International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 09 | Sep 2020 www.irjet.net p-ISSN: 2395-0072

Raspberry- Pi Controlled Landmine Detecting Robot

Miss. Tisha Lukose[1], Mr. Vijaykumar Patil[2]

[1]M. Tech. Student, Department of Electronics, KIT college of Engineering, Maharashtra, India
[2]Assistant Professor, Department of Electronics, KIT college of Engineering, Maharashtra, India

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Abstract – *This paper puts forward the solution to landmine detection. Detection of landmines is a serious problem in the mine prone areas. The system shown in this paper uses a robotic car equipped with different types of components like a metal detector, camera module, ultrasonic sensors, etc. for self-detection of landmines. This data or indications can be sent over a large distance using a GPS to the remote monitoring system. This monitoring system will therein be used for the exact detection of landmines.*

Key Words: Landmine detection, Raspberry-Pi, Metal detector, Robotic car, Ultrasonic Sensors, GPS

1. INTRODUCTION

Landmines are victim-activated explosive traps, whose main intention is to target a person or a vehicle. A mine is generally made up of a specific quantity of explosive that is placed within some form of the casing and a fusing mechanism to the detonation of the main explosive material. Some landmines are buried under the ground, while others are fixed to objects above the ground. They can be activated by a verity of mechanisms including pressure, tripwire, electrical command, or magnetic influence. Some modern mines can even get initiated using other forms of electronic sensors.

Landmines are generally classified into two categories: anti-vehicle and anti-personnel. The anti-vehicle or anti-tank mines are pressure activated and are designed such that the footstep of a person does not detonate them. Mostly military vehicles are targeted to such mines. Anti-personnel landmines are intended particularly to drive back foot soldiers from a specific area. They can be activated by direct pressure from above or with the help of tripwire, or by the proximity of a person within a predefined distance.

Landmines are hazardous and can create problems like removal require a large amount of time, tools, transportation, and a lack of skilled manpower. Landmines if not vacated, can cause loss to friendly forces.

Various landmine detection methods have been developed for the efficient detection of mines. Some of them are Ground Penetrating Radar technique (GPR), Nuclear Quadrupole Resonance (NQR), Electromagnetic Induction technique, Infrared and hyper spectral technique. All of these techniques have disadvantages such as failure in detecting deeply buried mines; slow detection speed, high false alarm rate, etc.

Detection of landmine can be done by combining a number of different types of sensors and robotic technology. The sensors present in the system detect traces of metal; they immediately capture the image of that area and send it to the central control and processing unit along with the location. The image is then processed using an image processing technique to identify if there is any landmine in the vicinity. Various methods such as Support vector methods, Sensor fusion, automatic target detection, etc can be used. When the scanning in the assigned plot is completed, the detector returns to its initial position.

Thus the use of robotics and image processing techniques can be used to save a lot of time, money, manpower, and life of civilians.

2. COMPONENTS FOR LANDMINE DETECTION SYSTEM

2.1 Raspberry PI

Fig-1: Raspberry Pi 3 Model B Board

This single-board computer is used as the main component as it controls all the functions and movement of the robot. Raspberry Pi 3 Model B board is used. This board is quad-core with 40 general-purpose input-output pins and is also faster and more capable than its

predecessor. It is capable of playing 1080p MP4 video at 60 frames per second. It has built-in Wi-Fi and Bluetooth. Also four USB 2.0 ports with 480 Mbps data transfer, 802.11n wireless LAN, 400MHz video core multimedia, and memory of 1GB LPDDR2 with 900 SDRAM, two interface ports camera interface, and display interface.

2.2 Ultrasonic Sensor

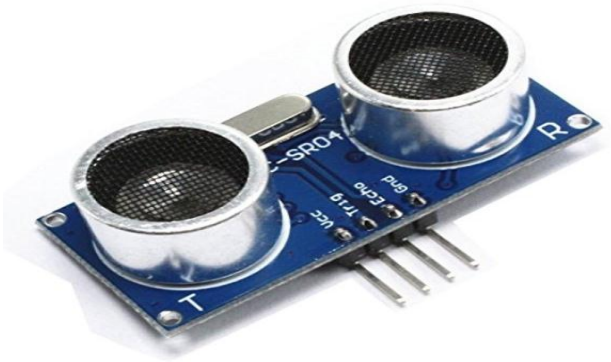

Fig-2: Ultrasonic Sensor

The ultrasonic sensor is an electronic device that measures the distance between an aiming object and the sensor by emitting ultrasonic sound waves. The reflected sound is then converted into an electrical signal. This electrical signal is transferred to raspberry-pi and then to the monitoring system for further processing using image processing. Ultrasonic waves propagate faster than the speed of perceptible sound. Ultrasonic sensors have two main components: the transmitter which emits the sound using piezoelectric crystals and the receiver which receives the reflected signal. Based on the time taken for the transmission and reception it can be used to avoid collision and also for obstacle avoidance and detection purpose. The ultrasonic sensor operates at 5V with a theoretical measuring distance of about 2 cm to 80 cm. it operates at a frequency of 4 Hz.

2.3 Metal Detector

Fig-3: Metal Detector

An electronic instrument that detects metal hidden within objects or metal objects buried underground. They generally consist of a handheld unit with a sensor probe that can be swept over the ground or over other objects. As soon as the metal has detected an indication is shown as a continuous beep sound or as a needle moving on an indicator. Also, this device gives some indication of the distance of metal as a higher beep sound when it is near the metal objects. The metal detector circuit consists of an oscillator producing alternating current which passes through a coil producing an alternating magnetic field. If a piece of metal is close to the coil, eddy currents will be induced in the metal and this produces a magnetic field of its own. If any other coil is used to measure the magnetic field, the change in the magnetic field due to the metallic object can be detected.

2.4 Raspberry Pi Camera Module

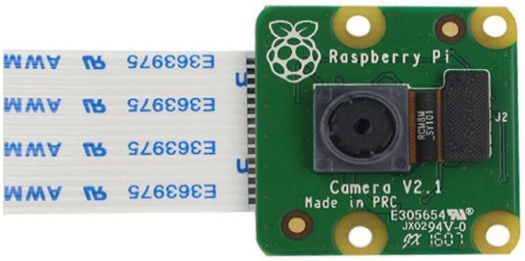

Fig-4: Camera Module

The Raspberry Pi Camera Module v2 is a high quality 8 MP Sony IMX219 image sensor designed with add-on board for Raspberry Pi that features a fixed focus lens. It supports 3280 x 2464 pixel static images, and also supports 1080p30, 720p60 and 640 x 480p90 video. It can be attached to raspberry Pi by one of the small sockets on the board upper surface. It uses the dedicated CSI interface, designed especially for interfacing with cameras.

It has fixed focus lens on-board, 8 megapixel resolution sensor which is capable of 3280 x 2464 pixel static images and supports 1080p30, 720p60 and 640x480p90 video. Its size is only 25mm x 23mm x 9mm; the weight of just over 3g and connects to the Raspberry Pi board via a short ribbon cable.

3. SYSTEM CONCEPT

This paper aims at the design of a landmine detection system using Raspberry-Pi.

Raspberry-Pi is a single-board computer with a CPU of 1.2 GHz quad-core 64-bit ARM Cortex A53. It has an

Ethernet port of about maximum throughput 100Mbps, four USB 2.0 port with 480Mbps data transfer, the memory of 1GB LPDDR2 – 900 SDRAM, expandable 40 general purpose input-output pins, full HDMI video port, DSI (Display Interface) and CSI (Camera Interface).

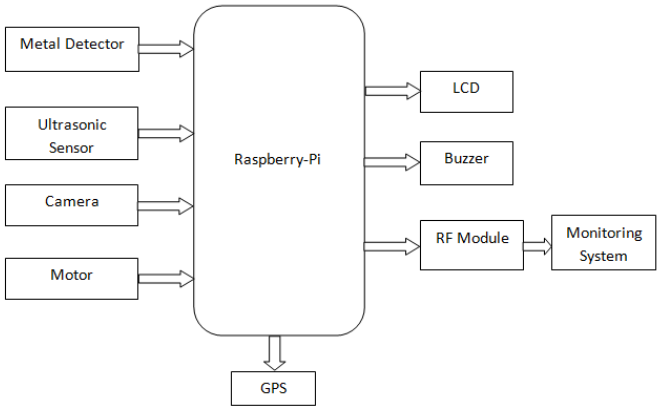

Fig-5: Block diagram

This project combines the technologies of Raspberry- Pi and Image processing. All components are connected to Raspberry- Pi as input which is placed on a robotic wheel framework. Its movement is controlled by the motors connected to the wheels. The metal detector circuit is interfaced which detects any metal object i.e. landmines present nearby. This detected signal is transferred to the monitoring system which will therein mark the location of the metal detected using GPS positioning with the help of image processing. The ultrasonic sensor is used for obstacle avoidance purposes.

The robotic device will be sent on the field at a starting point. Now as per the programming done this device will automatically move in the field and if any metal object is detected the raspberry- pi will send its location to the monitoring system. Also, the obstacles will not affect its working due to the implementation of an ultrasonic sensor for obstacle avoidance. All the readings received will be used to plot the exact location of the landmine at the monitoring system. This robot is automatically operated and does not require humans to operate it. After completion of the detection robot will return to its initial position. This will save human lives and also the time required for detection.

4. DESIRED OUTPUT

In this project, the output can be analyzed using images obtained by camera, GPS, and image processing techniques at the monitoring system. The camera connected to the robot captures images of the area at which the metal detector detects any metal object and is sent to the monitoring system; also the GPS location of the detected metal object is sent to the system. Using image processing techniques the images obtained are analyzed and are checked for landmines. If a landmine is detected the GPS position is detected and it is marked at the specified location using python at the monitoring system.

As GPS provides precise location as it uses satellite broadcast signals from space; the location is specified in three-dimensional representations. After all the detection process is completed the robot will come to its initial position. The operators just have to check his system to find the location with images of the landmines arranged in a systematic manner. The system will show all the landmines detected at the specified plot all at a time on a virtual plot with GPS location. This will increase the ease of detection and also will reduce the risk of loss of life.

5. CONCLUSIONS

There are a lot of landmine detectors in use nowadays, but many of them are human-operated. Most of these humanly operated detectors are not up to the mark, i.e. their controllers, sensors are not efficient. Due to such flaws, there is a high risk of loss of life and property. Such mistakes endanger the life of the military personnel or the residents of that area.

To overcome these shortcomings, there is a need for the development of an automatic, rigid, and efficient robotic system that will therein reduce the losses occurring otherwise.

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