

A CRITIQUE STUDY ON AUTONOMOUS WIRELESS WARFIELD EXPLOSIVES DETECTION SYSTEM

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Abstract— More than 68 countries around the world contain millions of land mines hidden beneath its ground waiting to be triggered. So there is urgent need of a system which is capable of finding and diffusing landmines. The development of new demining technologies is difficult because of the tremendous diversity of terrains and environmental conditions in which mines are laid and also, because of the wide variety of landmines. Currently, detecting and clearing mines demand specific expertise with special equipment. This paper incorporates in it the literature surveys followed by a robot prototype which is capable of detecting the land mines beneath the soil and applying counter-measures for tracking its location, while enabling the operator to control the robot wirelessly from a distance. This technology interfaces with the metal detector circuit in a robot with the array of sensors to search the landmines. The purpose of this paper is to propose a system for landmine detection by using the autonomous robots which are capable of exploring and detecting buried landmines and marking their locations. The main focus we put in this paper is to make a low cost and highly efficient system for the explosives detection.

Keywords— Semi-Autonomous robot, IEDs, GPS, Landmine detection.

I. INTRODUCTION

Landmines are causing enormous humanitarian and economic problems in many countries all over the world. Most of the victims are innocent children and women. However, landmine detection and clearance have turned out to be an extremely challenging problem. Currently, there reportedly are 50 ~ 100 million landmines buried all over the world. The detection and removal of these landmines have still been in progress by a manual method proposed several decades ago and practiced since then. Relying on only such manual work, however, study says it would require hundreds of years to dispose all these mines completely. Under such circumstances, the development of landmine detection and removal system in a short period has become an urgent and much called-for business.

As there are many terrorist attacks going all over the world and recently cited in India at the air force base camp in Uri. The forces failed to suspect the attack which is initiated by planting landmines all over the camp area. Due to which many casualties have been occurred. So, the government is now looking seriously for finding more precise detection techniques without causing threat to human life.

In this paper a brief literature survey is carried out to shed some light on the existing technologies which are in use for the detection of landmines, depicting their limitations. As the paper entitled “Autonomous Wireless Warfield Explosives detection system” an advanced system is proposed to tackle all the explosives related problems and giving fair results.

To be more specific the proposed system is basically a semi-autonomous system in which robotic vehicle is used and all the required sensors with the camera are mounted on the robotic vehicle. The system consist of mainly metal detector circuit with the array of sensors to detect the landmines as well as IEDs.

Also the system is integrated with camera so that the user can obtain fair results.

The major focus we are putting in our system is to make a low cost and highly reliable detecting robot, so that there would be no financial problem and government with the local agencies could easily afford them. The system allows the operator to stay at a safe distance by enabling him to control the robot remotely so that there should no threat to human life.

II. LITERATURE REVIEW

Kishan Malaviya et. al: The authors is this paper claims to optimize the problem of landmine detection has been studied for decades. Mine detection systems have typically been developed by first identifying a sensor technology, then testing on particular manmade test beds, then deploying the sensor on a vehicle or man portable device. The system comprises of metal detector circuit, GPS module for location tracing and gas sensor to also detect the hazardous gases in the targeted area. A custom made AVR board is used for the controlling the robot. Despite much effort, current systems still exhibit gaps between existing and desired capability, e.g., in terms of rate of advance, detection rate, and false alarm rate within demonstration test beds.[1]

Seiji Masunaga et. al: The author’s research group in this paper has developed an advanced cutting-edge system which comprises of a Controlled Metal Detector (CMD) having 3-DOF for any arbitrary positioning of the sensor head. The CMD system can generate 3-D high-speed mapping of the ground surface and can generate trajectories of the sensor head with 3-D stereovision camera. The trajectories are generated by the CMD in such a manner that any obstacle or possible impact with the ground can be avoided. The CMD then tracks the generated

trajectories by a trajectory-tracking controller so that the sensor head can follow the ground surface. The effectiveness and the impact are related to the gap and attitude control on the mine detection performance of the CMD. As the stereovision camera captures the images of the ground, some image-processing algorithm is being used for the recognition of the vegetation to autonomous operation of CMD in vegetated landmine.[2] The experiments with this system gives fair but it is very expensive and sensitive system which can only be deploy under a monitoring of a specialist team.

K. Vidyasagar ET. Al: In this paper the authors successfully made the detection robot with help of metal detector circuit integrated on a robotic vehicle. The system uses wireless electromagnetic signal for the communication between the robot and the receiving section. For the transmission of signals HT12E encoder is used to interface the RF transmitter to the path controlling switches. An address and data input is assigned to each switch. The signal information is transmitted through RF transmitter while in the receiving section HT12D decoder was used to receive the encoded signals. The decoder receives the data serially. The received signal is compared with their local address three times. The

received data is decoded if it contains no errors.[3] The paper fails to possess desired capabilities as it gives false alarm and very less detection rate at the experiment site.

Adzly Anuar ET. Al: The authors in this paper developed a simple low-cost robotic landmine detection system for operation on clear environment with no obstacles. The basic structure of the robot is simply two pieces of Teflon plate supported by several shafts. The controller, RF communication module, motors are mounted on top of this plate or base. Metal sensor is mounted at the bottom of the base. Each side of the robot, except rear side, is mounted with two infrared sensors. Two DC motors with encoders and gear heads are used. The sensors used on the robot are navigational sensors and metal detection sensors. Three types of sensors are used for navigation, which are the infrared sensors, motor encoder and digital compass. These sensors will send signals to the controller to be processed, and appropriate output signals will be sent to the motors. For mines detection, a powerful metal sensor is used. The mine detection robot was tested on a pitch of 4 meter by 4 meter. [4] The test results of the detection are fair but lack in fast detection.

Block Diagram:

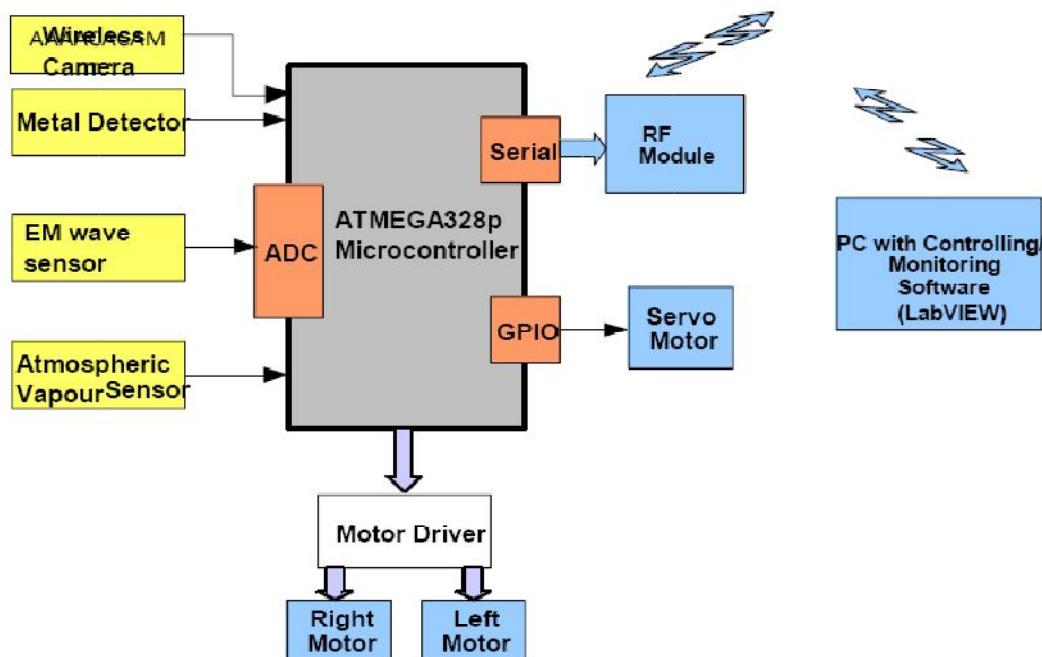


Figure 1: Block Diagram of Autonomous Wireless Warfield Explosives System.

III. PROPOSED MODEL

The proposed model of this project is an intelligent semi-autonomous robot for detection of landmines with an additional intelligent module for detecting IEDs and bare explosives (which are nitrite base). The system is also integrated with a wireless camera

for obtaining the operation side live footage, so that there would be no chances of false alarming. The location of the detected landmines will be traced with help of GPS module. The whole operation can be controlled by the operator sitting in a cabin using a laptop so that there would be no threat of death to the detection unit.

The system is majorly divided into two units:

- Detection with the robot.
- Controlling or operating unit.

For the landmines detection a metal detector module is mounted on the robotic vehicle. This will give the detection results of all the metallic objects which come in its path. To avoid the false alarming of the circuit, a wireless camera is also mounted at the top of the robotic vehicle so that the false object could be seen. The system also comprises with the Electromagnetic waves detecting sensor which works with the metal detector module to give the most precise result. The EM wave sensor also detects the IEDs which are planted on the area. An additional feature of our system is that it can also detect the bare explosive with the help of the atmospheric vapor sensor which is attached on the bottom of the vehicle. The sensor can only detect the nitride family explosives (RDX, TNT) only. The location of the detected landmine is marked and is traced with the GPS module.

The controlling and the monitoring of the robot is done with the help of LabVIEW software on a laptop. The operator can easily monitor the activities of the sensors, watch the live footage of the site and can control the direction of the robot. For the transmission/receiving of the signals RF module is used with a fair range of 150 meters.

This above figure is the block diagram of the explosives detection system. The three sensors block have been attached to the Atmega328p microcontroller. Camera module is mounted on the top. For the communication RF module is being used. For monitoring/controlling of the system LabVIEW software is used on the operating system. The signals from the sensors are transmitted from the microcontroller are processed out at the monitoring station.

Simulation Software

For testing and simulation we are using Proteus version 8.1. Software. The proposed system has been successfully simulated.

- **Proteus Simulation**

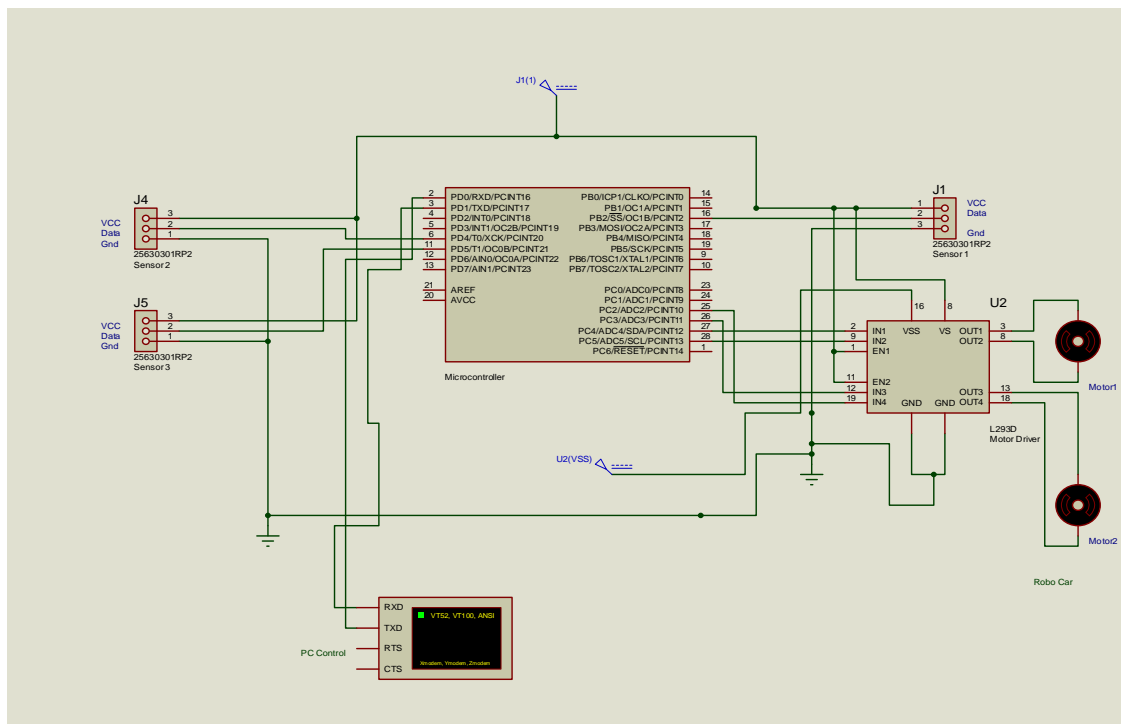


Figure 2: Circuit Diagram of Autonomous Wireless Warfield Explosives Detection System on Proteus8.1.

From this above Proteus simulated circuit we can see that the sensors work simultaneously and give the fair results. All the sensor modules are connected to the microcontroller ATmega328. The circuit has been tested in Proteus software to avoid any miscellaneous error and it works fine.

IV. RESULTS & DISCUSSION

The project which is presented in this paper is expected to detect landmines, IEDs and bare

explosive efficiently. Different sensors are integrated with the metal detector circuit on the robotic vehicle. The system gives fair results with minimum false error. The proposed project is absolutely feasible on war field. With the help of the simulated circuit it is demonstrated that the robot would not pose any performance problem for installation of the mine detection sensor. The system is expected to give fair results.

On the other hand, however, the tests also clearly indicated areas where improvement, modification,

specification change and additional features to the robot are required to serve better for the intended purpose. The robot can be enhanced and further develop for better and accurate results. Also it can be integrated with cutting-edge technologies like GPR (Ground Penetrating Radar) to detect the non-metallic landmines.

CONCLUSION

It has been successfully proven through this proposed theory and concepts for a landmine exploring platform works perfectly. It will be able to detect landmine with 1m width at one go. The metal detector circuit with the array of sensors successfully detect the metallic landmines and the different destructive materials. The development of this robot had achieved its objective to produce a small, low-cost mines detection robot that is affordable and easy to be used by the local individuals in countries with land mines problem. However, several problems have been found that cause the robot to perform less effectively in certain environments. The greatest advantage that this robot offers is the safety for the soldiers on war field. Thus, the proposed design for landmine detection and marking module had opened up a new area for the researchers to explore.

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