Lora Based End to End Tracking System Overcoming Signal Transmission Error

Dr.K.G.Revathi [1], S.Agnes Angela[2], A.Baby Shalini[3], T.Divya[4]
[1] *Professor, Department of ECE, DMI College of Engineering, Tamilnadu 600123*
[2,3,4]*UG Students, Department of ECE, DMI College of Engineering, Tamilnadu 600123*

***Abstract* - In today's world the security of the nation is depends upon the enemies' warfare and so the safety of the soldiers is considered as vital role in it. The security of any nation depends on military, army, air-force & navy of country and the backbone of all these forces are our soldier. one of the fundamental charges in military operations lies in that soldier not able to communicate with control room station. In this project the exact location and health status parameter of soldier can be sent to be base station in real time so that the appropriate action can be taken in case of crisis. GPS is used to log the longitude and latitude so that direction can be known easily. Here to find the health status of the soldier we are using the body temperature sensor to measure the temperature of body as well as heartbeat rate to measure heartbeat rate of soldier. The IoT makes the entire monitoring process fast, efficient and the decisions can be taken in less amount of time. So, by using this equipment we are trying to implement the basic life guarding system for soldier in low cost and high reliability. So by using these equipment we are trying to implement the basic life guarding system for soldier in low cost and high reliability. this paper presents the deployment of a LoRa W AN implemented by Thai people called Universal and Ubiquitous (ULoRa) for an application of Internet-of-Things in tactical troop tracking systems. The proposed long-range communication system comprises only the implemented gateway using Raspberry-Pi but also an end-device using microcontroller with GPS and other sensors for geological and physical tracking. The proposed system employs four gateways with bridge-to-bridge WIFI connection for communication to the server. The end node can be integrated more than ten types of sensors such as GPS, temperature, humidity, and water sensors. All data can be visualized real-time via monitor station. The proposed system provides not only an emerging long-range communication but also low-power operation in a military campsite within 0.5 kilometers using a transmission power of 4dBi.**

***Index Terms* - Internet of things, GSM, GPS, Longitude, Latitude.**

INTRODUCTION

In current world scenario, the security of a nation is the uttermost important factor, and the security of nation depends on the army force. Without the soldier it would be nearly impossible to protect a nation. There is a necessity to develop a wearable technology which is not bulky and dissipates very little power in the defense 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. So, this paper focus on tracking the location of soldier from GPS, which is useful for control room station to know the exact location of soldier and accordingly they with guide them.

Also, high speed, short range soldier to soldier wireless communication to relay information on situational awareness such as biomedical sensors GPS navigation, wireless communication. The biosensor consists of temperature sensor and heartbeat sensor. 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. 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 establishment of human settlements and the destruction of wildlife habitats have caused erratic butterfly effects in nature. Amalgamating this with the fascinating movement of animals and their herds over climatic and mating seasons result in patterns that require highly demanding studies and analyses to comprehend. They underpin multiple interconnected biological phenomena [1]. Understanding the migration and territorial behaviour is essential for their conservation and protection from mankind as well as from other displaced or invasive fauna. Conventional approaches to animal tracking use limited range GPS enabled trackers. These stores the location coordinates received via GPS locally, and may wirelessly respond to transmitted beacon signals when the field biologists or animal trackers enter the limited range with their transceivers. There on, the devices may allow extraction of the devices' location history wirelessly. Other alternatives are fully satellite based trackers; they are expensive to operate, bulky and could be deemed unsuitable for medium to small animals (or birds). The operability of these devices and their battery life too, is sometimes a hefty limitation. The Internet of Things (IoT) and Machine to Machine (M2M) communication technologies.

RELATED WORK

There are a number of options available for long range communication. Cellular networks (2G/3G/4G etc) would be a sensible option for small and enclosed wildlife reserves or sanctuaries, however, with increase in size, set-up costs prohibitively increase. Over open grasslands and plains, LoRa would function well, however, due to its selected frequency range, the signal deteriorates when obstructions are encountered. A normal LoRa network would require dense deployment of gateways. This is addressed in the proposed system and is discussed later. WiFi, Bluetooth and such short-range communication technologies paired with conventional application protocols [2], would suffice for indoor home automation [3] and office automation [4] use cases, however, entirely different radio spectrum is to be considered for long range communication. Sigfox [5], LoRaWAN [6] via The Things Network [7] and Narrow Band IoT [8] are some examples. Amongst these, LoRaWAN (upper layer protocol) uses the LoRa physical layer and is a set standard over the free-to-use frequency ranges allocated to LoRa. However, it is a star topology, supporting only a single hop. In indoor scenarios with obstacles such as walls and floors or in forests with rich flora and uneven terrain, this turns out to be a weakness. The interference and dampening of signals result in data loss and communication errors with low packet delivery ratio (PDR) [9]. Installation of multiple LoRaWAN gateways would be a possible but infeasible and uneconomical solution. A mesh network formed by the nodes, by the gateways or by both nodes as well as gateways is explored in this work in order to alleviate the aforementioned issues.

LoRa based antennas can be mounted onto basic cost-effective microcontrollers or microprocessors, allowing for the reinforcement of the sensor and GPS tags or collars. If an active communication link is maintained, the resolution of trajectories could be largely improved to such details, that analyzing and tracking relative locations between two animals to observe behaviour may be feasible with no eyes on the ground. These detailed facets of movement would give way to new discoveries in the field of ecology.

Salient Features of the Proposed Solution

- Easy setup
- Economical and cost-effective

- Flexible, with the ability to adapt to other applications
- Highly scalable
- Supports bi-directional communication, i.e, it allows devices to transmit as well as receive data
- Free to use frequencies
- Low power devices with battery life potentially up to tens of years
- Supports dynamic extension of range with ghost nodes

Hock Beng Lim, Di Ma, Bang Wang, Zbigniew Kalbarczyk, Ravishankar K. Iyer, Kenneth L. Watkin [1] had discussed on recent advances in growing technology, and on various wearable, portable, light weighted and small sized sensors that have been developed for monitoring of the human physiological parameters. The Body Sensor Network (BSN) consists of many biomedical and physiological sensors such as blood pressure sensor, electrocardiogram (ECG) sensor, electro dermal activity (EDA) sensor which can be placed on human body for health monitoring in real time. In this paper, we describe an idea to develop a system for real time health monitoring of soldiers, consisting of interconnected BSNs. We describe the basic prototype of the system and present a blast source localization application. In this paper, we have completed only an initial design of individual sensor nodes and developed a basic prototype of the system to collect the sensed data. In future, we will try to develop an integrated data management system and a web portal which will enable users to have easy access of data.

P.S. Kurhe, S.S. Agrawal [4] had introduced a system that gives ability to track the soldiers at any moment. Additionally, the soldiers will be able to communicate with control room using GPS coordinate information in their distress. The location tracking has great importance since World War II, when military forces realized its usefulness for navigation, positioning, targeting and fleet management. This system is reliable, energy efficient for remote soldier health monitoring and their location tracking. It is able to send the sensed and processed parameters of soldier in real time. It enables to army control room to monitor health parameters of soldiers like heartbeat, body temperature, etc. using body sensor networks. The parameters of soldiers are measured continuously and wirelessly transmitted using GSM. In this paper, it is possible to transmit the data which is sensed from remote soldier to the base station's PC by using wireless transmission device like GSM. The accuracy of this system may affect by some factors such as weather, environmental conditions around the soldier's unit and GPS receiver. The future works in this system may include the optimization of the hardware components, by choosing a suitable and more accurate GPS receiver. By improving the routing algorithm can be make this system more powerful and energy efficient. Upgrading this system is easy which makes it open to an advanced future.

METHODOLOGY

The block diagram of soldier position tracking and health monitoring system with environmental analysis is shown in above fig. It consists of two units soldier unit and base station unit. As it requires high speed communication it is intended to use Atmega 328 processor. Biosensors such as body temperature and heartbeat sensor are integrated to processor to monitor the health status. The GPS receiver is used to log the location (longitude and latitude) of so:ldier, which is stored in microcontroller memory. GPS Receiver receives and compares the signal from orbiting GPS satellite to determine geographic position. Using keypad, we can send messages to another unit. RF Transceiver gets the latitude and longitude of other soldier unit and calculates distance, speed, and height between them. It also sends the information to the army base station containing the health parameter and the location of soldier. At Army Base Station unit, it gets the details of soldier unit through GPS receiver, the soldier location and health status displayed on system at base station using software. This is a wearable technology which is the most important factor of this project. The basic working of a conventional LoRa based soldiers tracking system (Star Topology) is depicted in Fig. 1. It consists of a LoRa gateway router and multiple LoRa nodes. Each LoRa node consists of a LoRa transceiver module mounted onto a microcontroller/microprocessor (MPMC) which would be planted into a ruggedized soldier's collar or tag.

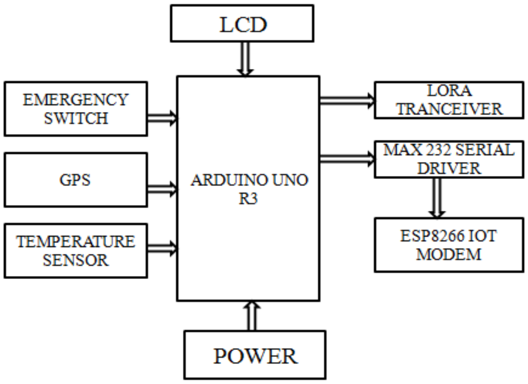

Fig 2: Soldiers Unit

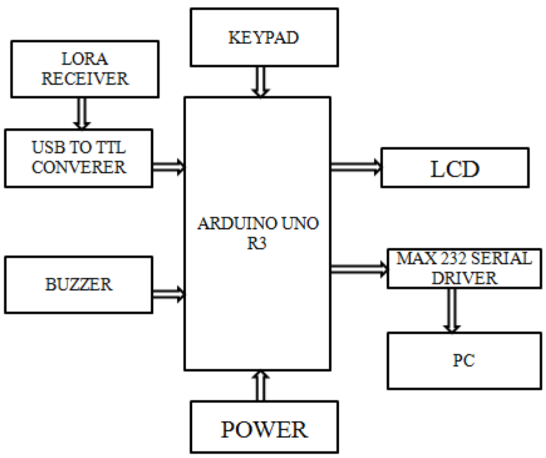

Fig 3: Control Room Unit

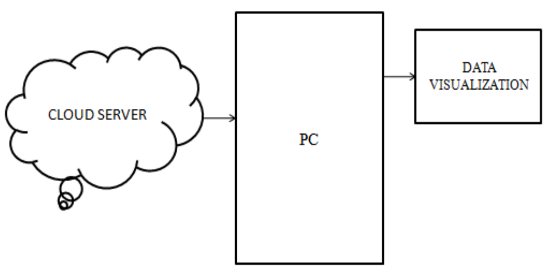

Fig 4: IoT Monitoring Unit

Hardware Requirements

- Arduino Uno R3
- Sx1278 Lora Tranceiver
- Usb To Ttl Converter
- Neo 6m Gps Receiver
- Esp8266 Iot Modem
- Temperature Sensor
- Emergency Switch
- Power Supply Unit
- Battery
- 16*2 Lcd

Software Requirement

- ARDUINO IDE
- Embedded C

HARDWARE IMPLEMENTATION

Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under Common Creative Attribution Share-Alike 2.5 license and is available on the arduino website. Layout and production files for some versions of the hardware are also available. "UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of arduino Software (IDE) were the reference versions of arduino, now evolved to newer releases. The UNO board is the first in a series of USB arduino boards, and the reference model for the arduino platform. The ATmega328P on the arduino UNO comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The UNO also differs from all preceding boards in that it does not use the FTDI USB-to serial driver chip. Instead, it uses the Atmega16U (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

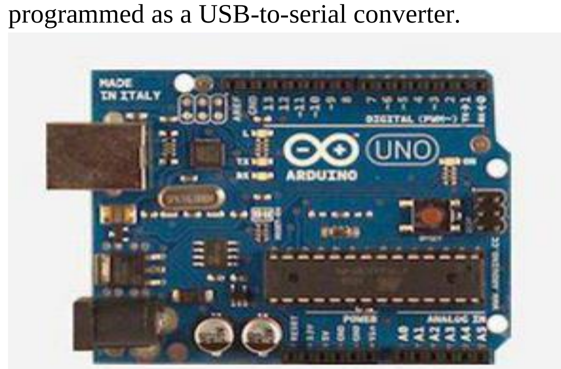

Fig -5: Arduino Board

LCD

Liquid Crystal Display (LCD) is used to display the output to the user in the form of GUI (Graphic User Interface) and a mono chromatic display. LCD used in this project is JHD162A series. There are 16 pins in all. They are numbered from left to right 1 to 16 (if you are reading from the backside). Generating custom characters on LCD is not very hard. It requires the knowledge about custom generated random-access memory (CG-RAM) of LCD and the LCD chip controller. Most LCDs contain Hitachi HD4478 controller. CG-RAM is the main component in making custom characters. It stores the custom characters once declared in the code. CG-RAM size is 64 byte providing the option of creating eight characters at a time. Each character is eight byte in size.

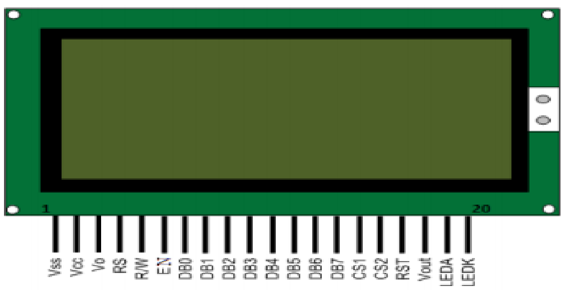

Fig -6: LCD

GPS sensor

The GPS system provides critical positioning capabilities to military, civil, and commercial users around the world. In our project we are using the GPS sensor module EM-406A, as it is new improved GPS Module with built-in antenna and memory back-up for OEM. This unit features low power consumption, high sensitivity. The unit is ideal for navigation systems, distance measurements, vehicle monitoring and recording, boating direction and location, together with hiking and cross country exploring.

Fig 7:GPS Receiver

Wi-Fi Module-ESP8266:

The ESP8266 is a low-cost Wi-Fi chip with full TCP/IP stack and MCU (microcontroller unit) capability. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. The ESP8285 is an ESP8266 with 1 MB of builtin flash, allowing for single-chip devices capable of connecting to Wi-Fi. The successor to these microcontroller chips is the ESP32.

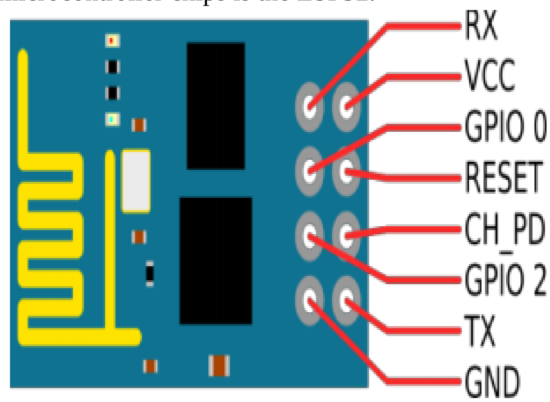

Fig 8:Esp8266 IOT Modem

LoRa nodes and multiple LoRa gateway routers

In scenarios where the spread of fauna is unevenly distributed, a hybrid mesh network consisting of multiple gateways as well as the nodes would be superior and advantageous. Such a system would also provide with more flexibility in order to further optimize the connectivity as well as the cost factors. Model C is a combination of Model A and Model B and is depicted in Fig. 4. There are multiple gateways of which the root node (and maybe some others) has active network connectivity, and the rest may be spread across strategically. The nodes are programmed to support node to node communication as discussed in Model B, and the gateways are programmed to support gateway to gateway communication as discussed in Model A. In Model C, the non-root gateway routers (‘Y’ and ‘Z’) act as mesh repeaters and periodically attain the route map from the root gateway. In Fig. 4, LoRa Node ‘E’ does not lie within the coverage of the gateway router ‘Y’; Node ‘C’ forms a node-to-node connection with Node ‘E’. The gateway router will now transmit the signal back to the root gateway router ‘X’.

RESULTS AND DISCUSSION

Location Information is sent to the desired receiver confirming about GPS geography. When the normal body parameters differ from threshold values an alert message/email is send to base station along with the exact location of the soldier. Following results can be get from above execution. It is capable of collect and process the vital body parameters and location information from the soldier's body. When temperature of surrounding rises above the threshold value greater or equal to 30 degree then cooler will turn ON. When the temperature falls below threshold value lesser or equal to 22 degree then heater will turn ON. When the pulse rate is higher or lower than the normal value the system will send E-mail/Msg along with the location information of soldier to base station. When the gas value is above the threshold value greater or equal to 700, then system will send E-mail/Msg along with the location information of soldier to base station.

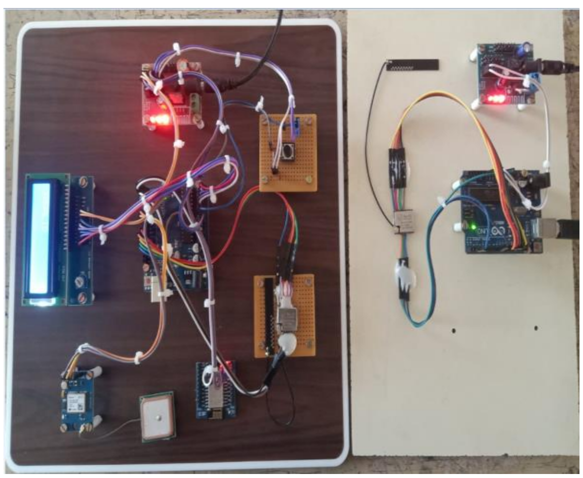

Fig 9. Experimental Setup

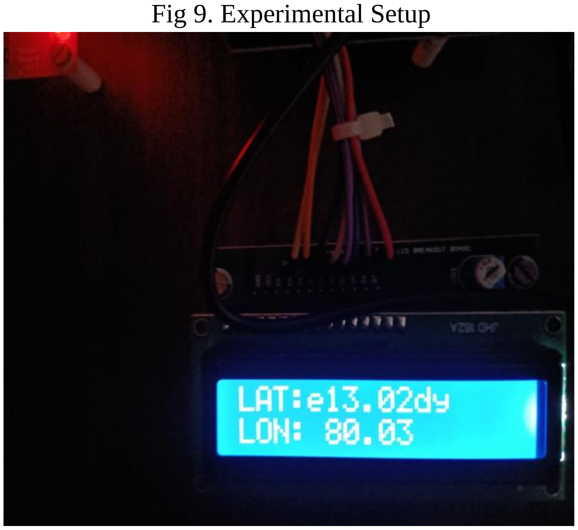

Fig 10: GPS Location

CONCLUSION

Soldiers can continuously communicate anywhere with the base station using RF, DS-SS, FH-SS which can help soldier to communicate among their squad members whenever in need. Use of 328 controller and low power requiring peripherals reduce overall power usage of system. Modules used are smaller in size and also lightweight so that they can be carried around easily. GPS tracks position of soldier anywhere on globe and also health system monitors soldier's vital health parameters which provides security and safety for soldiers. So, in this way concept of tracking and navigation system is very useful for soldiers when they are on military field during war. And also, for base station so that they can get real-time view of soldiers on field displayed on PC.

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