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Smart Wireless Autonomous Robot for Landmine Detection with Wireless Camera

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ABSTRACT

The tremendous recent involvement of technology in our life generates a lot of advantages and disadvantages. Nevertheless, and in order to highly augment its positive influence, at the expense of the negatives, technology most be deployed to serve humanity and society. With this objective, we highlight the importance of involving robotics, communication and data analysis in the domain of land mine detection. The main idea is to design and implement a prototype of an efficient low cost automated robot that has the aptitude to detect the buried mines and lets user control it wirelessly to avoid human causalities. This detector will wirelessly communicate with a server to transmit the detected information. The proposed system will help in significantly reducing the risk poses to the human detectors lives while they are in a field of mines.

Keywords: Arduino IDE, Autonomous Robot, Fire Sensor, IOT Device, Landmine, Metal Detector, Obstacle Detector

I. INTRODUCTION

Despite the general awareness on the amount of landmines laid down around the globe, end-user's needs for new technologies must be properly assessed in order to avoid the wastage of financial funds.

A. Autonomous Robot

Robotics is bringing innovatory changes in the world by introducing new technologies. Autonomous robots are intelligent machines capable of performing tasks in the world by themselves, without explicit human control.

B. Landmine

A mine is usually placed just below the surface of the ground and designed to be explode by the weight of vehicles or troops passing over it.

Classifications of Mines

Mines can be classified in two broad areas as Anti-Tank Mine (ATM) and Anti-Personal Mine (APM). There are also some misfired or undetonated explosives which are named as Unexploded Ordinance (UXO). These UXO can be found on battle field. These are typically bomb shells which are fired but due to some reasons did not explode.

Table 1. Gives the Details of All Three Types of Mines

Target	Unspecified	Armed personal	Human
Weight	Various	Heavy (6-11 kg)	Light (0.1-4 kg)
TYPE	UXO	ATM	APM

Size (in diameter)	Various	Large (13-40 cm)	Small (6-15 cm)
Case material	Mostly metal	Metal, plastic	Plastic
Detonation pressure	Unpredictable	120 kg	0.5 kg

II. MOTIVATION

There are nearly 50 million unexploded landmines in 60 countries around the world. These landmines kill and maim approximately 26,000 people annually of which 70% of victims are civilians and one-third die and others loose limbs. Large portions of land go unused due to fear of mines. Modern mines can be constructed with plastics and composites. The low metal content of mines makes detection extremely difficult. Despite global ban, 1 million new mines are laid annually which means 10 times more mines are laid than clear each year.

III. PROPOSED SYSTEM

The main problem in the existing system was that it doesn't detect the landmine accurately. It also doesn't have a wireless camera to monitor the surrounding environment and uses a PIC microcontroller to combine all the process.

Proposed system uses multiple sensor to detect the fire, obstacle and landmine in the field and to monitor the surrounding at safe place and also to update the status in IOT website and control the robot movement.

Every landmine ever build will have a trigger pin to trigger the landmine. These trigger pins are made up of metal device which can be easily detected. This system will focus on detecting the trigger pin using the metal detector. As this system is autonomous, it uses the ultrasonic sensor to detect the obstacle in front of the robot. Hence it can be send alone to a place without controlling. To detect the fire it uses the flame sensor. The system monitors the surrounding with the help of wireless camera. All the details and status about the landmine and environment status will be updated in a specific IOT website.

A. Metal Detector Sensor

Metal detectors use electromagnetic fields to detect the presence of metallic objects. Metal detectors use electromagnetism in two fundamentally different ways, active and passive.

*(1)*Active detection methods illuminate some detection space—the opening of a walk-through portal, for example, or the space directly in front of a hand-held unit—with a time-varying electromagnetic field. Energy reflected from or passing through the detection space is affected by the presence of conductive material in that space; the detector detects metal by measuring these effects. *(2)* Passive detection methods do not illuminate the detection space, but take advantage of the fact that every unshielded detection space is already permeated by the Earth's natural Magnetic field. Ferromagnetic objects moving through the detection space cause temporary, but detectable changes in this natural field.

B. Ultrasound Sensor

Ultrasound frequencies are frequencies above audible range i.e. 20KHz. Sound wave travel in the form of disturbance of molecules in the medium in form of waves. In a Homogeneous medium sound wave travels along the straight line as there is no change so far. But when other medium is encountered, sound waves get reflected and refracted. The reflected waves are processed to make prediction about buried object as wave travel with different speed in different material. Frequency plays major role in depth of penetration. Ultrasound wave travels

through humid conditions with less attenuation but gets attenuated in air.

C. Flame Sensor

A flame detector is a sensor designed to detect and respond to the presence of a flame or fire. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame.

D. IOT Device

The IOT concept is simple but powerful. If all objects in daily life were equipped with identifiers and wireless connectivity, these objects could communicate with each other and be managed by computers. IOT describes a system where items in the physical world, and sensors within or attached to these items, are connected to the Internet via wireless and wired Internet connections. These sensors can use various types of local area connections such as RFID, NFC, Wi-Fi, Bluetooth, and Zigbee. Sensors can also have wide area connectivity such as GSM, GPRS, 3G, and LTE.

E. Arduino IDE

Arduino is an open source, computer hardware and software company, project, and user community that designs and manufactures microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

Hardware Arduino: An Arduino board consists of an Atmel 8-, 16- or 32-bit AVR microcontroller. The boards use single-row pins or female headers that facilitate connections for programming and incorporation into other circuits.

Bringing all these important components and several supporting systems together we strive to fulfil our objective.

IV. BLOCK DIAGRAM

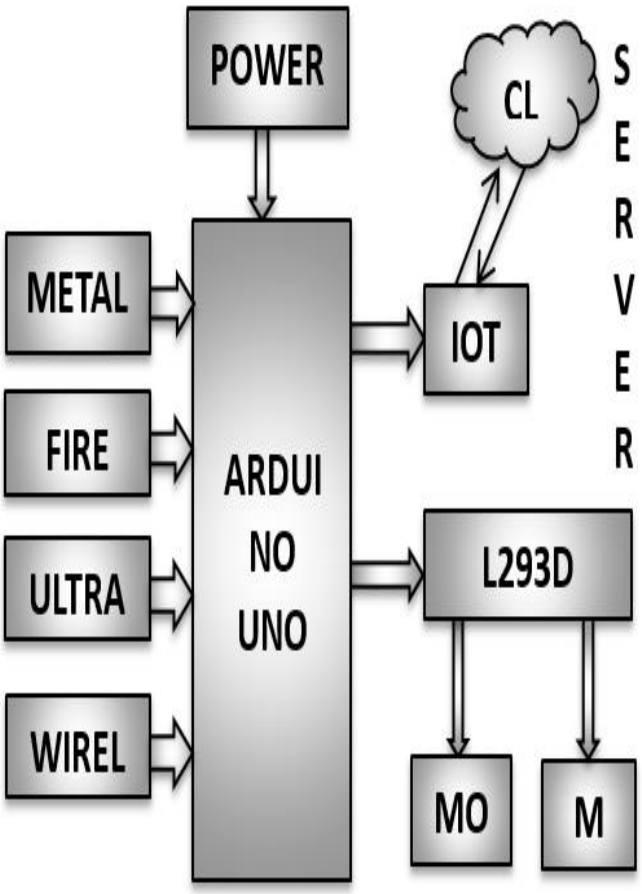

Figure 1. Block Diagram of Detecting Section

Multi sensor fusion (Decision Level fusion)

If $\sum_{i=0}^{n} P(S1) + P(S2) + P(S3) + P(S4) \geq 2$

Then the robot reverses.

P(S1) is sensor probability of mine existence by metal detector

P(S2) is sensor probability of mine existence by wireless camera

P(S3) is sensor probability of fire existence by flame detector

P(S4) is sensor probability of obstacle existence by ultrasound sensor

V. CIRCUIT DIAGRAM

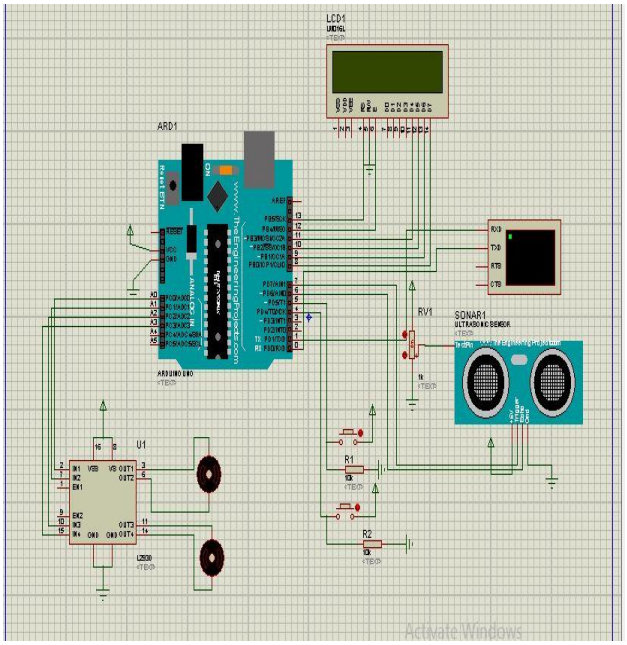

Figure 2. Circuit Diagram (Simulation of Electronic Part)

The simulation of all the electronics part like Arduino, ultrasonic sensor, DC motors etc are done using the Proteus software.

The two DC motors are connected to the output pins (9, 13), of the microcontroller board. The ultrasonic sensor is connected to the input pins (10, 11) to avoid the obstacles. The metal detector sensor are connected to the input pins (12, 13), for detecting of the mines. The LCD display connections are connected to the output pins (2, 3, 4, 5, 11, 13). For simulation, Arduino Uno library have to import first to display and then sensors and motors has to be imported. As pin configuration is stated above the connections are made in the software. Later the program is loaded in the microcontroller for simulation.

VI. APPLICATIONS

- Reconnaissance
- Bomb disposal
- Search and surveillance
- Border patrol and spying
- Active combat situations
- Stealth combat operations
- To undertake dangerous missions which involves loss of human life

VII. CONCLUSION

The main idea was to design and implement a prototype of an efficient low cost automated mine detector that will replace the current employed human detectors in the mission of detecting and extracting mines in a suspected area of land. The objective was to detect fire, obstacle and landmine in the field and to monitors the surrounding at safe place and also to update the status in IOT website and control the robot movement. Since this type of robots are mobile and operate in often communicationally challenging environments, communication systems must be both wireless and able to account for interruptions and delays.

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