**

1. **Space**: The amount of space occupied by the embedded program must be less as it needs to be incorporated into the Rensas RL78 microcontroller. Further the android application must be of size less than 100MB.
2. **Application memory Usage**: The amount of memory that is cache as well as main memory used must be low while executing the embedded program. This is to meet the requirements of the microcontroller.
3. **Budget**: The amount of money that can be spent on the hardware must be less than Rs3000/- so that the price of the overall is quite reasonable.
4. **Application Quality:** The quality of the product must be good and also it must be comfortable to wear it on the knee.

**8. OTHER REQUIREMENTS**

1. **Help:** A detailed user manual which is easy to follow must be developed and also an online demonstration of how to use the product must be available.
2. **Android version:** The application developed must be simulated on the latest Android version and also it needs to be backward compatible.