IOT Based Soldier Navigation and Health Monitoring System

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Abstract : In current world scenario the security of a nation is the uttermost important factor and hence enemy warfare plays an important role. The security of any nation depends on the military, army, air-force and navy of the country and the backbone of all these forces are our soldiers. Without the soldier it would be nearly impossible to protect a nation. But there are many concerns revolving around the security of these soldiers, especially the army soldiers. Even today when the world is at its prime for technology development, the army is still using rudimentary techniques especially when navigation technology is taken into consideration. When the soldier enters into the war zone, it is essential for the base station to determine the exact location and the health status of the soldier and hence more emphasis should be given to navigation and health monitoring technology for the soldiers in the war torn zone. In this project the exact location and the health status parameters of the soldier can be sent to the base station in real time so that the appropriate actions can be taken in case of crisis. This technology helps to minimize the rescue, time and search operation effort of army rescue control unit. This system uses GPS module and wireless body area sensor network to record all parameters in real time and send it to the base station. The different types of sensors used in this system are the humidity sensor, temperature sensor and pulse sensor which help in deciding the health status of that particular army official. This is a wearable technology which is the most important factor of this project.

Key Words: **Embedded Systems, Rasberry pi 3, Ardiuno, Zigbee, Sensors, Navigation, GPS, interfacing, Communication**

I. INTRODUCTION

The combined unit of Hardware and software constitute an "Embedded System" which is also integrated together to build a system which helps in design goals like speed and efficiency. The main advantage of embedded systems is the flexibility to choose desired hardware and software components to design the desired system which performs the desired task. This project is based on the above mentioned merits of the embedded system. There is a necessity to develop a wearable technology which isn't bulky and dissipates very little power in the defence sector so that the location and vital health parameters of the soldiers can be tracked in real time when he is on the battlefield. Using this Soldier Navigation system the base station can guide the soldier to reach the desired destination. The main essence of this project is that it is an Internet of Things (IOT) based project. IOT systems are systems that consist of interrelated machines(mechanical or digital), computing devices, animals, peoples and other objects which have unique functionalities and using the IOT their data can be transferred from one place to another over the network without the computer to computer and human to computer intervention. The relevance of IOT in Soldier Navigation and Health Monitoring system is that the real time location and health parameters of the soldier on the battlefield are instantaneously sent to the base station without the soldier having to input anything. The IOT makes the entire monitoring process fast, efficient and the decisions can be taken in less amount of time. The Raspberry Pi 3 is used as a gateway for displaying the sensor values over a server known as Thingspeak. Also, Raspberry Pi 3 gives better protection and isolation from stray intrusion.

II. RELATED WORK

Shruti Nikam and et.al explain in this paper the tracking of the location of the soldiers when they enter the enemy land. For tracking their location GPS(SR87 series) module was used which is highly sensitive and it can track upto 20 satellites at a time that helps in finding the accurate position of the soldier. Along with tracking the paper also incorporates the soldier safety and security aspects such as monitoring the blood pressure and temperature of the soldier. LM35 sensor and pulse rate sensor was used that are not very complex and can be easily fitted in a tiny device. ARM processor (LPC2138) which follows the principles and basic theory of on a 32 bit ARM7 TDMI-S CPU and which gives a very high speed communication. ARM processor is interfaced with graphical LCDs to display various parameters like height, speed, body temperature and pulse rate [1]. Richard B. Marth and et.al have introduces an integrated navigation system for the soldiers. DRM(Dead Reckoning Modules) and GPS constitute the main components of this integrated system. For decades, the soldiers have used all the conventional basic tools such as compass and other navigation tools while they are on their mission. DRM replaces the need for a compass as it

allows reliable and hands-free navigation. DRM consists of an analog circuit and a digital circuit. Analog board has magnetometers, accelerometer, temperature sensor and a barometric altimeter. These components are useful to determine the horizontal component of magnetic field, number of steps taken by soldiers, temperature etc. RS232 serial interface ports are used by DRM for communication. Kalman filter is used in integration mode that makes use of both GPS and DRM. This filter can adjust the step size, body offset as well as spurious jumps in GPS position. Thus, the integrated navigation system allows soldiers to focus on the mission because of automatic pace count and indication of the direction and distance to waypoints which helps soldiers to avoid obstacles in their path [2]. Xinfeng BA and et.al have presented a system that monitors the health status of soldiers, soldier tracking andBeidou satellite navigation system which is also a wired communication system is used for two-way short message communication signs acquisition and soldier positioning. The hardware system has two ports: Handheld devices and Wireless Pulse Acquisition system. Handheld device consists of S3C2410 embedded processor, Bluetooth modules, peripheral circuit and communication terminal module. Msp430 single chip microcomputer, pulse signal amplification circuit, pulse sensor and Bluetooth module are components of Wireless Pulse Acquisition System. Specified soldiers are sent short messages via the Beidou navigation system [3]. Vongsagon Boonsawant and et.al have proposed a basic prototype system based on wireless sensor networks for monitoring temperature in a building. Xbee wireless communication module which is based on the IEEE 802.15.4 standard was proposed for that kind of a system. WSNs are combination of wireless communication and embedded system allowing transmission of data among various sensor networks. The prototype system was developed for temperature monitoring remotely in each classroom of SIIT. Arduino board that comes with ATMEGA168 is easily interfaced with Zigbee modules. This system consists of two types of nodes co-ordinator and end devices that were deployed within SIIT building which collected temperature readings every one hour [4]. R. Archana and et.al have presented an idea of tracking the location of soldiers and their health status to ensure safety of soldiers when they are in the battlefield. For implementing the project they used PIC mincrocontroller(PIC 16F877A) whose function is to collect data from various sensors (heart rate sensor, temperature sensor) bomb detection unit, GPS unit. All the information sent to the base unit (control room). Paper sensor is used to detect bombs and this sensr has inbuilt communication system. At the base unit, GSM modem is used to receive information which is sent by the main army station. Video camera was also used in this project to display real time videos to base unit [5].Harshavardhan B. Patil and et.al have presented the design and implementation of biomedical parameter monitoring system of patients. The different health parameters measured include ECG monitoring, pulse rate, blood pressure and body temperature. The system consists of two sections: transmitter section (patient's side) and receiver section (doctor's side). The patient is wirelessly monitored and all the data from biomedical sensors are transmitted to microcontroller unit Arduino Uno and then Zigbee module is used to transmit this data to receiver section which is present in the doctor's cabin. LCD is used at both the sections i.e. transmitter and receiver sections to display all the output values from biomedical sensors. This project proves to be very helpful for doctors, as they can analyze the health condition of patients and provide necessary diagnosis and cure the patients quickly [6].

III. MOTIVATION

Necessity for the army base station to identify the health status of the soldier and his surroundings is a must for soldiers behind enemy lines. Tracking the location of soldier may help him if he's off course and blind navigating. Monitoring health parameters gives us assurance of the soldier's safety and his environment. Both of them together might assist rescue operations and guidance of an injured soldier. From the literature survey it was found out that most of the systems used require a lot of space and some were bulky depending on various microcontrollers or technologies used. There were few systems which used the processing power of newer systems like Raspberry Pi and Arduino, which are also easier to program and more focused on implementing ideas rather than supporting circuitry.

1.1 PROPOSED WORK

We propose an efficient system which has an application of tracking the soldier's location and health parameters during the war, which also invokes the military or army officers to plan the war strategies. Base station gets location of soldier from GPS and communication takes place through the Zigbee modules. An important service of the base station is to guide the soldier on correct path if he is lost in the battlefield. The base station can access the current status of the soldier which is displayed on the PC and this system uses The IOT. Therefore an immediate action is taken by sending rescue and help for the soldier or sending backup for threat predicted ahead. Using various biomedical sensor health parameters of soldier's are observed, the position and orientation of soldier is trapped using GPS.

2. SYSTEM ARCHITECTURE

This project uses the master-slave technique for communication. The Raspberry pi acts as the master and the nodes with the soldier act as slaves constantly their health status and location using a Zigbee module.The hardware components requirement for this project are:

- Raspberry Pi 3 with inbuilt wifi module
- 2 Arduino Mega boards
- 2 Zigbee modules
- GPS module

- Temperature and humidity sensor
- Pulse sensor

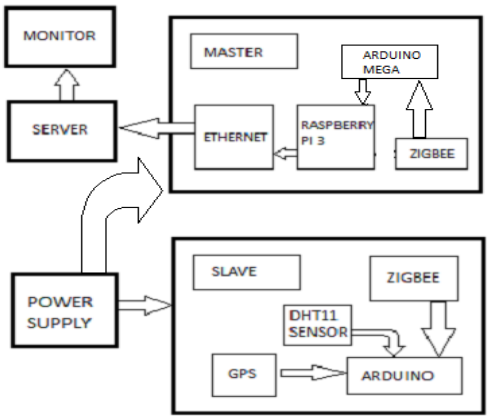

Fig 4: Block diagram of the proposed system

The software requirements of this project are:

- Knowledge of Python(for Raspberry Pi 3 programming) and embedded C(for Arduino Mega).
- Sensor network basics
- Cloud computing basics
- Zigbee protocol and GSM interfacing

2.1 CIRCUIT DIAGRAM

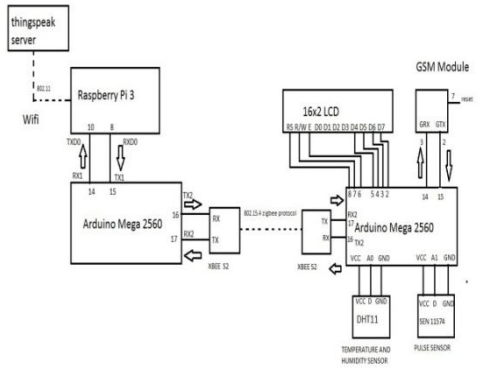

Fig 5:Circuit Diagram of the proposed system

The Arduino Mega(1) board is connected to the sensors, particularly DHT11(humidity and temperature sensor) and SEN 11574 (pulse sensor) both which are Arduino compatible. The Arduino Mega board is also interfaced with a 16x2 LCD which works on 4-bit mode which is used for saving the connecting pins. The 16x2 LCD can be interfaced in 8-bit mode for increasing the speed of the process. The LCD display is used to display sensor reading, GPS location and also used to show messages sent from the base station. The L80 GPS module is interfaced with the Arduino Mega(1) board and it provides us with the location. Final important component interfaced with the Arduino Mega(1) board is the Zigbee S2 module which is used for sending values to other Arduino Mega (2) board. The second Arduino Mega(2) board is interfaced with the Raspberry Pi 3 over the Universal Asynchronous Receiver Transmitter (UART) to send the values received from Arduino Mega(1) to the server. The Raspberry Pi 3 is necessary as it provides better isolation and fault identification if at all it occurs. The Raspberry Pi 3 is connected over the inbuilt Wi-Fi to an IOT server-Thingspeak which is used for monitoring of sensors values and sending messages.

III. EXPERIMENTAL IMPLEMENTATIONS

2.2 INTERFACING OF ARDUINO MEGA WITH 16X2 LCD

Simulation is a feasible technique to check the interfacing of components before its hardware implementation. Proteus 8 software is an excellent platform to check all the interfacing and simulation. The 16X2 LCD interfacing with the Arduino Mega(1) was done using this software to obtain the appropriate results. After the programming the LCD, the hex file created by Arduino Mega (1) was put on Proteus model of Arduino and the 16X2 LCD displayed the "Helloworld" message.

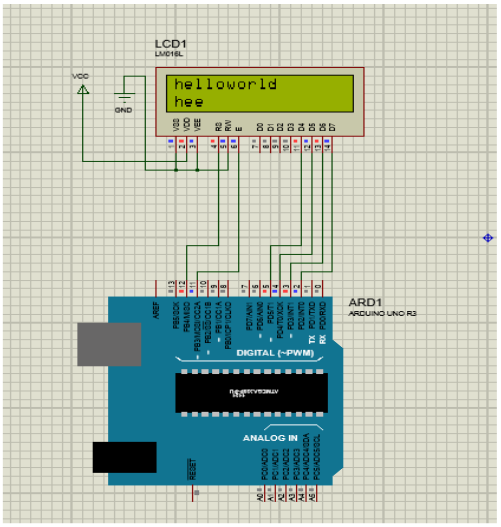

Fig 6: Interfacing of arduino mega with 16X2 LCD

2.3 INTERFACING OF ARDUINO WITH DHT11 AND 16x2 LCD

Once the simulation of LCD was done, DHT11 sensor was interfaced with Arduino. Arduino was programmed in order to display the temperature and humidity sensed by the DHT11 Sensor on the 16*2 LCD. The hex file created by Arduino was put on Proteus model of Arduino. The Arduino Board was programmed in order to display temperature and humidity. 16*2 LCD displayed Temperature as 28 degree Celsius and humidity as 64. When humidity was increased the DHT11 sensor sensed the change and accordingly the LCD displayed the change in humidity as 65.

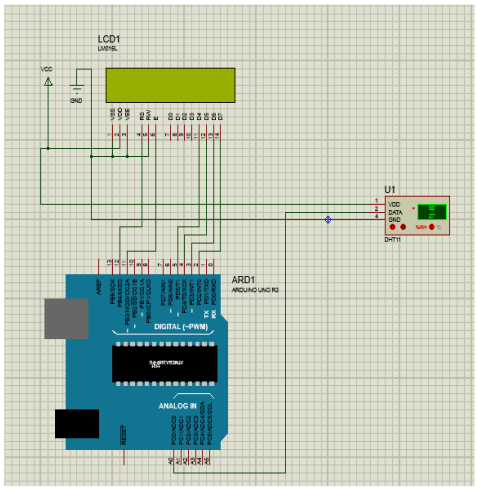

Fig 7:Interfacing of Arduino with DHT11 and 16X2 LCD

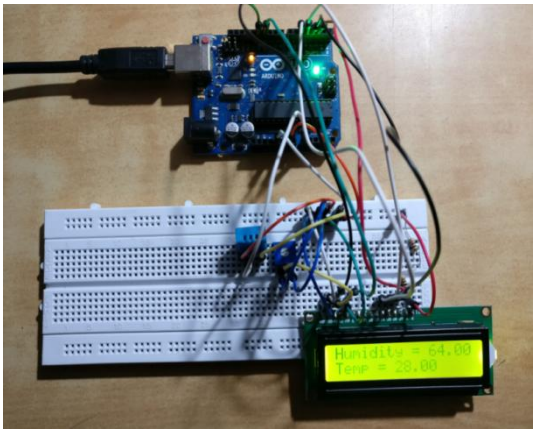

Fig 8: Mapping of Arduino with DHT11 and 16X2 LCD

2.4 INTERFACING OF ARDUINO WITH SEN11574

The pulse sensor has three pins: power supply, ground and signal. The Vcc pin is connected to 5V pin on Arduino2560 , ground pin to gnd while the sensor pin is given to A0(analog pin). The pulse sensor is programmed in such a way so that whenever a pulse is detected, an interrupt is raised for calculating all the pulse related parameters. A 16x2 lcd was used to display the BPM which was refreshed every 2ms. A method of running average was used to calculate BPM so that error was accounted for. When the tip of the finger was placed on the pulse sensor, accurate reading was shown on the LCD display.

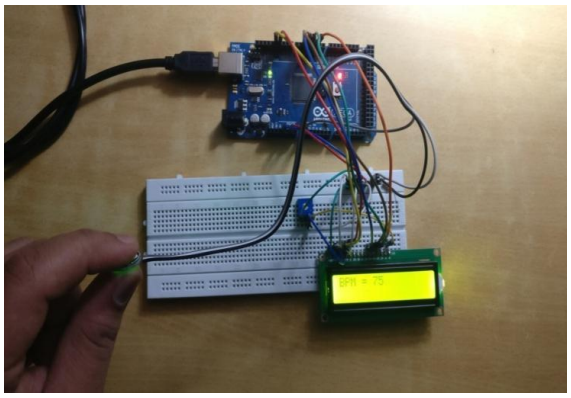

Fig 9: Mapping of Arduino with SEN11574(when finger is on the sensor)

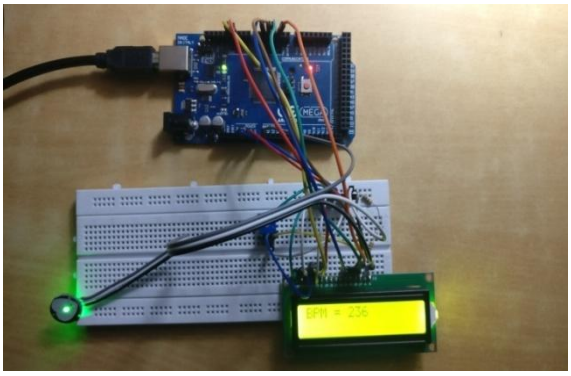

Fig 10: Mapping of Arduino with SEN11574(when finger is not on the sensor)

IV. FUTURE SCOPE

Apart from the brilliant Soldier Navigation and Health Monitoring usage, this system can be utilised by pro trekkers who trek extensively in remote areas and have no means of communication. By using this system the trekkers can be monitored and in case of crisis help can be sent to them as soon as possible. Also, for professionals like wild life photographers and vet doctors who have to go deep into the jungle can make use of this system. This system is useful for the miners too as they work in deep caves and might face health issues.

V. CONCLUSION(BASED ON THE EXPERIMENTAL IMPLEMENTATIONS)

DHT11 gives near accurate reading of humidity and temperature when displayed on LCD as well as the serial monitor. Due to the ease of programming in Arduino, another sensor SEN1154 i.e. the pulse sensor was implemented which gave the Beats per Minutes (BPM) reading.

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