



IOT based Monitoring and Detection of Electromagnetic (EM) Radiation Levels

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EM radiations are considered as one of the major reasons for effecting and heating up the body tissues that could even burn when exposed at certain frequencies. At lower frequencies, external electric and magnetic fields induce circulating currents inside the body and radiations from EM devices are very harmful for human health. One such example is mobile phones which we always carry and utilize in our daily routines. Radiations emitted from mobile phones are harmful to human health. Hence, it is of paramount importance to detect and monitor EM radiation levels so that preventive measures could be taken to minimize or to completely avoid such radiations at prohibited areas such as Hospitals. The main aim of the proposed work is real time monitoring of the EM radiations emitted from mobile phones and comparing with FCC and ICNIRP levels that is allowed for general public. The system is mainly composed of arduino uno, RF detector and receiver, 16*2 LCD display, ESP 8266. Arduino Uno acts as a controller and responsible for converting voltage level to electric field value. RF receiver with RF detection circuit detects the radiations from the surrounding. 16*2 LCD will display electric field value. If the electric-field value is greater than the allowed range, the piezo electric buzzer will turn on. The ESP8266 Wi-Fi module will upload the electric-field value data on the Think Speak cloud so that the radiations level can be monitored remotely. Simulation is done using proteus ISIS and finally the hardware is implemented to showcase the results.

Introduction

This section discusses about the state of the art technologies, background of the work and existing solutions to the work. The problem and work implementation is explained in brief. Objectives and project limitations were discussed. Due to the advanced developments of advanced technologies, EM radiations are exposing at each and every place which are not only harmful to human beings but also harmful to birds. All the electronic gadgets are based on E-tools. In today's world, Mostly health effects are based on EM radiations. From the researcher's point of view, cell phone and GSM towers might effect the health of human beings. To avoid this, it is very important that the EM radiations must be characterized. Hence, this could help to reduce the risks associated with EM radiations. This could help various stake holders to plan accordingly to optimize the space appropriately. After installation of GSM towers, the radiations should be monitored properly. Hence, Safety measures should be followed considering base stations and mobile phones.

In the urban areas , the public has totally disagreed to install any kind of inside or outside due to heavy EM radiations. However, even though it is installed it must be continuously monitored and strictly maintained.

The objectives of the proposed work are

1. Detecting Electric field levels using antenna and RF receiver.
2. Generating DC voltages and converting into E-fields with antenna factor(AF)
3. Electric field values are uploaded to cloud data base using thinkspeak using ESP 8266/12E.

S No.	Methodology	Remarks
1.	AGILE	Mainly focused on requirements rather than product design. Not suitable for large organizations
2.	WATERFALL	It is simpler and easy to use. Follows sequential steps. Each step is verified before going to another step.
3.	V-MODEL	In this model, each step is executed in a sequential manner. The next stage is followed only when the previous step is executed.

Table 1. Methodology

Research Paper	Remarks
(Z. H. Bohari, 2014)	Detects low frequency EM radiation. Flashing LED's displays the results. Radiation levels are not displayed. High frequency radiations are not displayed. Real time radiation and detection is not possible
(Venkatesulu, Varadarajan, Prasad, & ramana, 2014)	Complex system. Monitoring and detection of radiation levels is only for specific frequencies
(Venkatesulu, Dr, & Prasad, Real Time Monitoring System For Electromagnetic Radiation Measurements Using Arm Processor For Cellular Base Stations, 2012)	Data usage is not efficient. There is a continuous monitoring of radiation levels
(Mavromatis, A., Samaras, Ch., & Sahalos, 2008)	The radiations cannot be monitored remotely. Radiations are measured on 24 hour basis
(Nishat Tasnim1, 2014)	Remote monitoring of radiations is not possible. If the value is above the allowed range, the system is not notified.
(Gabriel Galindo-Romera, 2017)	Continuos monitoring is possible and the system measures the electric field level automatically.

Table 2. Literature Review/Theory

Design and Analysis

This sections contains brief description of the work. Block diagram, flowchart, technical requirements and detailed explanation of the work is discussed below.

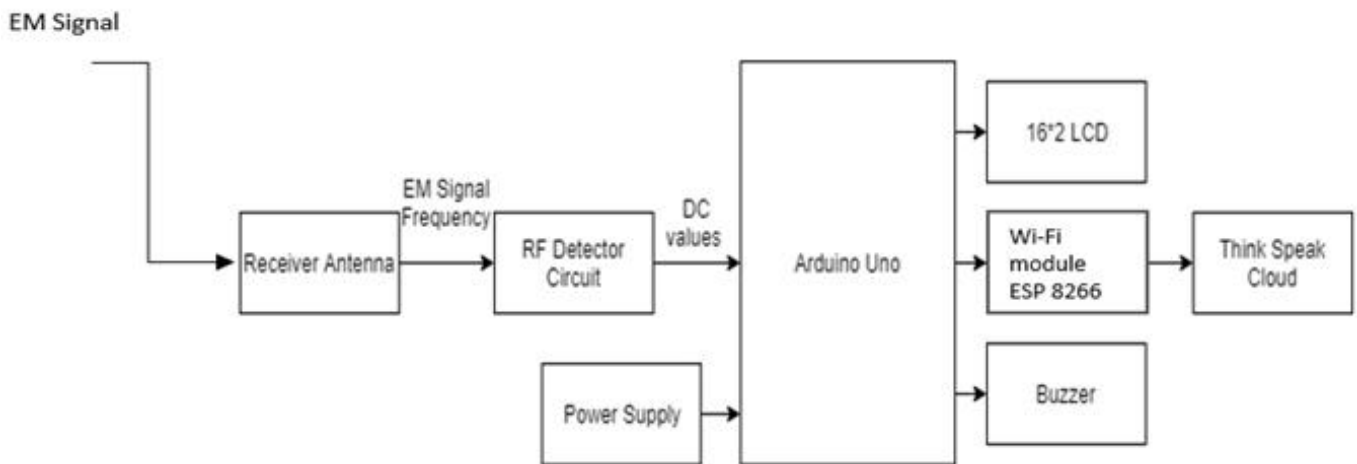


Figure 1. Block diagram of the system

Figure 1 above shows the block diagram connected with Receiver antenna, RF detector circuit, Arduino Uno, LCD, ThinkSpeak Cloud and Buzzer. The radiations from the environment is captured through RF detector and receiver antenna. Arduino Uno does the overall processing and the results are displayed in LCD. Also, The Arduino Uno converts the input voltages to electric field value.



Threshold values are set so that if the electric field is greater than the threshold then the alarm is executed. The data is uploaded to thinkspeak for analysis. RF receiver antenna takes the RF signals and RF detector circuit detects the RF signal. Figure 2 explains the flow chart of the proposed work.

SystemFlow Chart

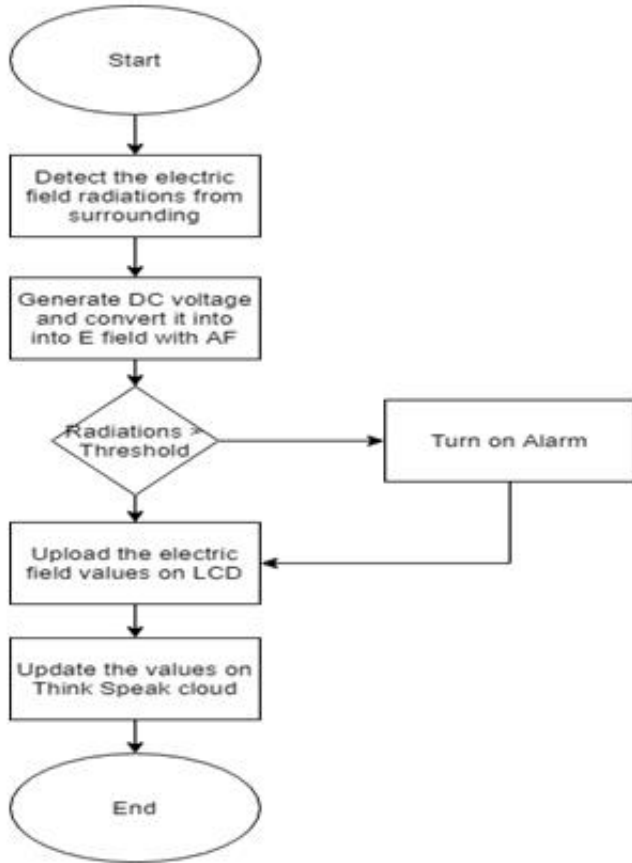


Figure 2. Flow chart of the system

Schematic Diagram

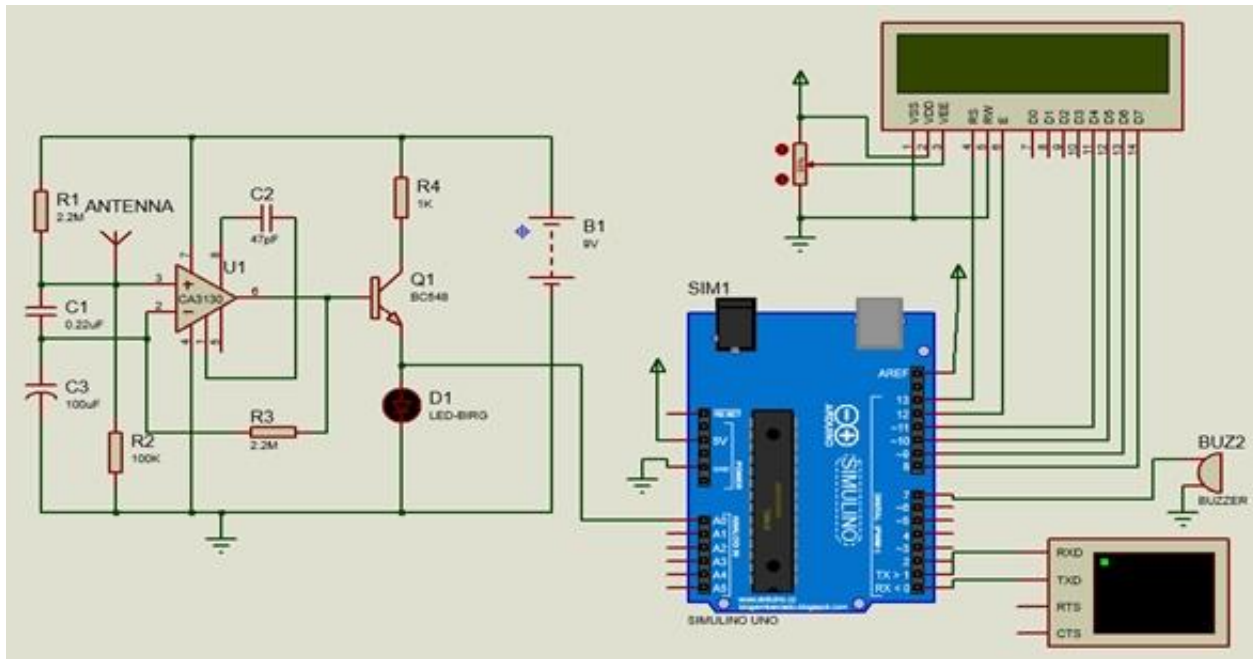


Figure 3. Schematic diagram of the proposed system

The inputs and outputs of Arduino are RF detector circuit and RF receiver antenna whereas outputs are LCD, Buzzer and ESP8266.

The main hardware component in the proposed work is Arduino uno which does the overall processing. All the components are powered up by 12V power supply. Below is the complete analysis of the circuit.

Consider following notification:

E_{rms} : rms value of AC voltage

E_m : max value of AC voltage

V_{dcNL} : no load DC voltage, V_{dcFL} : full load DC voltage

R_o : internal resistance, I_L : full load output current

V_{Lmin} : minimum output voltage from unregulated supply, V_{rms} : rms value of ripple

The power supply is comprised of two parts. Regulated and unregulated power supply. Regulated section involves input capacitor of value 0.33 micro farads , output capacitor of value 0.1micro farads and voltage regulator.

The electrolyte capacitor is taken as 1000 uF, $R_o = 8$ ohms and $I_L = 1A$.

230/15 VAC with 2A rating transformer is selected. 1A, 25V diode is selected. Capacitor of 1000 micro farads with 25V is selected. Presence if mobile phone and BTS receiver radiations are selected using RF detector.

Current to voltage converter, Op-Amp IC CA3130 is used where capacitor is placed between inverting and non-inverting inputs. In addition to this , two resistors are also connected



16*2 LCD displays electric field levels. It consists of 16 pins. GND pin and supply pins are connected to ground and 5V supply. Variable resistor is used for contrast adjustment. Reset pin and Enable pin are connected to digital Arduino. R/W pin is connected to ground. LED+ and LED- pins are connected to +5V and ground pin of power supply. Buzzer consists of two pins. One is connected to Arduino and the other is to ground.

Simulation, Testing and Implementation

This section contains the complete description of simulation softwares used, implementation phase and test phase. This section includes the complete steps performed as shown in Figures 4-10. ISIS proteus is used to simulate the circuit performance.

Figure 4. *System Enable sign*

Figure 5 illustrates the signal detecting or not detecting. The signal detection is very low so the Arduino does not sense the signal.

Figure 5. *No signal Indication*

Figure 5 and 6 indicates no signal indication and signal detection. Reading in the multimeter and RF signal detection is shown. Arduino sense the signal and result is displayed.

Figure 6. *Signal Detected*

Figure 7. *Signal Detected*

Figure below shows no display signal. The complete connection pins are shown below

Figure 8. *No display*

Figure 9 displays no signal as very low input voltage signal is detected by the RF detector circuit. Since the voltage is low, Arduino will not sense the signal. Hence, LCD will not display, Buzzer is OFF.

Figure 9. *No signal display*

Figure 10 shows signal detection display. When the signal is detected by the RF circuit, LED will be ON. Arduino will convert input voltage to electric field levels.

Figure 10. *Signal detected*

System Implementation and Prototyping



The system is implemented on the breadboard for testing and once all the things are working fine then the system is connected on PCB board. Figure 11 and 12 shows the final prototype and Figure 13 shows think speak where data is monitored and analysed.

Figure 11. *System prototype 1*

Figure 12 shows signal detection using RF detector circuit. When the signal is detected, The LED is ON and the signal is detected. LCD display the reading, Buzzer alarms and data is sent to thinkspeak.

Figure 12. *System prototype 2*

Figure 13. *Think Speak*

Conclusions

The proposed prototype is designed to demonstrate the monitoring of EM radiation levels produced by cellular base stations, RF sources and base units. The prototype can be connected anywhere to monitor and detect the radiation levels and the alarm will be turned on once detected. The complete data is uploaded in thinkspeak for analysis. EM radiations are everywhere and the sources of EM signals are base stations, mobile phones and other electronic gadgets. The proposed system is set with threshold levels below which indicates no harmful and if the value is above threshold indicates harmful to health. Future work can be extended by sending messages to the authorized people so that prior precautions can be taken.

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