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Indoor Localisation Using RSSI Technique

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Abstract: ***As positioning systems that can track and monitor moving objects/people become more widely used in our everyday life, we face the challenge of doing the same in places where such systems cannot be practically implemented. This is where the need for an alternate system arises. The main objective of the project is to provide a wireless means of tracking and monitoring objects/people in closed environments such as mines. There are two parts in this system- Transmitter which is a small portable device that can be carried around by the user inside the mines, and Receiver which is stationary can be interfaced to a PC or remotely connected to PCs outside the mine through Internet of Things. Additionally, a climatology unit is kept at various points in the mines, to monitor the ambient parameters such as temperature, humidity, light intensity levels along with a safety sensor that detects vibrations caused by landslides or earthquakes. The receiver display shows the location of the moving object/person and the values of the ambient parameters. The tracking and monitoring are done by using an RSSI algorithm that is implemented using the Visual Basic software.***

Keywords: RSSI, Indoor Localisation, Tracking.

I. INTRODUCTION

In present day situation, tracking of objects and locating people in a certain area is done using GPS. It plays a vital role during emergency situations, where tracking and locating individuals is necessary. However, when it comes to places where GPS cannot be used, we need a system to perform the same task. This is where we can implement Received Signal Strength Indicator (RSSI) algorithm. This way, we can determine how far an individual is, from a fixed receiving end. Let us take an example of implementing this system in an underground mine. There are two units present, the Transmitter, which is carried by the mine worker, and a fixed Receiver, where the worker can be monitored. To implement this system, there is a requirement of a microcontroller, with an appropriate number of input-output ports. As this system requires both analogs as well as digital data input-output ports, we have decided to use the microcontroller PIC16F877A. The controller has five I/O ports, out of which two ports support analog data too. The software part of the system requires an output screen that can display the location of an object/person, as well as real-time values of a set of ambient parameters. Programming for the Windows user interface is made easy by Visual Basic. Therefore, the software part of this particular system is done entirely using Visual Basic 6.0. The basic block diagram is as shown in Figure 1.

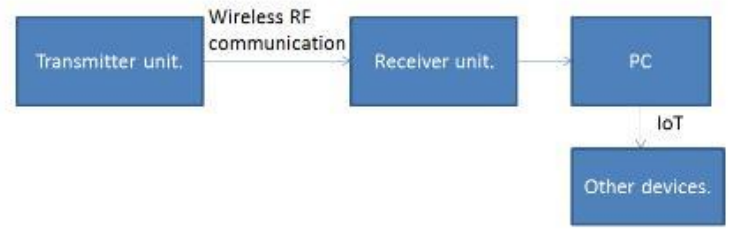

Figure.1 Basic Block Diagram of System

As mentioned previously, this system consists of two units. The transmitter is a portable device that is carried around inside the mine. The receiver, on the other hand, is fixed, it can be placed outside the mine. The receiver is interfaced to a PC that displays the output screen. The same output screen can be viewed in other devices like smartphones or tablets using IOT. A detailed block diagram of the receiver side is shown in Figure 2. The climatology unit is connected to the analog I/O port An of PIC16F877A. Digital data from the transmitter is

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received using the RF receiver module. This data too is given to the microcontroller. The controller is connected to the PC, where the output can be viewed.

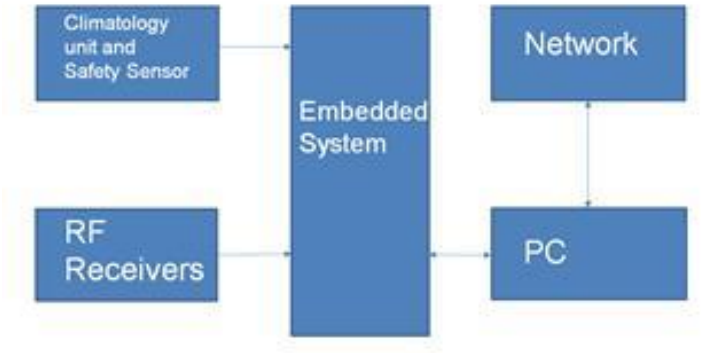

Figure 2: Receiver side of the system

II. FUNCTIONAL BLOCK DIAGRAM & CIRCUIT DIAGRAM

From the circuit it can be seen that the reference analog supply after being regulated by the 9v regulator enters the Zener diode through the resistance R4 where it is again regulated to 5v since the Zener diode used here has a cut off of 5v R6 is a potential divider used for setting the dynamic response range of the reference supply. This means that the reference 5v can be used as it is or it can be made into a fraction of the 5v, for example, 1v so that readings in this range can be read with more precision.

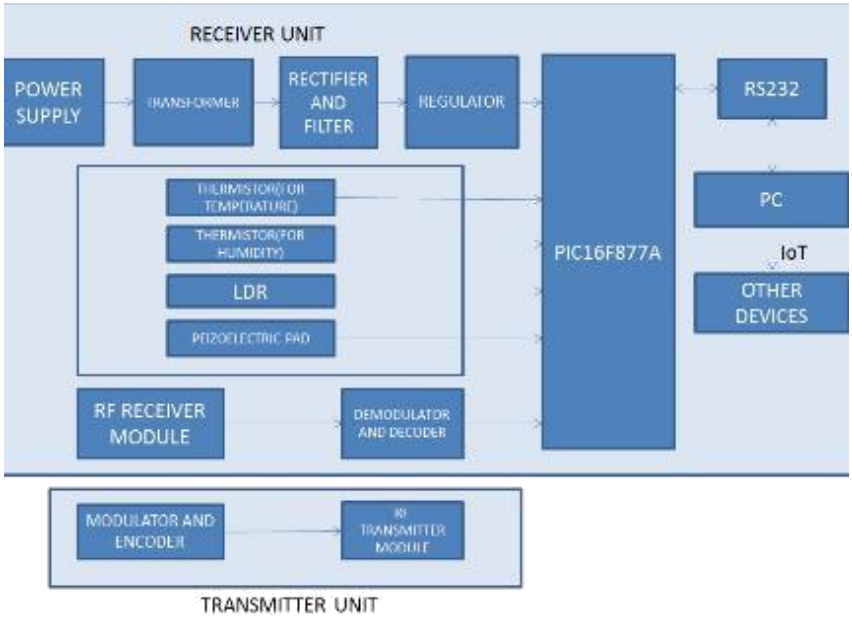

Figure 3: Block Diagram

This is because the ADC has 10-bit resolution, which can be totally used for representing the 1v rather than 5v. The pins 2-5, 7-10, 35 and 36 are used as the 10 channels of the ADC. To these pins, the analog inputs to be processed by the ADC are given. Y1 is the crystal oscillator used. It is of 10 MHz and gives a baud rate of 9600 bits/s. The capacitors C2 and C3 are used as decoupling capacitors to remove the high-frequency noise signals. The capacitor C1 is in the off condition when power is switched off. When the power is switched on or reset then this capacitor gets charged through the resistor R2 and then through R1 this appears at the MCLR pin of the PIC. This is the memory clear pin and thus the memory is cleared and is ready for use as soon as power is switched on. S1 is the synchronous switch, which is also used for the same operation and for PC and PIC synchronous operation.

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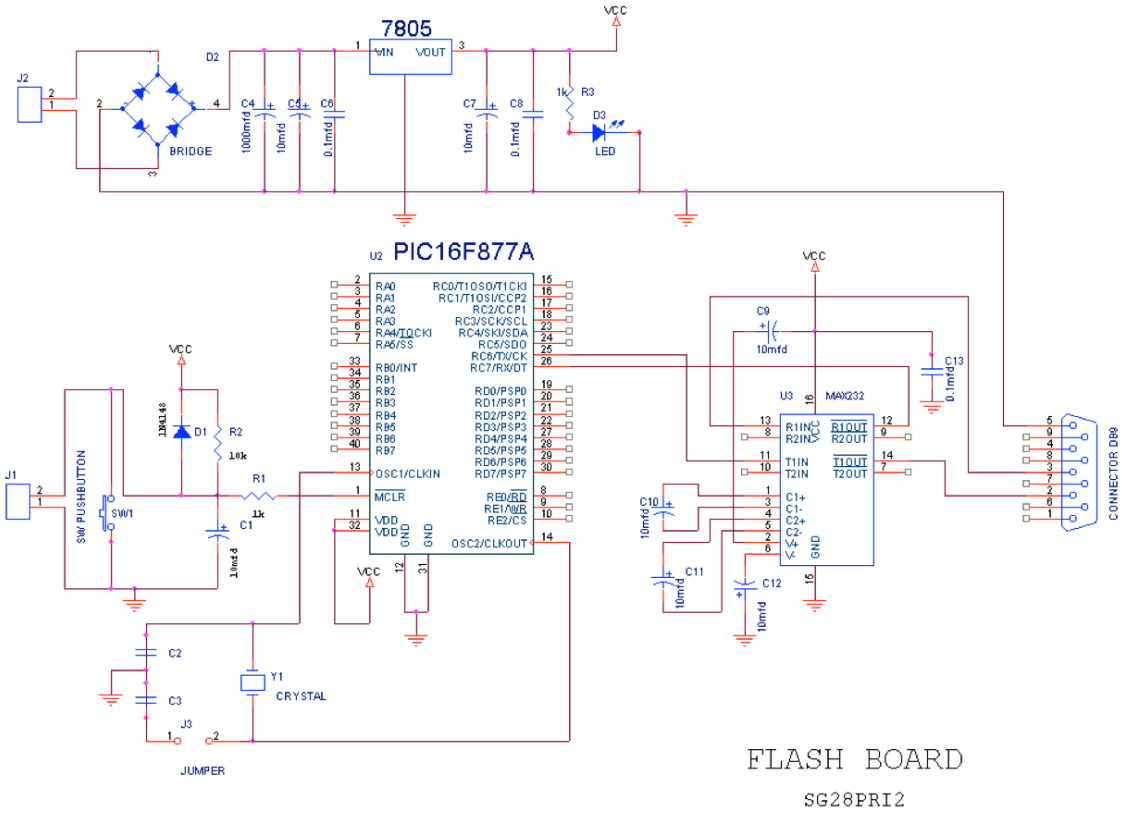

Figure 4: Circuit Diagram

III. HARDWARE DESCRIPTION

A. MICROCONTROLLER (PIC16F877A)

For performing various operations and conversions which require to control and monitor the devices a processor is needed. The processor may be a microprocessor, microcontroller or embedded controller. In this project an embedded controller, specifically, PIC16F877A is used due to its various features like a number of ports.

The PIC16F877A is a capable microcontroller that can do many tasks because of its large programming memory 8k words and 368 Bytes of RAM. One of the main advantages is that it can write-erase as many times as possible because of its FLASH memory technology. It has a total number of 40 pins and there are 33 pins for input and output, two 8 bit and one 16 bit timer and an inbuilt 10 bit ADC. It also has a watchdog timer which is a hardware timer that automatically generates a system reset if the main program neglects to periodically service it. It is often used to automatically reset an embedded device that hangs because of a software or hardware fault. The PIC16F877A has a wide operating voltage range from 2.5V to 5.5V and an operating frequency of 0-20 MHz

B. MAX232

The most common communication interface for short distance is MAX-232. MAX-232 is a standard for serial communication from a device to a computer communication port, with speeds up to 19,200 Baud. In simple words, the MAX232 block is used to interface the system with the PC. It chip converts the 5V power supply from the microcontroller to 20V supply to the PC and vice versa. It helps in amplifying the voltage without attenuating the RF signal

C. HT12D

HT12D is a decoder integrated circuit that belongs to 2^{12} series of decoders. It is mainly provided to interface RF and infrared circuits. They are paired with 2^{12} series of encoders. The chosen pair of encoder/decoder should have the same number of addresses and data format. 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. HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits.

D. HT12E

HT12E is an encoder integrated circuit of 2^{12} series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.

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E. RF MODULE

This RF module comprises an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

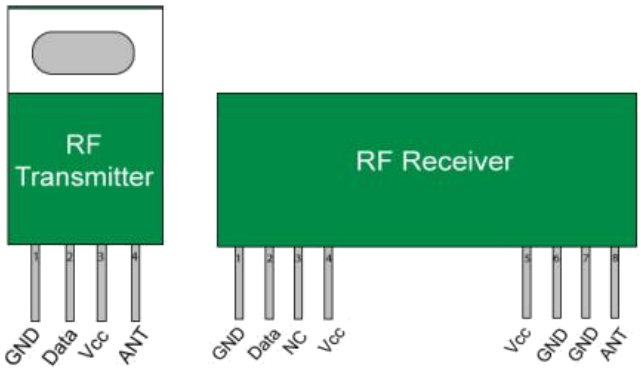

Figure 5: Circuit Diagram

IV. SOFTWARE DESCRIPTION

Visual Basic is a third-generation event-driven programming language and integrated development environment from Microsoft. Visual Basic was derived from BASIC, a user-friendly programming language designed for beginners, and it enables the rapid application development of GUI applications.

In this project, we have used visual basics for the output screen which essentially dis- plays the real time values of the four ambient parameters, as well as shows where a particular person is located in the mine using a map. The real time values are calculated directly from the voltage values obtained by the respective sensors. These analog values are sent to the analog port available in the microcontroller. Using the visual basic programming, we display these values in textboxes.

For implementing tracking of moving objects or people, we first need a map in which the above can be viewed. The RSSI algorithm is implemented in the programming, which produces a value between zero to thousand and twenty (approximate value), depending on where the transmitter is present. If the transmitter is close to the receiver end, the signal strength is high, which gives the RSSI value somewhere in the range of 900-1000. As the transmitter moves away from the receiver unit, the strength of the signal gradually decreases, consequently causing the values to drop. Using these values, we can track the moving object or person's location. This is done by placing a shape at the receiving station which represents the moving object or person in the VB output screen. As the RSSI values change, we can program the shape to move or shift in the respective direction.

By implementing IoT in this project, it allows the output screen to be shared by other users. This shared screen can be viewed from any web-enabled device without having to download or install any software. This mobile user cannot control the screen but only view it, thus increasing security.

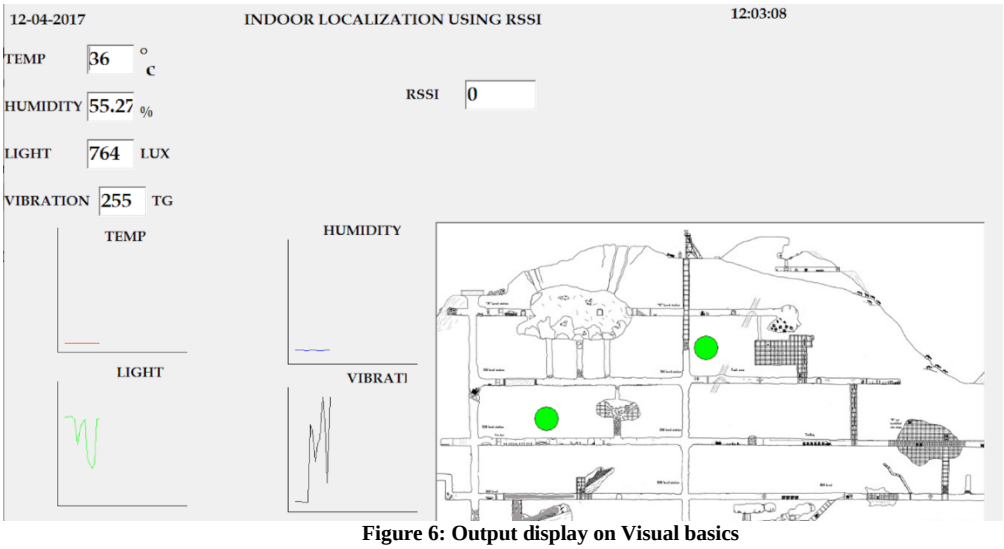

Figure 6: Output display on Visual basics

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V. IMPLEMENTATION AND RESULT

The system has three main objectives, transmitting, receiving and monitoring. The transmitter unit is a portable device which is given to each individual using which the tracking and locating of every single identity are done at different frequencies. These frequencies are predefined and an HD12E chip is used for encoding the signals. An RF transmitter is used for this purpose.

A receiver side is a fixed unit that is used to get the tracking information from the transmitter side and can be viewed using a computer. An RF receiver is used for this purpose with consists of an HD12D chit that decodes the signal that is received from the transmitter side. This decoded signal is then given to the microcontroller (PIC16F877A) which runs the already existing visual basics program to give the output on the computer screen. An additional feature such as the Internet of things (IOT) is used so that multiple persons can access the output on different devices but cannot make changes to it.

The monitoring is done using a climatology unit which is also fixed. This is placed in the location where tracking is done. The climatology unit consists of four separate units. The thermistor is used for monitoring temperature variations. The relative humidity which is the water to air ratio is calculated and is monitored by the thermistor. An LDR is used to determine the light intensity within the closed environment. A piezoelectric sensor is used to detect vibration. Since the variation of the above factors causes a large difference in the voltage, a potential divider is used, which is also cost efficient.

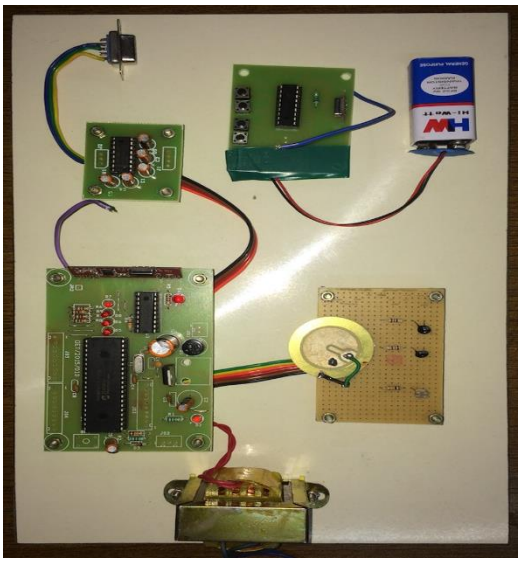

Figure 7: Circuit

VI. CONCLUSION

This concludes that the present work was a success and will provide an efficient method to track and monitor moving objects/people in closed environments like mines where GPS is not an option. In addition, we can also monitor three ambient parameters such as temperature, humidity, and light intensity levels. If these parameters are at abnormal levels, they compromise the safety of the mine workers. A safety sensor that detects slight vibrations in the mine due to landslides or earthquakes is also present. These above parameters can be monitored and be viewed by mobile users outside the mine with the help of IOT.

VII. FUTURE SCOPE

In the future, we can improve by adding voice communications between the transmitter and the receiver side. That way, in the case of emergencies, voice instructions can be given to the mine workers in order to get them to safety. Another improvement that can be done is that multiple users can use the same system instead of a single individual.

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