GPS for Kids Care, Pilgrims and Commandos Using ZigBee

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Abstract– **This paper describes design and development of ZigBee smart non-invasive variable physiological and geographical parameters monitoring device. Energy efficiency, robustness and reliability are the key factors for the developed system. The system can be used to monitor physiological parameters like temperature, stress and heart rate of human subject. The system consists of an electronic device which is worn on wrist and finger, by an at-risk person. Using several sensors to measure different vital signs, the subject is wirelessly monitored. The device detects if the person is medically distressed and sends a signal to a receiver unit that is connected to a computer. This WSN (wireless sensor unit) is interfaced to the Internet through gateway(s) available from an internet service provider (ISP). A central server maps the latitude and longitude information on a geographical information system (GIS). The developed system can be used to track a specific or a group of human subject. Alternatively any pilgrim can request emergency help using the same system. The location of the person needing help will be identified on the map to make it easy for the help to reach in the most efficient way.**

Keywords –**Pilgrim commandos and kids tracking, GPS, body temperature measurement, heart rate measurement, stress sensor, wireless communication, ZigBee.**

I. Introduction

The use of satellite aided navigation in the modern transport sector is well established worldwide. This proposed work is an attempt to design a tracking unit that uses the ZigBee module to support GPS tracking system in terms of latitude and longitude. A location and tracking system becomes very important to our future world of pervasive computing. The location of the person is seen on the map on the computer interfaced.

The system uses geographic position and time information from the Global Positioning Satellites. It gives pin point location of the target by using latitude and longitudes. Since the system has used a combination of GPS and ZIGBEE it will provide the advantage of multiple applications, viz., GPS for locating the missing ones, a heartbeat monitor to determine the health of the person in distress. The frequency of measurement is application-dependent. Pulse monitor will calculate the pulse rate and that data can be compared with standard pulse rate to determine the level of medical attention that person needs. This same application can be used for commando operations, at war zones, so that even in an event of surprise attack, the increase in heartbeat will trigger heartbeat monitor and it will send warning signal to control room. This system is also used for kids. During a time of emergency the kid can press the panic button which has been made available on the device, so that their caretaker can locate the position using GPS. This system can also be used by educational institutions, suppose during a field trip one of the kids is missing, the concerned au Completion of the project will demonstrate the feasibility authorities can use a GPS to locate that kid.

Completion of the project will demonstrate the feasibility of the theory, and in such a broadening market, it may be possible to develop the system further into a commercial product.

II. Overview

ZigBee technology is the standard of choice among other wireless technologies due to its efficient low-power connectivity and ability to connect a large number of devices into a single network. ZigBee technology uses the globally available, license-free 2.4GHz frequency band. It enables wireless applications using a standardized set of high level communication protocols sitting atop cost-effective, low-power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks. ZigBee uniquely offers low-latency communication between devices without the need for network synchronization delays as required by Bluetooth®, for instance. ZigBee defines the network, security and application framework for an IEEE 802.15.4-based system. These capabilities enable a network to have thousands of devices on a single wireless network. ZigBee creates robust self-forming, self-healing wireless mesh networks. The ZigBee mesh network connects sensors and controllers without being restricted by distance or range limitations.

ZigBee mesh networks let all participating devices communicate with one another, and act as repeaters transferring data between devices. The ZigBee Alliance's focus on the healthcare space has resulted in the development of the ZigBee Health Care public application profile. ZigBee Health Care was designed for use by assistive devices operating in non-invasive health care. ZigBee Health Care provides an industry-wide standard for exchanging data between a variety of medical and non-medical devices.
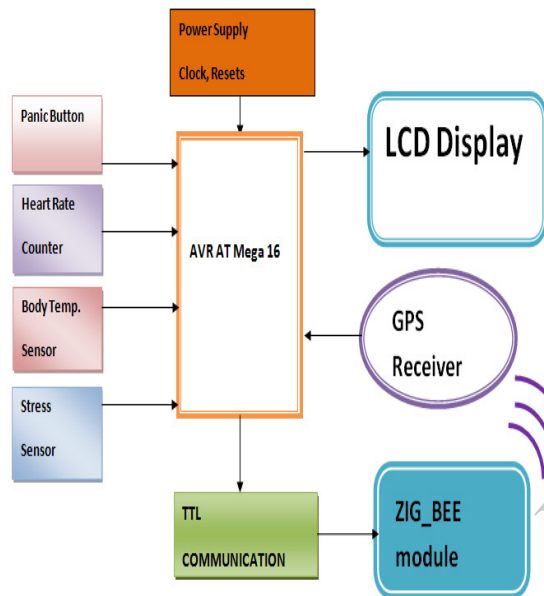
III. Block Diagram

A. Transmitter Section

Fig1. Block Diagram of Transmitter Section

1) **AVR Microcontroller:** The ATmega16 is a low power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system design to optimize power consumption versus processing speed. The transmitter consists of a microcontroller AVR ATMega16 IC, which has inbuilt ADC. This microcontroller ha six inputs and two outputs and ZigBee as bidirectional antenna. The IC gets its input from the supply, Heart beat sensors, Temperature sensors, Stress sensors.

2) **Power Supply:** There are many types of power supply. Most are designed to convert high voltage

AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.
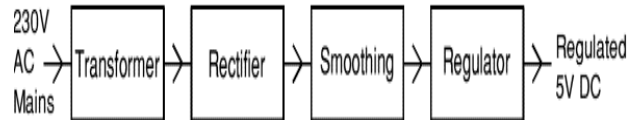
For example a 5V regulated supply:

Fig2. Block Diagram of Regulated Power Supply

Each of the blocks is described in more detail below:
- Transformer- steps down high voltage AC mains to low voltage AC.
- Rectifier-converts AC to DC, but the DC output is varying.
- Smoothing- smoothes the DC from varying greatly to a small ripple.
- Regulator- eliminates ripple by setting DC output to a fixed voltage.

3) **LCD Display**: Various display device such as seven segment display. LCD display, etc can be interfaced with microcontroller to read the output directly. In this project a two line LCD display with 16 characters each has been used. Liquid crystal Display (LCD) displays temperature of the measured element, which is calculated by the microcontroller. CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption.

4) **GPS**: MS2400HS4P0 is a L1 band 12 channel Global Positioning System Receiver module based on Analog Devices NAV2400HS chipset. This chipset consists of a GPS RF down converter, programmable NAVDSP processor and an accelerator ASIC. The GPS RF chip is a highly integrated chip with built in LNA, RF amplifier, dual stage IF amplifier, 2 bit ADC, VCO and PLL. The programmable NAVDSP, directly interfaces with the GPS RF down converter and runs the 12 channel correlation which is completely software based and navigation processing to provide GPS NMEA0183 messages for host system interface. The receiver is capable of providing up to 4 position fixes per second.

5) *Crystal Oscillator***:** It uses crystal oscillator which has a clock frequency of 11.0592MHz, power supply of +5V. There are several different ways to provide a clock source, including crystals, oscillators, RC circuits, and resonators; this article gives a good comparison. Crystals offer a good compromise of low cost, high accuracy, offer a good compromise of low cost, high accuracy, good temperature stability, and low power use.

6) Heart Beat Sensor**:** This circuit made from an infrared phototransistor and infrared LED. This transducer works with the principle of light reflection, in this case the light is infrared. The skin is used as a reflective surface for infrared light. The density of blood in the skin will affect on the IR reflectivity. The pumping action of heart causes the blood density rises and falls. So that we can calculate the heart rate based on the rise and fall of intensity of infrared that reflected by skin. The heartbeat sensor will measure the heartbeat of the person using LDR and LED.

7) *Stress Sensor***:** The stress sensor will measure stress level by measuring amount of perspiration with the help of GSR (Galvanic Skin Resistance). The stress level will be measured in terms of percentage.

8) *GPS***:** This project also consists of a GPS (Global Positioning System), which can pinpoint the location of the missing person, in terms of latitude and longitude using Google maps which uses NMEA0183 protocol.

9) *LCD Display***:** Various display device such as seven segment display. LCD display, etc can be interfaced with microcontroller to read the output directly. In this project a two line LCD display with 16 characters each has been used. Liquid crystal Display (LCD) displays temperature of the measured element, which is calculated by the microcontroller. CMOS technology makes the device ideal for application in hand held, portable and other battery instruction with low power consumption. This system uses 20*4 LCD to display the desired output. The 20*4 LCD display will display temperature, heartbeat and stress level in one row, followed by latitude and longitude co-ordinates in the row below it.

10) *Panic Button***:** A panic button is also included in this system which acts like an alarm and can be used by the individual in distress to call for help. Panic buttons are devices generally used by the elderly to summon assistance when they have fallen or otherwise hurt themselves. Elderly adults use them at home as an alternative to living in assisted care

facilities. When the individual needs help, they simply press the panic button that immediately notifies a caregiver or loved one who can come to their aid. Panic buttons need to be small, wireless, and easily accessible to be useful to everyone. They can activate an audible or silent alarm as soon as an intruder or threat is encountered.

11) *Vibration***:** When the alarm signal is received, a vibration is sent as a feedback to reassure the individual that help is on its way.

B. *Receiver Section***:**

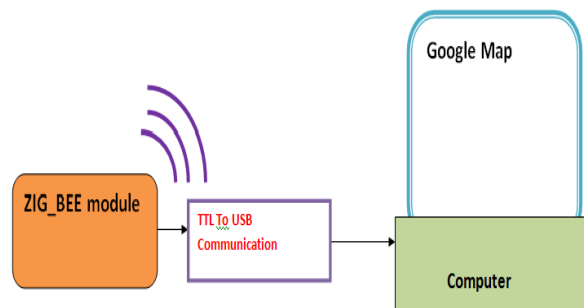Fig3. Block Diagram of Receiver Section

The receiver consists of ZigBee, TTL to USB converter circuit, a keyboard and the Control Room. The control room which is actually a monitoring system monitors the frequent updates received by the ZigBee at the receiver side. With serial ports rapidly disappearing from modern PC's we decided to create this simple serial TTL to USB adapter unit. It allows users with TTL uart output signals to be connected via an USB bus as a virtual com port. For the feedback a reassurance message is sent by the control room. This message is displayed on the same LCD on the transmitter side.

IV. Circuit Diagram

1) *AVR Controller:* AT Mega 16 IC is used in this circuit which consists of 16kB of memory with built in ADC.

2) *Power Supply:* The supply is given of 5V to the Vcc. The two crystal oscillator of value 11.0592MHz along with two capacitors of 22pF is used to push the circuit in ON state.

3) *Reset:* When the supply is on the circuit gets negative triggered pulse which resets the IC and program starts at 0 memory location.

4) *Ports:* The circuit uses four ports all of 8 bits and are bidirectional. Port B is assigned as heart beat sensor.LED and LDR are used exactly in opposite position to sense the flow of blood to give the output as change in voltage.LED is placed on the nail while LDR in its opposite position. When person is in critical condition the rate of blood circulation increases and when blood pumps with high intensity there will be less emition of light and in normal condition of blood flow there will be increment in light emition.   Heart beat sensor is designed to give to give digital output of heat beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. As the output pulse is low, two Op- Amps are used. One stage of Op-Amp amplifies the output while the second stage is used as a comparator to give the output in pulse form.

• Port A is assigned as temperature and stress sensors with ADC. Port A use a thermistor with 10K NTC (Negative Temperature Co-efficient). An equivalent value of resistor is used as voltage divider. As the temperature increases, voltage also increases and vice-versa. While for the stress sensor, this port uses GSR (Galvanic Skin Resistance) of 5V and a resistor of 10K to resist the circuit from high value of current flow. This sensor works with two electrodes sensing the dryness of the skin. A person in stress sweats more than usual resulting in small value of current between the two electrodes and thereby giving the output as high value in %.

• Port C uses its 4 bit pin for the supply data/command, read/write and enable. Between the power supply and ground a 10K resistor is used to adjust the brightness of LCD. While the other 4 bit pins also known as 4bit mode are used for LCD display as these pins are used to twice for the updated information. Port D is used as both transmitter and receiver for GPS.

5) *GPS 1269:* It has a baud rate of 9600.Its works on the principle of relay connector. When the physical parameters are to be connected to the transmitter section of ZigBee, the 7th bit of port D is at its high value while to send the locative parameters the connector is at its low value. For this latitude and

longitude parameter GPS uses NMEA0183 Protocol. From this protocol only the required values are selected. These updated information is been displayed on the LCD of the person. The same information's are sent to the control room. While sending back to the control we need to retrieve the original protocol. Thus GPS send 8 messages (max 40 characters) per second with the help of Embedded C program.
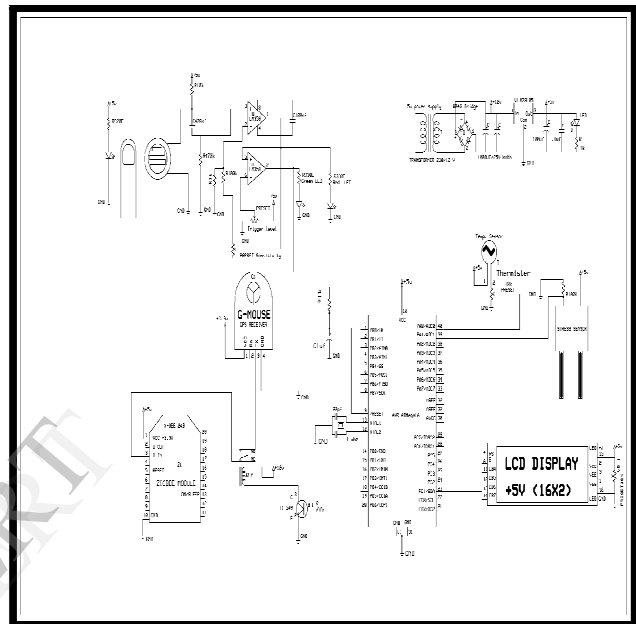
6) *GPS Tracking*

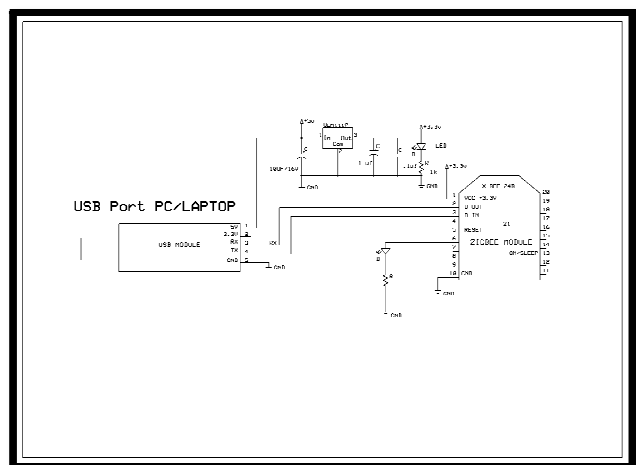Fig4. Circuit Diagram of Transmitter Section

7) *ZigBee PC Receiver***:**

Fig5. Circuit Diagram of Receiver Section

8) *ZigBee:* It is the heart of this device which is used to transmit and receive the information's with the help of the antenna present on it. The first pin of ZigBee is connected to the supply of 3.3V while the 10th pin is connected to the ground. The 2nd and the 3rd pin is connected to the Receiver and Transmitter used for the serial communication. The feedback will be send from the control room with the help of the terminal program used by Google map and then is given to the GPS with the help of antenna only.

V. Advantages

- This system is cost effective, reliable, and flexible due to use of ZigBee technology.
- It can be used in multipurpose applications.
- It has non invasive technique.
- It uses ZigBee so it does not need synchronization between devices like in the case of Bluetooth.
- Since ZigBee technology uses the globally available, license-free 2.4GHz frequency band; this device covers a wide area for wireless communication.
- Since ZigBee is used re-routing is possible if anode is down.
- Use of ZigBee has provided with long battery life essential for remote control.
- This project provides timely intervention for individuals who have a change in heart rate or stress level by displaying the result on LCD monitor and sending a copy to respective persons via reliable technology of ZigBee.
- An added advantage of the GPS tracking system is that it can be used anywhere; it doesn't matter whether the respective person is in rural or urban area.

VI. Applications

- *Health Care Department*: This project includes a heartbeat monitor which can keep a track on heart rate of a patient.

- *Application in Time of Distress*: This project includes a panic button which allows the person in need to raise an alarm by simply pressing it. This project will be equipped with a ZigBee which will enable the user to wirelessly alert the appropriate resources in emergency situations.

- *Pulse Oximeter*: This is a project includes a facility that measures the amount of oxygen in a patient's blood. Pulse oximeter sensor devices equipped with ZigBee Health Care will measure the amount of oxygen in the user's blood which will store and transmit that information to the receiving device.

- *Alarm Control and Display Device*: This project transmits the data from panic button, heartbeat monitor, body temperature monitor and stress level sensor to designated recipients using ZigBee.

- *Kids Care*: This project consists of GPS which can be used to monitor the location of kids. Also the kids can be trained to press panic button in time of distress.

- *Locating the Missing Person*: If in case the whereabouts of an individual are unknown then co-ordinates pinpointed by GPS and received via ZigBee can be used to pinpoint the location of the missing person.

- *Health Monitoring*: If a person suffers from major heart conditions then the family members or doctors can keep a tab on heartbeat rate of that patient.

- *Monitoring Pilgrims*: Thousands of people go on a pilgrimage, if a natural calamity like earth quake or floods occur then the location can be determined by using this device, also the health of each individual can be monitored and medical help can be sent accordingly. Also if a person is stuck in some place or finds himself in unknown territory then he can press the panic button.

VII. Future Developments

To make this project commercially available it needs to be more compact in size. Though the ZigBee module used in this project provides reliable and longer range of communication, it is a bit expensive. With some modification, the system can be made available commercially. Future improvements will focus on the use of flexible PCBs to replace the stiff cards, so that it could be mounted around the wrist unit, making it more comfortable for the wearer. Beyond the applications already provided by this project, it can be used as personal trainer for example, training for a marathon could include running on a treadmill according to a schedule designed by his/her trainer. For each training day, the trainer schedules the distance, the pace, and the maximum heart rate at which the individual is to train. The trainer would also like to monitor the individual's

respiration pattern. While the distance and the pace are provided by the treadmill, the heart rate and the respiration are monitored by wireless device worn by the individual. If EKG monitor and blood pressure tracker can be added in this project, it can work as disease-specific indicator. By including an alarm system and adjusting some predetermined settings, alarms can be issued and actions can be taken accordingly, for example, if during the monitoring of a diabetic patient the blood glucose level falls below a certain threshold, an alert can be sent to the patient, physician or medical personnel. Thus a patient alarm monitoring can be made available to trigger alarms based on preset conditions that are specific to the patient and the disease. The receiver unit would ideally be enhanced so that in the case of an emergency would contact an ambulance. Beyond the application for patients is the use by anyone who is at-risk, with a mental or physical disability.

VIII. Future Scopes

According to research firm Research & Markets, wireless sensor networks (WSN) represent an emerging set of technologies that will have profound effects across a range of medical, industrial, scientific and governmental applications. There are many sensor fit in the circuit they will monitor in any condition and anywhere. Recent developments in wireless technologies and the semiconductor fabrication of miniature sensors are making wireless sensor networks smaller and more cost-effective for a growing number of uses. The wireless network use will become more in few years. The authors of the report illustrated with this graphic discuss that if the potential market includes North America, European Union and Japan then the overall total potential market would be 87.8 million people.

IX. Conclusion

This paper describes a flexible system which acts like a locating device by using GPS, a heartbeat monitor to determine the level of medical aid each individual needs in case of medical emergency or during accidents, and also as a stress level sensor in time of distress. This will help in handling calamities like the devastating floods and landslides. For the location information is mapped onto a Google map or any geographical information system for ease of localization and efficiency in providing needed help. We have used IC ATMEGA16 which has a built in ADC. Our system will provide a flexible security system, which will have the facility of panic button (such as an alarm button) for person in distress to request help in case of emergency.

In this paper, we have presented the research, of applied nature, done to monitor physiological parameters such as skin temperature, heart rate, and body impact. A prototype was successfully developed and tested to establish the proof of concept. The algorithms were tested and found to be accurate and reliable at this developed/development stage. The novel aspect of the design is its low cost and detection of medical distress which does not necessitate pressing any panic button. This is an enormous improvement over existing commercial products. A panic button has also been provided in the developed system which can be used under an emergency situation. An important aspect of the design was miniaturization, so that the system was as nonintrusive as possible to the wearer. This was achieved by the use of surface-mounted devices on the PCBs designed. Low-power operational amplifiers were used to minimize battery consumption. The major cost comes from the use of ZigBee modules in the current design. With some modification, the system can be made available commercially. Future improvements will focus on the use of flexible PCBs to replace the stiff cards, so that it could be molded around the wrist unit, making it more comfortable for the wearer.

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