IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

LANDMINE DETECTION USING ROBOTS: A REVIEW

[1]Miss. Tisha Lukose, [2]Mr. Vijaykumar Patil
[1]M. Tech. Student, [2]Assistant Professor
Department of Electronics,
KIT college of Engineering, Kolhapur, India

***Abstract*:** Several techniques are available for the detection of a landmine in a diversity of environments. Various present landmine detection technologies are Remote sensing technology, ground penetrating radar (GPR), nuclear quadrupole resonance (NQR), Electromagnetic induction (EMI), Ultrasound, Explosive vapor detection (EVD) and Infrared detectors (IR). A self-governing robotic system in a minefield is a popular method as it decreases the hazards in manual detection. For the detection of landmines using robots the components consist of a control unit that contains a controller or processor and various sensors. Such robots can be used at Warfield for the detection of landmines and also for surveillance purposes at the border areas. This paper gives you a review of landmine detection using an unmanned robotic vehicle. The purpose is to give a summary of the landmine detection techniques by using robots that are capable of exploring and detecting semi-buried as well as buried landmines and mark their location.

***Keywords* - Landmine Detection, Robot, unmanned vehicle**

I. INTRODUCTION

Landmines are victim activated explosive traps, whose intended target can be a person or a vehicle. A mine comprises a specific quantity of explosive, normally placed within some form of casing (typically in metal, plastic or wood), and a fusing mechanism to detonate the main explosive charge. Some are buried under the ground, while others are placed on post or poles or are fixed to objects above the ground. They can be activated by a verity of mechanisms including pressure, trip wire, electrical command or magnetic influence. Some modern mines can even get initiated using other form of electronic sensors. Landmines have significant hazards like manufacture and removal requires considerable amount of time, material, tools, transportation and man power. Landmines if not vacated, can cause loss to friendly forces and noncombatants as well as limit friendly movement. Use of robots for landmine detection provides a reduction in cost of mine detection and low risk of life as these can be operated wirelessly from a distance.

Classification of Landmines -

Landmines are generally classified into two categories - Anti-Vehicle and Anti-Personnel.

The anti-vehicle or anti-tank mines are pressure activated but are typically designed such that the footstep of a person does not detonate them. Most anti-tank mines require a pressure of 348.33 pounds i.e. 158 kg to 745.16 pounds i.e. 338 kg in order to detonate. Most tanks and other military vehicles can apply that kind of heaviness.

Anti-personnel landmines are intended particularly to reroute or drive back foot soldiers from a geographic area. These anti-personnel mines can even kill their victims and generally get activated by pressure or by tripwire i.e. a wire stretched close to the ground or by remote detonation.

II. LITERATURE SURVEY

Majd Ghareeb, et.al. proposed a system for landmine detection using Robotics, communication and data analysis. The system mainly consists of raspberry pi, camera board, metal detector circuit and GPS shield. A raspberry pi based moving unit for detection, data collection and transferring to the central unit that will be later investigating the received data. Metal detector circuit is used for metal detection. GPS shield is used to detect the exact location of the detected object. The type of detector and camera resolution capacity has to be considered to improve the performance of the system. [1]

S. Sasikumar, et.al, proposed a multi utility based landmine detecting robotic vehicle which uses metal detector as a complementary tool for landmine detection. The system consists of GPS, metal detector, microcontroller ATmega328. GPS system detects the position of the landmine and sends its position to a web server with the help of IOT. A metal detector with driver circuit is

implemented using ATmega328P microcontroller to regulate the complete operation. The main advantage in this project is that it accurately measures the latitude and longitude positioning using the GPS module hence it is easy to point out the position of the landmine. Also this prototype provides less complex structure and reduces the cost to build a landmine detection robot. [2]

V. Abilash and J. Paul Chandra Kumar implemented a Landmine Detection Robot controlled by ardunio. The system consists of Arduino UNO microcontroller, ultrasonic sensor, buzzer, metal detector and GPS. Metal detector for detection of mine, buzzer for warning alert, the robot is controlled with help of computers using the zigbee module, ultrasonic sensor fixed to it in order to locate and avoid the obstacle, robot actuation is done with high powered DC motor supported by H bridge circuit that allows robot to move in any direction, GPS sensor for latitude and the longitude detection. The advantage of wheeled robot proposed is less expensive, robust and it is a helpful tool in military for surveying and monitoring purpose. [3]

J. Bharath presented a robot design, capable of detecting buried land mines and changing their locations, while the robot can be controlled wirelessly from a distance. This technology uses the metal detector circuit present in robot to search the land mines. The metal detector circuit that is interfaced with robot, is left on the search area to detect metallic components used in landmine production. It detects the uneven landmines present under the ground and generates an alarm to the user and can consequently change the place of landmine by taking it safely from one place to another, without risk of detonation. [4]

Yuvaraj Ganesh, et.al, implemented a surveillance drone for landmine detection. The system consists of a quadcopter, metal detector circuit, IR camera, RF Transmitter and Receiver, Ardunio Uno, GPS module and GSM module. GPS module provides location of the detected mine in terms of latitude and longitude. GSM module is used to send the location via text message to the user. Wireless communication is achieved using RF Transmitter and Receiver. Ardunio Uno used for processing the algorithm and interfacing the GPS, GSM, metal detector and IR Camera. Disadvantage comprises in terms of operating range of drone and the implementation cost. [5] Kishan Malaviya, et.al proposed a Autonomous landmine detecting and mapping robot. The system consists of a metal detector circuit, servo motor, gas sensor, GPS, GSM module. As per the output 2 cm metal beneath the soil can be detected with an accuracy of 90%, 5 cm beneath the soil has accuracy of 60% and 10 cm beneath the soil has accuracy of about 50%. [6]

Mohammad A. Jaradat, et.al, implemented a robot structure, equipped with strong capabilities that allow it to navigate in the minefields freely without any constrain on its steering. The wheeled locomotion type in the robot has the advantage over other types in its stability, simplicity, and less control effort, while the Bogie suspension has good response over the other types of suspension. Also the force angle measure of tip-over stability margin is programmed inside the robot controller to alert it before any tip-over. [7]

William Benn and Stanislao Lauria proposed a model for robot navigation control based on monocular images using image processing algorithm. Using colour segmentation against a selected floor plane to distinctly separate obstacles from traversable space was implemented this is then supplemented with canny edge detection to separate similarly coloured boundaries to the floor plane. In the resultant binary map, white identifies an obstacle-free area and black identifies an obstacle. This was then processed by fuzzy logic to control the robot's next movements. As per the output, this image processing algorithm performed strongly on solid coloured carpets, wooden, and concrete floors but had difficulty in separating colours in multicoloured floor types such as patterned or decorative carpets. [8]

Kuo-Lan Su, et.al, implemented a multi robot-based landmine-detection system that contains a landmine detection mobile robot and a following mobile robot, the landmine detection mobile robot goes ahead which uses a landmine detector to find landmines and the GPS module to track the location. It records the coordinates and transmits it to the following mobile robot via a wireless RF interface. The following robot records the position and orientation of the landmine detection robot and the coordinates of the landmines in the region. The following robot moves close to the landmine, and programs a route to automatically avoid obstacles. [9]

Pedro F. Santana, et.al, proposed a roadmap for the application of robotics for humanitarian demining. A portable demining kit to handle urgent situations in remote locations is used, which consists of a low cost four-wheel steering robot with a biological locomotion control. Advantage of this work was having a low-cost robot with locally available components like bicycle wheels, using low mechanical and energetic stress with the use of virtual components and simple sensory and computational equipment. [10]

III. DATA PROCESSING TECHNIQUES

Main objective of this step is to make information additionally viable to extract feature for proper detection of presence of landmine. Usually when buried object is scanned by array of sensors throughout the length of a space it's found that hyperbolic signature is immerged in concert moves step by step on the length. Unprocessed information is incredibly hard to process, as sensible restriction of detector results in low resolution and extremely degraded data. Reliance on nature of soil makes it even of inferior quality. To beat these serious issues a number of the image process techniques like noise filtering, mathematical morphological, distinction stretching, and error removal techniques can be used. [11]

The Raw GPR images used while bridge deck condition assessment comprise some noise and can have low quality due to environmental conditions and low light performance. The histogram equalization technique can be used for improving the visibility and quality of image. Also this image processing techniques can be used to prepare a high volume of GPR images from the reinforced concrete bridge deck to make them ready for easy and rapid interpretation. [12]

W. Al- Nuaimy, et.al, proposed a method by combining neural networks and pattern recognition techniques to automatically construct a high resolution image of the shallow submersed object in a very extremely small computation time, appropriate for on-the-site GPR mapping of utilities and other objects like landmines. The neural network makes use of the spectral features of the information to spot areas within the radar gram containing helpful reflections. While the Hough Transform is applied as a pattern recognition technique to find and determine the hyperbolic anomalies related to buried targets, generating high resolution pictures appropriate for exact location and mapping of submersed utilities and weapons. Results reported from variety of sites indicated a degree of robustness and encourage further analysis into this method as an automatic target detector and mapper. [13]

Kaur Gurpreet, proposed a method for detecting buried landmines at various conditions using GPR. The image processing process consisted of background removal, estimation of the number of objects, noise reduction of the GPR data and visual identification. This approach has one limitation i.e. the choice of values i.e. sigma values for use by Gaussian filtering method and smoothing image filtering value, these values may depend on the experimental setup and may vary with actual scenarios. [15]

One of the methods called Support vector machine, where aberrations in hyper spectral images are known by improving detection of the spectral signatures of unknown targets. Support vector data description is a technique that can be utilized in different domains like machine parts defect detection, Content-Based Image Retrieval and Feature Extraction. [16]

One of the developing techniques Fusion is used where data from multiple detection systems become significant. Output data from completely dissimilar systems are sorted and compared, obtaining full potential from each applied technique and avoiding the fault. With data fusion, a multi-system consists of three main levels i.e. unprocessed data level, vector level and conclusion level. In the unprocessed data level, the information from every sensor devices is combined. In the second level, every sensor device analyses the unprocessed data and produces a feature vector in which its coordinates are combined to get a combined vector. At last, in the third level, every sensor device analyses the information to produce a feature vector, which makes a choice of what feature vector is being represented. Neural networks are used as another option for automatic target detection. [14]

The study of the literature concludes that these pre-processing steps enhance accurate detection rates also reduce false detection.

IV. CONCLUSION

Landmines are unsafe because of their unidentified positions and often difficulty in detection. The landmine detection technique using robots can provide a reduced risk of life and also a low cost of detection. Also use of image processing techniques can be implemented for pre-processing and extraction of relevant data. Combining different kinds of sensors can obtain better results in landmine detection.

REFERENCES

[1] Majd Ghareeb et al., “Wireless Robo-Pi for LandMine Detection", IEEE, 2017.

[2] S.Sasikumar, et.al, “Multi Utility Landmine Detecting Robotic Vehicle”, IRJET, Vol. 5, Iss. 3, Mar 2018.

[3] V. Abilash and J. Paul Chandra Kumar, “Ardunio Controlled Landmine Detection Robot”, International Journal of Engineering Science and Computing (IJESC), May 2017.

[4] J. Bharath, “Automatic Landmine Detection and Sweeper Robot using Microcontroller”, International Journal of Mechanical Engineering and Robotics Research, Vol.4, No.1, Jan 2015.

[5] Yuvaraj Ganesh, et.al, “Surveillance Drone for Landmine Detection”, International Conference on Advanced Computing and Communications, 2015.

[6] Kishan Malaviya, et.al, “Autonomous Landmine Detecting and Mapping Robot”, IJIRCCE, Vol. 3, Issue 2, 2015.

[7] Mohammad A. Jaradat, et.al, “Autonomous Navigation Robot for Landmine Detection Applications”, 8th International Symposium on Mechatronics and its Applications (ISMA), April 2012.

[8] William Benn and Stanislao Lauria, “Robot Navigation Control Based on Monocular Images: An Image Processing Algorithm for Obstacle Avoidance Decisions”, Hindawi Publishing Corporation Mathematical Problems in Engineering, Article ID 240476, 2012.

[9] Kuo-Lan Su, et.al, “Motion Planning for a Landmine-Detection Robot”, Artificial Life and Robotics, Vol. 16, No. 3, pp. 277-280, 2011.

[10] Pedro F. Santana, et.al, "Sustainable Robots for Humanitarian Demining", International Journal of Advanced Robotic Systems: 207-218, 2007.

[11] L. Robledo, et.al. , “A Survey of Landmine Detection Technology”, International Journal of Remote Sensing, Vol. 30, No. 9, May 2009.

[12] Shakibabarough, et.al, “Investigating Different Image Processing Techniques for Better Interpretation of GPR Images”, Conference on Security and Cooperation in Europe, 2018.

[13] W. Al- Nuaimy, et.al, “Automatic detection of buried utilities and solid objects with GPR using neural networks and pattern recognition”, Journal of Applied Geophysics, 1999.

[14] Rennie. C and Inngs. M,“Sensor fusion in the detection of land mines”, IEEE Proceedings of the South African Symposium on Communications and Signal Processing, pp. 23–26.

[15] Kaur Gurpreet, “Multi algorithm based Landmine Detection using Ground Penetration Radar”, IEEE, 2016.

[16] Banerjee, A., BURLINA, P. and DIEHL, C., “A support vector method for anomaly detection in hyper spectral imagery”, IEEE Transactions on Geoscience and Remote Sensing, 44, pp. 2282–2291, 2006.