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SURVEY ON ROBOTIC LANDMINE AND GAS DETECTION

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ABSTRACT Several countries suffer from the existence of millions of buried landmines. These landmines are highly dangerous and may still cause horrific personal injuries. The presence of toxic gases in the war field is often more menacing. So there is a need to develop an efficient technique to detect and clear the landmines and to detect the presence of toxic gases in the war field .This paper presents the overview of some of the existing techniques with its merits and demerits highlighted and compared. The purpose of this comparison is to show the ideal conditions and challenges for each technique.

KEYWORDS : Landmine, Toxic gas, Metal detector.

I. INTRODUCTION

A land mine is an explosive device concealed under the ground and designed to destroy enemies as they pass over or near it. It bursts when a certain amount of pressure is exerted on it. It is mainly used in war fields to attack the hostile nation. So, many people has lost their lives. The remaining left unexploded may even cause serious issues. Hence it is necessary to find and remove those landmines before anyone steps on it.Landmines are cheap ,easy to make and are generally laid in groups, the area is called as mine fields. This field needs to be cleared soon after the war ends. A robot is built to protect the life of humans. Since the landmines are mostly made of metal components, metal detectors are used to detect them. Various techniques have been used to build the robot. Use of GPS and camera gives us exact location of the landmine .Bluetooth technology adds more advantage to operate the robot from a distance. Toxic gases are also used by military people to make their opponent ill and stressful. Some of the toxic gases are chlorine, phosgene , carbon monoxide nitrogen dioxideand .They are very harmful to people and causes eye irritation, vomiting, skin disease and breathing problems. The military people suffer a lot with no way to escape from the gases. So it is mandatory to detect its presence before entering the war field. Gas sensors can be used for this purpose and an alarm can be set to notify its presence.

II. LITERATURE SURVEY

A. AUTONOMOUS LANDMINE DETECTING AND MAPPING ROBOT

An autonomous simple robot is built to find about 50%-60% of the hidden landmines. A microcontroller is used to interface GPS, GSM, Bluetooth and the sensors. Metal sensors are attached to the servo motor which can rotate 0 to 180 degree. With these metal sensor even the landmines buried underneath can be found. When the metal detector comes in cotact with a metal, a flux is generated and the output current changes.MQ4 gas sensor is used to find target combustible gas. When the gas concentration is high, the conductivity is high. The GPS module receives the data from the satellites in the form of NMEA(National Marine Electronics Association) standards. This gives the complete information of the velocity, time and position of the landmine. Experiments has shown high accuracy in detection rate. When the mine is 2cm under the soil , the accuracy is 90%.As the distance increases, the accuracy decreases. Future work may include attaching a camera to take pictures of the mine.

B. CONTROLLED METAL DETECTOR MOUNTED ON MINE DETECTION ROBOT

Humanitarian landmine detection method is highly dangerous and very slow, so it is replaced by bots, which makes accurate predictions. The detection of mines are highly dependent on the distance between the sensor heads and the buried landmines. Sensor heads follows the ground surface maintaining a uniform gap with the ground surface. Controlled Metal Detector (CMD) has a 3-DOF for attribute positioning sensor head. It generates 3-D high-speed mapping of the ground and trajectories of the sensor head with 3-D stereovision camera. The camera can also capture colour information, which can be used to detect the vegetation. The trajectory-tracking controller helps avoid the obstacles while moving in the ground. The frequency of the output changes when the metal detector, mounted on the CMD passes over the metallic object. The output value of the metal detector is negative if the mine is present at the right side and value is positive when mine is present at left side. The trajectory algorithm is used to traverse the robot even at uneven surface by altering the gap and attitude of the sensor head.

C. MOTION PLANNING FOR LANDMINE DETECTION ROBOT

This system contains landmine detection mobile robot and the following mobile robot. The landmine detection robot uses landmine detector to detect the mines, GPS module to record the coordinates of its location and transmits these coordinates to following mobile robot via a wireless RF interface. The following robot records the coordinates of landmine detection robot and programs the path of trajectory to avoid landmines. The following robot moves forward close to the location of the landmine which has been recorded in its memory and programs a trajectory to avoid obstacles automatically. The landmine detection robot uses microprocessor dsPIC 30F4011 as the core and controls two DC servomotors to program the motion path. Both the Robots use Borland C++ languages a user interface to receive the location data. In future the curved path can be developed for the landmine detection robot and the following robot to avoid landmines and program a uniform user interface for the landmine detection system.

D. *A BACK-PROPOGATION NEURAL NETWORK LANDMINE DETECTOR USING THE DELTA TECHNIQUE AND S-STATISTIC*

Back propogation neural network (BPNN) network is combined with statistical technique to compare the performance of mine detection against the performance of energy detector and the delta technique. The network architecture has two input neurons,six hidden neurons and two output neurons . The input neuron provide the neighbourhood information to the network by using s-statistic and delta technique.The six hidden neurons are responsible for processing the data and the output neurons provides the result of the network analysis.The delta technique is used for preprocessing the minefield data which reduces the false alarm rate by making use of neighbourhood information. The BPNN based detector offers a robust technique for landmine detection.

E. *MULTI SENSOR DEMINING ROBOT*

A robot equipped with multiple sensors consists of pedipulators which help the robot to adjust the working position of the sensors while searching for mines. The robot mine detection block consists of a metal detector , an active infrared detection system and a chemical sensor. The metal detector is based on the effect produced by metallic objects in variable electromagnetic fields. The metal detector ATMID is used with the robot. The IR based sensing system is used to scan the suspicious area with the microwave emitting valve and a temperature measuring device. The chemical explosive sensors allow the detection of the mine explosive materials which slowly release vapours leaking from the mine. The high vapour pressure explosives are easy to detect from their vapour emissions using detectors. The data from the sensors are fused together to improve the reliability and accuracy of demining operations. The robot is controlled by means of an on board processor and by an operator remote station in an interactive mode. The robot could further be improved for performing high level tasks which may include extraction, isolation and marking of mines.

F. *EMBEDDED SYSTEM FOR VEHICLE CABIN TOXIC GAS DETECTION AND ALERTING*

An embedded system is used to detect the leakage or presence of toxic gases inside a vehicle cabin with the help of gas sensors. This can be used to prevent the driver from getting ill due to the effects certain gases. CO is a toxic gas which is harmful to humans when it exceeds 30 ppm. Similarly, oxygen levels lesser than 19 ppm also causes adverse effects to human beings. An embedded system has a CO sensors(MQ7) and an Oxygen sensor(AGS) that detects when the concentration of the gases are either too high or too low. The embedded system then sends alert messages to the user via GSM and provides ventilation automatically when it is necessary.

G.*ELECTROMAGNETIC INDUCTION SPECTROSCOPY FOR CLEARING LANDMINES*

Broadband electromagnetic induction spectroscopy (EMIS) based system can both detect and identify buried objects as landmines. An object which is made partly or entirely of metals has a different combination of electrical conductivity and magnetic permeability. EMIS-based mine detector has in its memory the spectral signatures of all known landmines .A GEM-3 monostatic, broadband, electromagnetic sensor designed for investigation. When the object is exposed to a low-frequency electromagnetic field, it produces a secondary magnetic field. By measuring the broadband spectrum of the secondary field, we obtain a distinct spectral signature that may uniquely identify the object. According to the Electromagnetic theory, an object must exhibit different responses at different frequencies. By measuring an object's EMI response in a broad frequency band the object's geometry and material composition can be detected. Thus the number of false alarms can be reduced which in turn significantly reduces the costs associated with landmine removal.

H. *COORDINATED MULTI ROBOTIC SYSTEM FOR DEMINING ACTIVITIES*

The coordinated multi robotic system works with closer shared supervision with a monitoring station. Here instead of single robot, multiple robots have been used to increase efficiency. The structures of individual robots in the system constitute multi levels of control enhanced by different sensors to support collaborative work. The designed robot is 10 inches long and weighs 16kg but only 6kg of weight is exerted on the ground during its operation. The design of the robot enables it to climb inclined surfaces of 30 degree slopes. The top part of the robot is in the form of hemisphere to prevent the sensors from damage. It takes the coordinates of the area to be mined as input and scans it in a zigzag manner.The information collected by robot in the mined area is reported to the central station and it is analyzed using fuzzy algorithm.Each robot can be assigned with individual tasks. The robots can also communicate with each other, which helps it to scan the mined area in the faster manner. The battery used in the robot drains within one hour, so it should be recharged frequently. Another major issue involved in this system is that the robot cannot recover itself from the deadlock.

I. 2D SURFACE MAPPING FOR MINE DETECTION USING WIRELESS NETWORK

This system has designed a mapping robot system (MinerBot) using microcontroller and sensors which is capable of mapping any surface with depth value in real time which will then help in mine detection. MinerBot can move in any direction and collect information using ultrasonic sensor, which is connected to a microcontroller then it is passed on to the mapping function in MATLAB via socket communication. The system allows the operator to stay at a safe distance by enabling him to control the robot wirelessly. The robot travels at 0.5976 kilometer/hour. Whenever the robot detects any metal it sends a signal along with the co-ordinates to the microcontroller which is then passed to the server and it is mapped in MATLAB. The Robot gets the coordinates of the location from MATLAB. After receiving the co-ordinate, robot starts its traversal. Afterwards the field is divided into nodes and modelled as a matrix. The data of sensor along with the coordinate of the current node is sent to the host. MinerBot can successfully sense and detect metal objects beneath and find the co-ordinates of that particular space which was then sent to MATLAB where it is mapped. The Robot has been interfaced with the microcontroller using Bluetooth technology. MATLAB is used for mapping the location sent by the robot.The designed robot can send the location of mined area to the MATLAB where it is notified to the user. The designed MinerBot can be controlled only upto 10m distance and this can be extended using highly developed wireless controllers.

J. WIRELESS ROBO-PI FOR LANDMINE DETECTION

This system will communicate wirelessly with the server to transmit the detected information such as the location of the metal objects and captured images of the land where it exists. The system is mainly composed of a central unit which receives the information and a moving Robo-pi unit for detecting data collecting and transferring information to the central station. The Robo-pi is composed of a vehicle equipped with raspberry pi, metal detector, GPS shield and a camera that are all connected and managed by Robo-pi.The Raspberrry pi technology is used for interfacing the central station to the robot. The GPS shield and camera also used to send the location and images of the mined area. The designed Robot can send the location and captured images of the mined area.The main issue of this system is that it cannot detect the non-metallic mines that has become very common lately. Another major issue is that the system can detect only the mine buried upto 10cm depth.

K. *MOTION PLANNING FOR AUTONOMOUS LANDMINE DETECTION AND CLEARANCE ROBOT*

This system uses motion-planning algorithm which enables the robot for detecting landmines. The robots can systematically scan a minefield, detect landmines and clear it is presented. The algorithm works on two steps:

(1) generate the driving tracks that can be used to scan the minefield

area.

(2) connect these tracks using Dubin's path in order to generate a continues and complete trajectory which can be used for the robot's navigation**.**

The inputs to this algorithm are the coordinates of the outer boundaries of the minefield's vertices and the operating width of the robot. The output is a trajectory that consists of the coordinates of a number of headland paths connected using Dubin's curves and a set of parallel tracks covering the entire minefield area connected using Dubin's curves. The resultant trajectory enables the robot to scan the minefield area in the shortest time in a way that prevents missing any landmine by scanning the entire field area. A complete coverage algorithm is a path planning technique that generates a trajectory that allows the robot to pass over all points in the environment in a systematic way.A complete coverage algorithm enables the robot to pass over all points in the environment in a systematic way so that the landmine can be thoroughly detected and cleared in the affected area.The robot cannot be controlled from very long distance as it communicates the central station via Bluetooth technology.

III. CONCLUSION AND FUTURE WORK

The overview of several landmine techniques with its relative strength and limitations are analyzed. The nature of surface, environment and the type of landmines determine the performance of each technique. The GPS based mine detectors gives good results in finding the exact location of buried mines. MD technique can be used to detect only landmines with metal content. New techniques need to be adopted to detect plastic mines. IOT technique can be adopted to operate the mine detector from a safer distance. The robots can be made to fly to avoid the weight applied by it on the ground,which avoids the bursting of the mines . The presence of toxic gases in the war field is highly threatening and causes several disturbances to the soldiers during battle. These gases are generally cheap to prepare when compared to the nuclear and other weapons.Essential strategies has to be taken to detect and escape from the toxic gases.

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