

# Detection of Metal Landmines using Unmanned Vehicle through Bluetooth Nodes



Nishi K. U., S. Hemalatha, P. Sonia Lakshmi, Amrutha K.

**Abstract:** The landmines are created for war purpose by burying explosive metals underneath the earth surface at the length of 15 cm. It can stay active for up to 50 years. They rely on the effect of explosive blast to damage the victim. Mostly, these could be Blast mines where the explosive material is buried. These explosive materials are made up of metal or other materials where explosive chemical component embedded in it. These landmines could be found with the help of inductive proximity sensors to detect metallic objects and ultrasonic sensors to detect the distance of the detected object from the vehicle. With the help of Bluetooth module which is implemented on the unmanned vehicle is used to search the minefields will transmit the information to its paired device. The vehicle is programmed using Arduino Uno (AT mega 328) to analyse and process the information. The device is programmed in such a way that as soon as it finds any objects it stops right there. Indicating the presence of metal object on that location. This detection is done with the help of creating Bluetooth nodes and then activating the sensors through Bluetooth transmitter (user's device). Based on the target object 's electromagnetic radiation the presence of metal can be found. This is done to demine the unknown landmines across the world.

**Keywords:** Ad-hoc Networks, Bluetooth low Energy (BLE), Frequency hopping, Landmines, Nodes, Piconets.

## I. INTRODUCTION

The landmines are used primarily as defensive weapons in conventional warfare. These landmines are buried on the surface of the ground which is mostly used to slow enemy advances, and deny locations of enemy troops. While still many minefields are barely recorded or never marked making them dangerous and unpredictable. These landmines could be made up of metal and other materials. These could be triggered by stepping on the pressure plate applying 5 to 16 kg of pressure. The mines which become active by the human foot is known as Anti-personnel mines. To detect the dangerous mines and to avoid any human intervention in the minefields. The unmanned vehicle is used which is equipped with sensors.

The inductive proximity sensors detect the metal without any physical contact. It also has high response frequency of 3.3 KHz. Where reliable sensing is possible even in adverse conditions. To detect the distance, ultrasonic sensors have been used. This could also be used in the landmines that are made up of material other than metals. This has the frequency from 40KHz to 70KHz and measuring distance from 2cm to 400cm.

The unmanned vehicle transfers the information by establishing connection to the user's device. This connection is made with Bluetooth. Although Bluetooth might seem impossible to make any nodes. But Bluetooth 4.0/5.0 version has the capacity to form Bluetooth mesh network which is built on the top of Bluetooth low energy (BLE) which forms nodes. BLE uses radio frequency of 2.4 Ghz to 2.4835 Ghz ISM band. This uses frequency hopping method to transfer information across the node due to this interference and eavesdropping of information can be avoided. When two or more Bluetooth devices are connected, they are connected by ad-hoc network. It means that the device does not have the knowledge of the arrangement of the nodes in that location. Where one node acts as a master and remaining node as slaves to initiate data exchange. This exchange of data takes place between master and slave as in [4], which is bidirectional. The Arduino UNO acts as the brain of the system to give instructions and analysis the result. This unmanned vehicle is controlled via Arduino Uno. Buzzer will alert the system if it finds any metal, and the vehicle will stop on that spot. Otherwise, the vehicle will move along the specific direction for the given time period.

## II. MATERIALS AND METHODS

The Arduino UNO is interfaced with the sensors, Bluetooth module, DC motor, Power supply and Buzzer. The interfaced device is programmed using Arduino IDE software. These materials are implemented on the top of the unmanned vehicle, and then it is connected to the user's device for data transfer. At first, the connection should be established between the unmanned vehicle and the user's device using Bluetooth. These devices are connected by Ad-hoc Network where it does not require any router or switch. Here one device acts as a master and another as slave which forms Piconet. A piconet connects two or more devices using ad-hoc network through Bluetooth. When two or more piconets joined together, it forms scatternets. Any two devices connected via Bluetooth are in a pair of complementary states that are inquiry and inquiry scan state. The master device will be in inquiry state, and slave device will be in inquiry scan state. Only then the connection will be established. If any other devices present in that region could also be connected to Bluetooth which forms Bluetooth nodes.

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But there will be presence of only one master in a Piconet. In a Piconet data transfer between different nodes takes place through frequency hopping method. Where the maximum number of hops is about 79 in a Piconet. As in [3], the number of hops creates the mesh network in BLE. Therefore, the topology and hopping of data are dependent on each other.

Even though, the presence of many nodes in the piconets, the nodes which have clock synchronization, and same hopping sequence will be transferred data in the physical channel. The frequency hopping will avoid the interference between the signals. Where the data transfer is up to one or two Megabits per second.

Then, the Bluetooth transmitter (master) will send the instruction to the Bluetooth receiver (slave). The data will be sent to the Arduino module then the vehicle will work

accordingly. The unmanned vehicle will move in the direction given by the user. The sensors will start to detect. The ultrasonic wave will transmit the wave from trigger port and when it finds any object the wave will get reflected through echo port using this distance could be measured. But the object that is found is metal or not can only be found by inductive proximity sensors.

The inductive proximity sensors work based on the principle of electromagnetic induction to detect metals. It can be used in severe environments. It mostly detects ferrous metals like Iron, Cobalt, Nickel, Magnesium, etc. because these metals have higher electromagnetic losses when compared to Non-ferrous materials such as Aluminium, Copper, Brass, etc. After the metal has been detected by the sensor, the data will be analysed and processed by Arduino. The information will be transmitted to the user's device.

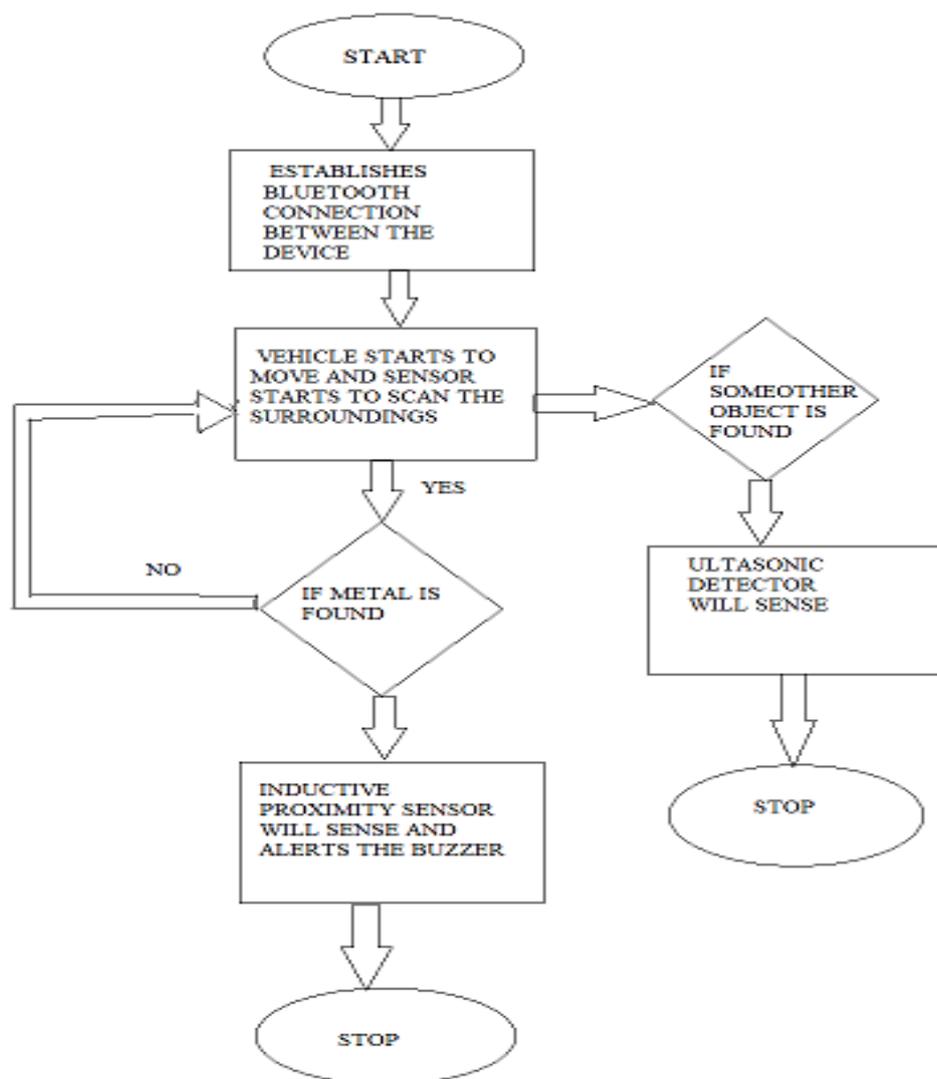


Fig: Algorithms used in working of Unmanned vehicle

III. RESULTS AND DISCUSSION

Table: Experimental results

Type of Material	Inductive Sensors	Range	Condition	Ultrasonic Sensors	Range	Condition
Ferrous Metal	Detects Due To High Sensitivity	3mm- 60 Mm	Detects In Dry As Well As Wet Condition	Detects	2cm -400 Cm	Detects In Dry Condition And In Water
Non-Ferrous Metal	Does Not Detect Due To Low Sensitivity	Does Not Detect In Any Range	Does Not Detect In Any Condition	Detects	2cm – 400cm	Does Not Detect In Wet Soil Condition
Plastic	Does Not Detect, Because It Does Not Have Electromagnetic Property	Does Not Detect In Any Range	Does Not Detect In Any Condition	Detects Only When The Object Is Large	2cm – 400cm	Does Not Detect In Wet Soil Condition
Wood	Does Not Detect, Because It Does Not Have Electromagnetic Property	Does Not Detect In Any Range	Does Not Detect In Any Condition	Detects Only When The Object Is Large	2cm- 400cm	Does Not Detect In Wet Soil Condition

The metal conductivity and permeability will determine how well the metal can give loss. Based on the electromagnetic loss eddy current will be produced which causes variation in the magnetic field of inductive proximity sensors. This inductive proximity sensor is used in place of other types of metal sensors due to the short response time, high precision, non- contact detection, long life and work well in adverse conditions. This metal detecting sensor could reduce the detection time as mentioned in [2]. The ultrasonic sensor detects object distance based on its speed and time taken by the transmitted and reflected wave. Sometimes, the ultrasonic sensor could not able to detect the object which are smaller in size and could not detect in wet condition due to reflection of wave from target object is not good. As the buzzer alerts, the detection of metal can be determined. The advantage of using Bluetooth low energy (BLE) is even one node gets damaged this connection will send information to other nodes in the network without any interruption. Due to the use of frequency hopping by BLE, the interference between signals can be avoided. So, the collision of data in the network will be reduced.

operating nodes, even some nodes are damaged in the network. So, demining can be done faster and safer.

The high response time of the inductive proximity sensor, faster processing of data by Arduino and reduction of collision during data transmission by BLE helps in faster detection of explosive metals in Anti-personnel mines.

IV. CONCLUSION

The demining of landmines is considered as dangerous and the unmarked mines make it unpredictable. These landmines could cause injuries and death to human lives. To prevent the further death of humans, the unmanned vehicle using the Bluetooth nodes could avoid the possibility of human interference into the landmines. With the help of sensors detection of metals or any other objects can be done, without any direct contact to the target. Non- direct contact with the object and due to the use of BLE which makes the target to be accessible from the distance. The transmission of this information to the user’s device is done without any interruption due to the use of frequency hopping method, and BLE provides good interoperability between the nodes. Due to this, it can transmit the information to other

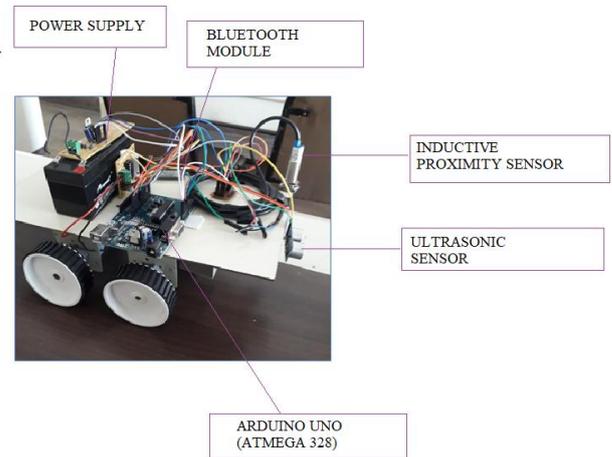


Fig1: Prototype of an Unmanned Vehicle

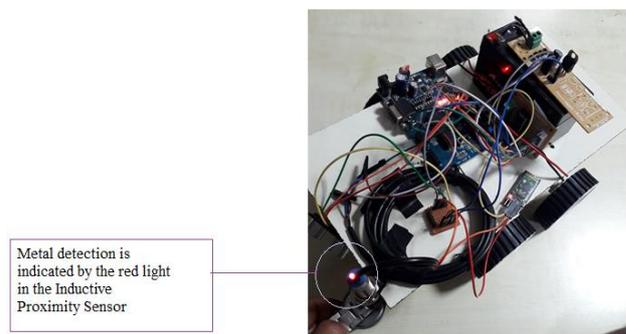


Fig2: Metal detection by Unmanned Vehicle

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