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A COMPLETE SOLUTION FOR INDOOR LOCALISATION IN UNDERGROUND TUNNEL AND MINES

Saishashank Balaji[1], Rahul.S[2], Sriram.J[3], Sathyanarayanan.K.B[4], Dr.Gunaselvi Manohar[5]

[1,2,3,4] *Electronics and Instrumentation Engineering, Easwari Engineering College, Chennai-89*
[5]*Professor, Electronics and Instrumentation Engineering, Easwari Engineering College, Chennai-89*

Abstract - *An Indoor Positioning System (IPS) is a technique to locate objects or people inside a building using Radio Frequency Signals transmitted by a hand module given to locate individual in underground tunnel or mines. The signal is sensed by a stationary receiver located at multiple positions according to the range. These receiver(s) send the signal to the Local Control Unit that is placed in specific anchor points as per requirement. These data are collected and sent to the workstation and to the individuals connected to the same network through IoT. The Local Control Unit also has sensors to sense any change in environment. These parameters are helpful in early warning of changes in environment to prevent loss of life. The Indoor Localization is critical in during rescue operations, these data can also be used to infer other information.*

Key Words: Indoor Positioning, Localisation, Tracking, IoT, Sensing

1. INTRODUCTION

Tracking people and objects became a very interesting field of research in the last ten years. The theory of positioning has been used in various application areas. For example, a company could acquire the necessity to position its equipment to track down its assets. Additionally, indoor positioning is very useful for positioning people within buildings such as hospitals and nursing homes. These applications require positioning, either to track down people or to guide them to a certain place within a building in order to save their lives. The positioning in complex areas like mines and underground bunkers has serious implications for which we have proposed this system. The system is designed specifically for tracking and guiding of personnel. The Indoor positioning system was inspired by the incident that happened in Chile where many miners were trapped underground due to a cave-in that occurred. The system that was earlier in place was not feasible for long distances. The IPS is a system to locate objects or people inside a building or underground using radio waves, Magnetic fields, acoustic signals, or other sensory information collected by mobile devices. The crucial need for IPS is to locate people inside caves and monitor their movement using RF waves. The benefit of this system is it can locate multiple individuals on multiple floors and longer distances compared to existing systems.

2. EXISTING SYSTEM

These are the following existing used for locating a person or an object:

2.1 Global positioning system

Global Positioning System (GPS) receives signals from multiple satellites to determine the physical location of a user. Each one transmits information about its position and the current time at regular intervals. These signals, travelling at the speed of light, are intercepted by the GPS receiver, which calculates how far away each satellite is based on how long it took for the messages to arrive. Once it has information on how far away at least three satellites are GPS receiver can pinpoint your location using a process called trilateration.

2.2 Wi-Fi positioning system

Wi-Fi positioning system is used where GPS is inadequate due to various causes including multipath and signal blockage indoors. The most common and widespread localization technique used for positioning with wireless access points is based on measuring the intensity of the received signal (received signal strength indication or RSSI) and the method of fingerprinting.

2.3 Visible light communication

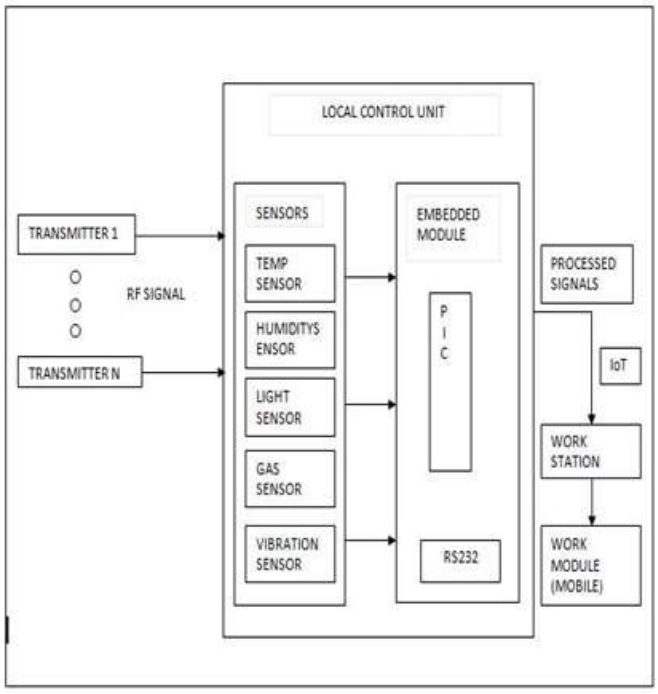
VLC can be used as a positioning technology, mainly for inside areas. Special LED and fluorescent lamps send out indiscernibly flickering light which can be detected by a Smartphone camera or a separate photo detector. Each lamp has its own ID which it compiles into pulsing light and sends to smart phones in the reception range. The app can access a map in which the lamps and their IDs are located. The Incidence angle helps refine the position. Additional hardware such as beacons can fill in, where light doesn't advance.

3. PROPOSED SYSYTEM

The Indoor positioning System is integrated with RSSI using radio frequency that can detect and monitor movements. The system gives us the environmental changes and allows continuous monitoring. The concept is to idealize the changes and take the necessary action that helps us save time if any untoward incidents occur. The environmental changes such as temperature, vibration, humidity can be monitored with the help of sensors integrated into the system. If the situation goes out of hand, the system alerts the personnel in the control room for emergency services to be dispatched.

The proposed system ensures that every individual has a handheld module to monitor and communicate if the individual faces any crisis. The modules are self-powered and regularly send out signals to receivers within the area of interest. This is the reverse operation of GPS. Knowing the location of the receiving sensors allows for accurate indoor locating in near real-time. Locating a person or device is only half of the solution. So we need indoor mapping of a location as a revaluation for locating individuals. This often makes positioning quite an easy task. The RSSI is used to triangulate a position based on the transmission from transmitter to receiver between multiple antennas placed every 10mts in the underground.

4. COMPONENT DESCRIPTION



Block Diagram 4.1 LCU

The Local Control Unit consists of the sensors which sense the changes in environment and converts it into digital through ADC. The LCU is a small unit that works beside the embedded module. LCU has a PIC 16f877A microcontroller it feature a 14-bit wide code memory, and an improved 8-level deep call stack. The instruction set differs very little from the baseline devices, but the two additional opcode bits allow 128 registers and 2048 words of code to be directly addressed. for processing. It also has Texas instruments driver/receiver IC MAX232N used to convert RX, TX, CTS, and RTS signals. The drivers provide TIA-232 voltage level outputs (about ±7.5 volts) from a single 5-volt supply by on-chip charge pumps and external capacitors. This makes it useful for implementing TIA-232 in devices that otherwise does not need any other voltages.

4.2 HARDWARE COMPONENTS:

4.2.1. HAND MODULE

The Hand Module (refer Fig 4.2) is a wearable transmitter that is worn by the individual to monitor his status and gives alerts in case of untoward instances. This consists of 4 switches which when pressed sends unique signals related to emergencies. The switch is foolproof and cannot be tampered with. It has a HT12D IC a decoder integrated circuit that belongs to 2^{12} series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc. It is mainly provided to interface RF and infrared circuits. They are paired with 2^{12} series of encoders.

In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin.HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits.

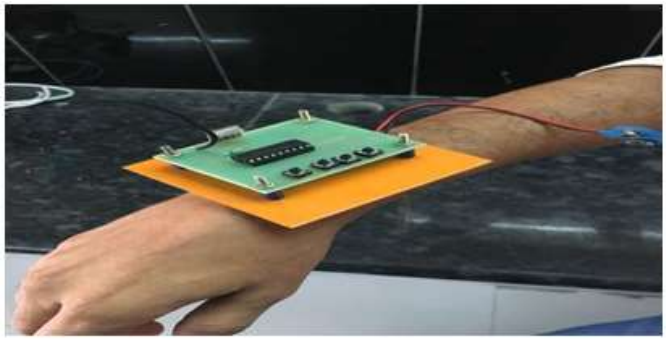


Figure 4.2: Hand Module

4.2.2. SENSORS In order to monitor the surrounding we need sensors. So we have a integrated sensor module as shown in Fig 4.3 , has temperature sensor to detect rise in temperatures, humidity sensor to detect moisture content, seismicity sensor to detect vibrations, gas sensor to detect leakage of toxic gases. The sensors are incorporated into the embedded module for conversion.

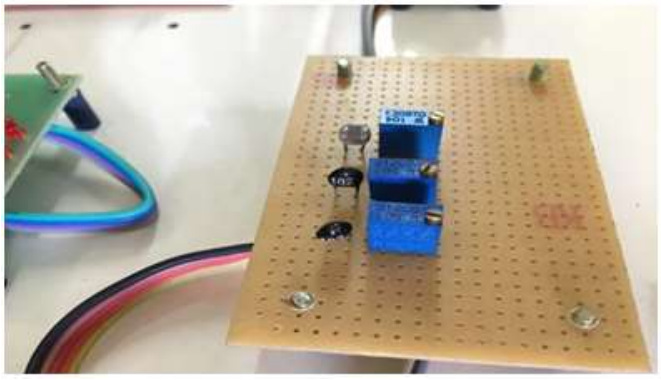


Figure 4.3: Sensor Module

4.4.3. TEMPERATURE AND HUMIDITY SENSORS

The wide varieties of temperature sensors are available. In this project thermistor made up of bismuth oxide material is used as temperature sensor. It is a negative temperature coefficient thermistor as shown in Fig 4.4 which means temperature is inversely proportional to resistance and exhibits non linear characteristics. The Bismuth oxide thermistor is a temperature sensor constructed of semiconductor material such as Bismuth and Oxide that exhibits a large modification in resistance in proportion to a tiny low modification in temperature. Bismuth oxide thermistor covers a range of about 0-200^0 Celsius. Thermistors are inexpensive, rugged, and reliable and respond quickly. Because of these qualities thermistor are used to measure simple temperature measurements**.**

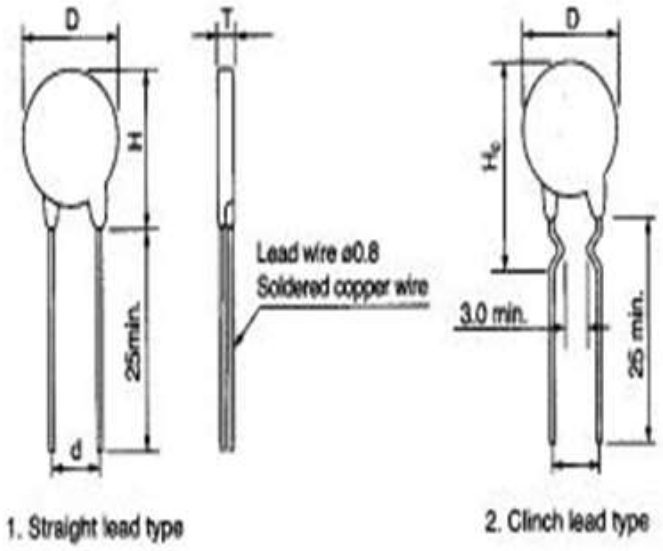


Figure 4.4: Temperature Sensor

4.4.4.PIEZOELECTRIC SENSOR

Piezoelectric sensors measure the electrical potential caused by applying mechanical force to a piezoelectric material. The 27mm piezoelectric sensor made up of lead zircon ate titanate-piezoelectric ceramic material is used which can produce 1.5V. It works on the principle of conversion of energy in mechanical and electrical energy forms. When a polarized crystal is put under pressure, some mechanical deformation takes place in the polarized crystal, which leads in the generation of the electric charge. The generated electric charge or the mechanical deformation can then be measured using a Piezo sensor (Fig 4.5).

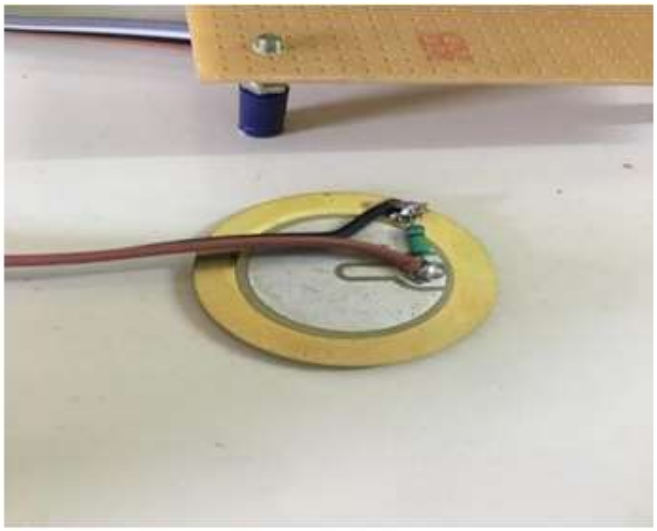


Figure 4.5: Piezo Film Sensor**4.4.5. GAS SENSOR**

A gas detector is a device that detects the presence of harmful gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions. The MQ9 gas sensor is used which changes its resistance for different concentrations of varied gasses. They are useful in gas leakage detection of LPG, propane, methane, i-butane, alcohol, Hydrogen, and smoke. The sensor is connected in series with a variable resistor to form a voltage divider circuit and the variable resistor is used to change sensitivity. When one of the above gaseous elements comes in contact with the sensor after heating, the sensor's resistances change. The change in the resistance changes the voltage across the sensor, and this voltage can be read by a microcontroller. The voltage value can be used to find the resistance of the sensor by knowing the reference voltage and the other resistor's resistance. The sensor has different sensitivity for different types of gasses. Due to its fast response time and high sensitivity, measurements can be taken as soon as possible. The sensor sensitivity can be adjusted by using the potentiometer.

5. SCREENLEAP IOT

IoT (Internet of things) is an integration of connectivity between the physical devices, vehicles, appliances with electronics, software, sensors to exchange data. This is reliable since the parameters can be monitored anywhere and allows controlling using application. This is done with Screen leap, software which enables screen sharing. Any changes in the parameters or alerts can be done with ease. In computing, Virtual Network Computing (VNC) is a graphical desktop sharing system that uses the Remote Frame Buffer protocol (RFB) to remotely control another computer. It transmits the keyboard and mouse events from one computer to another, relaying the graphical screen updates back in the other direction, over a network. VNC is platform-independent – there are clients and servers for many GUI-based operating systems and for Java. Multiple clients may connect to a VNC server at the same time. Popular uses for this technology include remote technical support and accessing files on one's work computer from one's home computer, or vice versa.

6. Results And Discussion

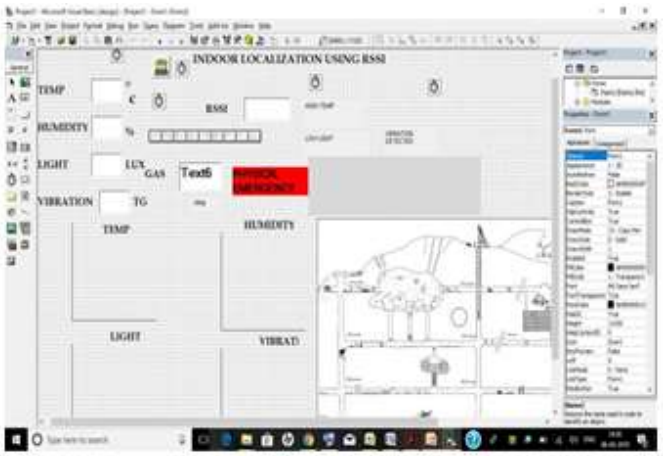


Figure 6.1 Response 1

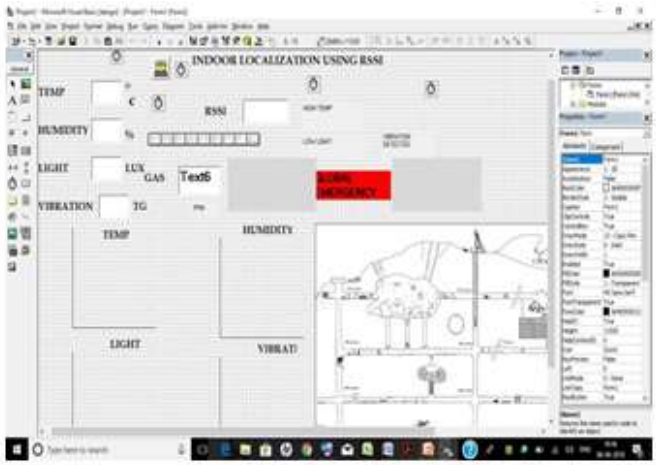


Figure 6.2 Response 2

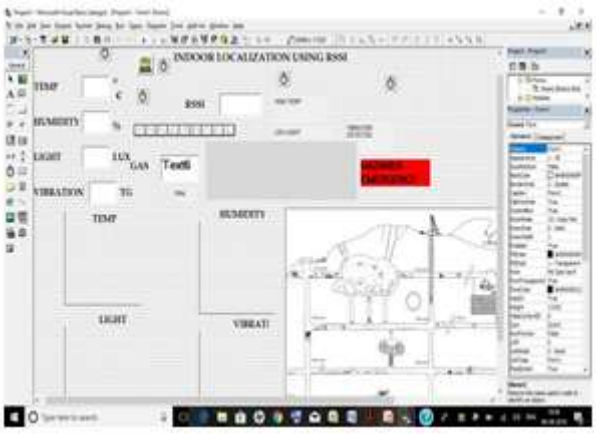


Figure 7.3 Response 3

This result will discuss the methodology and preliminary results of experiments related to the effect of the presence of people on the value of the RSSI signal. This research consists of four experiments. First and second experiments are to know the effect of

people presence to RSSI when the position of transmitter and receiver are in same height from floor (horizontal). Then, the third experiment is conducted to explore the effect of people presence to RSSI when the position of transmitter is higher than receiver (diagonal). How the user position or orientation can affect the RSSI is explore in the fourth experiment.

6.1. People Presence Effect on Horizontal Signal Path

People are standing in a position that blocking the LOS path between transmitter and receiver. The sender is an access point (LCU) and receiver is a mobile device (Hand Module). Distance between transmitter and receiver is 3 m and the height of access point and mobile device are 70 cm from the floor. Description of the experiment can be seen in Fig

The first experiment is one person stands between access points and mobile devices by setting the distance between people with MD (from 5-0.2 m). We measured 40 data RSSI at each position. The experimental results can be seen in As a comparison, when no one is blocking LOS, the median value of RSSI received by mobile devices is 156 dBm. It appears that the people as a barrier between the AP with MD on LOS path can reduce the value of RSSI, especially when the people as barriers are very close to the MD.

The second experiment is many persons (1-4 persons) stand between AP and MD with some variation of position. Detail of experiment result show on Table when there are more people so the value of attenuation are also getting bigger and then the RSSI decreasing. Same as the previous experiment we also measured 40 data of RSSI at each position.

6.2. People Presence Effect on Diagonal Signal Path

The third experiment is one person stands between AP and MD by setting the distance between people with MD (4-0.2 m). We measured 40 data of RSSI at each position. As a comparison when no person is blocking LOS, the median of RSSI received by mobile devices is 163 dBm. When the position of people is getting close to the MD, the RSSI value received will significantly reduce.

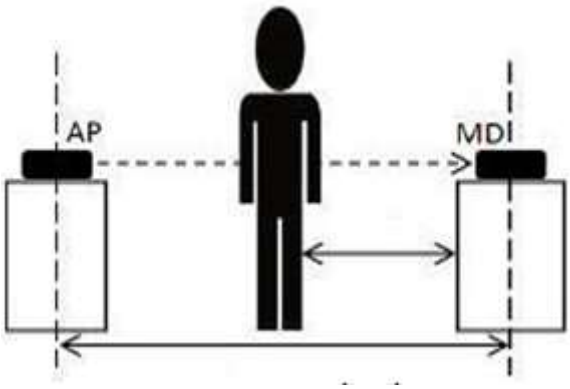


Fig 6.1 Horizontal Path

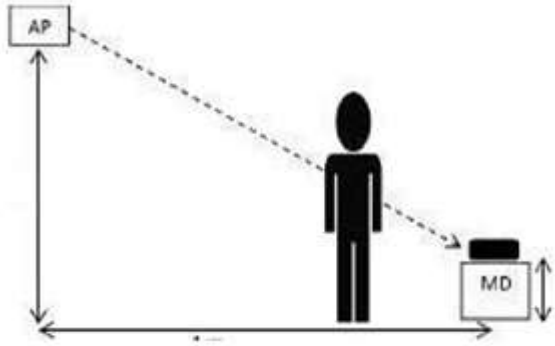


Fig 6.2 Vertical Path

CONCLUSION

The ultimate objective was to reduce the rescue time in accidents, for which the individual tracking and positioning were important factor; this project/device solves this issue. The Innovative hand band design introduced to report Personal, Global and Precautionary situations helps reduce and mitigate the disaster. The observation and monitoring of the environmental parameters allows predicting any accidents that may occur.

Fig 7.1: Project Module

8. LIMITATIONS

- The major challenge for RF location system is the harsh nature of indoor environment. Noise, multipath propagation of RF signals and lack of LOS results in erroneous location estimates.
- These limitations have been addressed in many location systems and have been able to successfully reduce their impact. Techniques have been developed to mitigate its effect but a permanent source of noise may still degrade system performance severely.
- There exists no system that can address all needs and advantages and each system has different application area depending upon its accuracy, update rate, scalability and cost.

9. FUTURE SCOPE

- Improve ranging accuracy by reducing the noise, using multiple small nodes to pick up RF signals.
- Corroborating with dig data analysis, Data mining and Cloud systems for overcoming indoor navigation traffic and latency in response.
- Personalize the IPS system for individual need and necessity.

10. REFERENCES

1. Bahl.P and V. N. Padmanabhan, "RADAR: an in-building RF-based user location and tracking system," in Proceedings of 19th Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM '00), vol. 2, pp. 775– 784, Tel Aviv. Israel, March 2000.
2. Bai.Y; Jia, W; Zhang, H; Mao, Z. H.; Sun, M (2014). Landmark-based indoor positioning for visually impaired individuals. 12th International Conference on Signal Processing ISBN 978-1-4799-2186-7. PMC4512241 PMID 26213718
3. Carboni, David; Manchinu, Andrea; Marotto, Valentina; Piras, Andrea; Serra, Alberto (2015). "Infrastructure-free indoor navigation: a case study". Journal of Location Based Services. 9: 33–54. doi:10.1080/17489725.2015.1027751
4. Chen and H. Kobayashi, "Signal strength based indoor geolocation," in Proceedings of the IEEE International Conference on Communications (ICC '02), vol. 1, pp. 436–439, New York, NY, USA, April–May 2002.
5. Laoudias, C.; Constantinou, G.; Constantinides, M.;Nicolaou, S.; Zeinalipour-Yazti, D.; Panayiotou, C. G. (2012). "The Air place Indoor Positioning Platform for Android Smartphone". 13th IEEE International Conference on Mobile Data Management (MDM).2012: 312–315. doi:10.1109/MDM.2012.68.
6. Lim, H; Kung, L; Hou, JC; Haiyun, Luo (2010). "Zero-configuration indoor localization over IEEE 802.11 wireless infrastructure". Wireless Networks. 16 (2): 405–20.
7. Qiu, Chen; Mutka, Matt (2017). "Self-improving indoor localization by profiling outdoor movement on smart phones". 2017 IEEE International Symposium on A World of Wireless, Mobile and Multimedia Networks. doi: 10.1109/WoWMoM.2017.7974311
8. Youssef, Moustafa; Agrawala, Ashok (2007-01-04). "The Horus location determination system". Wireless Networks. 14 (3): 357–374. Doi: 10.1007/s11276-006-0725-7. ISSN 1022-0038.
9. Zhou, Y; Law, CL; Guan, YL; Chin, F (2011). "Indoor elliptical localization based on asynchronous UWB range