The Use of Mobile Technology for Detecting Landmines

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ABSTRACT

Arab Republic of Egypt suffer from the absence of maps that show spread of landmines locations planted from World War II in the Egyptian western desert ―El Alamein region‖ in addition to the lack of funds and the limited use of technology. This paper presents an enhancements of the method of mine detection of previously published research paper in [1], enhancements include a new direct approach for remote sensing based on the concept of metal detectors to expansion of the ground, which are scanned in addition to the accuracy in detection of explosives and the ability to re-check them many times to identify landmines locations. The solution based on integrated technologies by using the wireless communications, cellular technologies, the packet oriented mobile data service and sensor technology to obtain a full control from a safe distance for landmine monitoring team in El Alamein region. GSM sound tracker, GPS tracker, smart cellphones plus advanced applications and RC truck equipment were brought together to do three main tasks for metal landmines, a)Tracing,-b)Detecting,-c)pinpoint coordinates.

Keywords

Cellular Technology, Integrated Technologies, Landmines Detection, Mobile Communications, Sensor Technology, Spatial Databases.

1. INTRODUCTION

One of the worst problems that face the humanity is the buried landmines and unexploded ordnance (UXO) due to the long life of these mines [2]. The landmine defines as a device designed to kill or injure anyone that comes in contact with it through direct pressure [3]. The cost of producing a mine is as little as $3, but it can cost as much as $1000 to remove it [4]. There are several methods for landmine detection, some of this methods are satellite and airborne sensors for detection of minefields and landmines, focusing on multi-temporal aerial photographs and satellite images was carried out by [5], other method focus on some of the most common _direct‘ remote sensing technologies in landmine detection, defining _direct‘ as a technology used in actual humanitarian demining processes [6]. The common current conventional tools include in principle metal detector (MD),all metallic objects are detected and identified by a metal detector [7]. It is interesting to note that the present paper would complements the aforementioned studies because it introduce a new direct approach for sensor technology based on the concept of metal detector.

2. SYSTEM DESCRIPTION

The present paper concentrates on the nature of landmines planted during WWII in Alamein. The present work shows possibility of use smart cellphones devices, mobile networks and packet oriented mobile data service in landmine detection to provide real-time tracking process. A mini RC truck that controlled from a distance to go all directions in desert environment to provide safety to the detective landmine team, the main components for the proposed solution shows in figure 1.

Fig.1 Hardware component for the proposed solution.(1) RC truck with a movable fiber arm, (2) Mini GPS + GSM audio\sound tracker + SIM card, (3)Two smart cellular based on Android OS, (4)Laptop equipped for wireless connectivity to the internet in addition to the spatial database.

Applications and rest of tracking units that attached to the truck are very sensitive and effective in completing its specific tasks. The robot is used in humanitarian demining operation to reduce risks on human operators and to speed up operations [8], An autonomous electric vehicle used for land mine detection to speed up operations [9]. An RC truck and special sensors to replace the human‘s audiovisual perception system to obtains a safe distance for human in the process of detection [10]. The present paper shows the truck platform structure in section (3), the truck is caring two devices a) a smart cellphone based on Android operating system for tracing metallic explosives, the cellphone will be used as a sensitive sensor to detect explosives through an installed application for metal detection as shown in section (4.1), b) a micro GPS device

to pick up the landmine coordinates, the GPS will be harnessed to perform two deferent major processes, one to monitor the noise caused by the cell phone detector when it passed nearby a mine via a built-in GSM sound tracker, the second to pinpoint the coordinates of those explosives with the GPS tracker devices as will show in section (4.2).

3. TRUCK PLATFORM STRUCTURE DESIGN

The truck platform is made of a light plastic and equipped with three DC motors, the first is a stepper motor for steering the front two wheels, the second motor is controlling the truck slow motion by the rear-wheel drive, the last one is the motor which moves in a full circular motion, a fiber arm is fixed and extended from it with 50 cm for radius to carry the metal detector sensor to apply a full circular scanning (angle of 360 degree, radius 50 cm) around the truck to increase the scanned area , and also to carry the GPS tracker device to pinpoint the location coordinates of landmines as shown in figure 2. There are different configuration for the arm which is used for the detections, one arm fixed to the front of the truck used for linear detection [1], a 2 DOF for an arm manipulator with two steeper motors for linear and rotational movement [9], a 3 DOF for full surface contact interfacing [10]. The truck currently gross weight less than one kilo gram distributed on the four wheels, that‘s make the truck too light to set off mines[1].

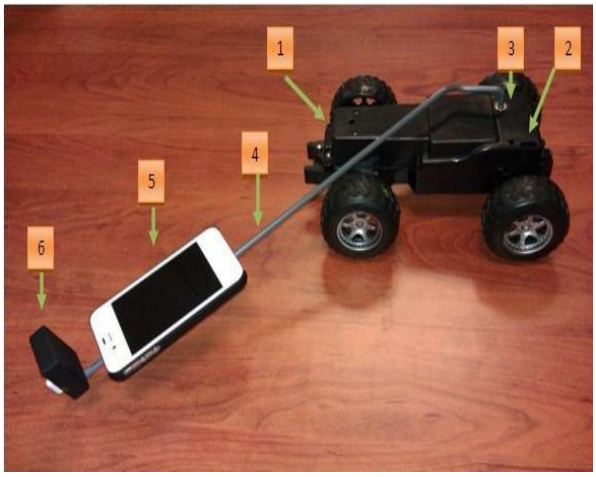

Fig.2 Truck platform structure design. (1) The stepper motor for steering the front two wheels, (2) The back motor to control the back wheels, (3) The third motor to rotate the fiber arm in a circular shape with 50cm radius to increase the scanned area,(4) The fiber arm with 50cm length, (5) The smart cellphone that act as a metal detector sensor, (6)The GSM Audio\Sound tracker and GPS sensors.

4. SOLVING PROBLEM APPROACH

4.1. Landmine tracing strategy

All metallic objects are detected and identified by a metal detector [7], a metal detector consists of an oscillator which produces alternating current, when it passes through the transmit coil built-in in the metal detector, a magnetic field is produced around it, when an electrically conductive metallic object comes in contact with the coil, it produces another magnetic field around it, the metal detector contains another coil in its loop called receiver coil, which detects the changes in the magnetic field caused due to presence of the metallic object. As mentioned in section (2) the truck is a RC truck, it is controlled by landmine monitoring team to go all directions from a safe distance, when directing truck to go away within a fenced minefields or suspicious area, how is the detective landmine team know the existence of a landmine and how to monitor or locate mines?, the present paper has relied on a smart cellphone based on Android OS and the professional metal detector application for smart cellphones, there is no need to insert a SIM card into this cellphone, it attached to the movable fiber arm for a perfect detecting process only as shown in figure 3(a), the metal detector application stimulates the magnetic sensor built-in the smart cellphone that based on Android OS to acts as a specialist scanning tool, the smart cellphone scans the surrounding area, the magnetometer measure the magnetic field, the intensity of the magnetic field in nature is about 49μT or 490mG, 1μT = 10mG, as shown in figure 3(b).

Fig.3(a) No landmine is nearby the truck, the metal detector’s unite in a normal mode.

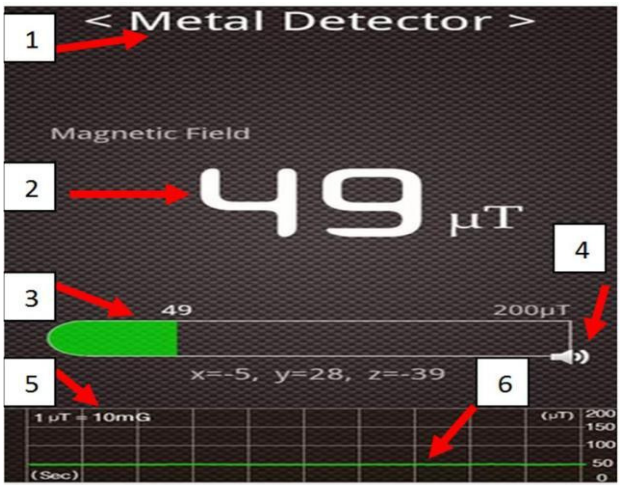

Fig.3(b) The normal phase for the metal detector.(1) Metal detector app/Android OS, (2) Magnetic field level in nature is about 49μT, (3) The green color reflects the natural state of magnetic field level, (4) The sound alarm sign, (5) 1μT = 10mG, (6) The green color of line chart means that magnetic field level in natural range [1].

If there is a buried metallic mine nearby the truck, immediately happen a high peep by the detector, announcing the presence of a landmine, the strength of magnetic field should increase as shown in figure 4(a) and figure 4(b).

Fig.4(a) The Truck is near by a landmine prototype, the metal detector detect a tiny metal nearby it.

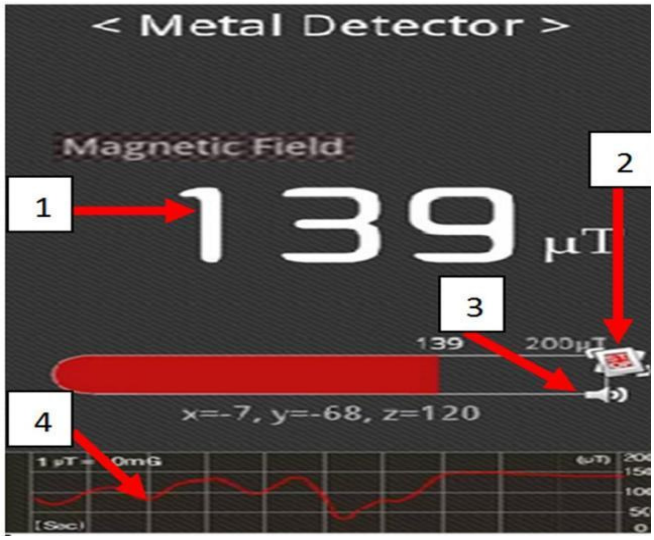

Fig.4(b) The metal detector detect a tiny metal nearby it.

(1) Magnetic field up to a high level, (2) The cellphone vibrates due to the high magnetic field value, (3) A loudly alert beep occurs according to the same reason , (4) The red color of line chart means that magnetic field level is too high [1].

Each hotspot ―buried metall be unveiled at least twice to ascertain the existence of landmine as shown in figure 5.

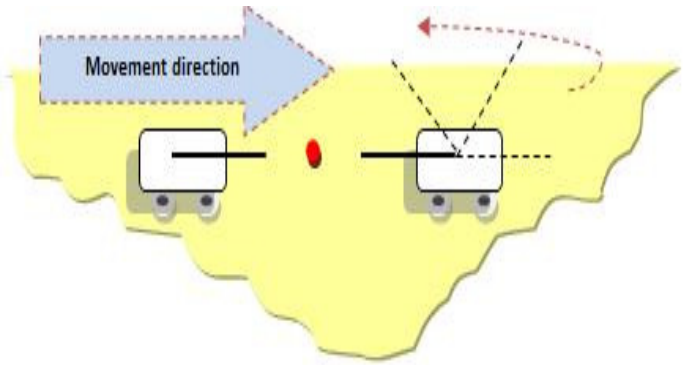

Fig.5 The arm movement anticlockwise. Each hotspot be unveiled at least twice to ascertain the existence of landmine.

4.2. The explosives detection strategy

As mentioned before in the present paper the traditional function of the landmine monitoring team is replaced by integrated technologies based on wireless communications and cellular technologies as shown in figure 6.

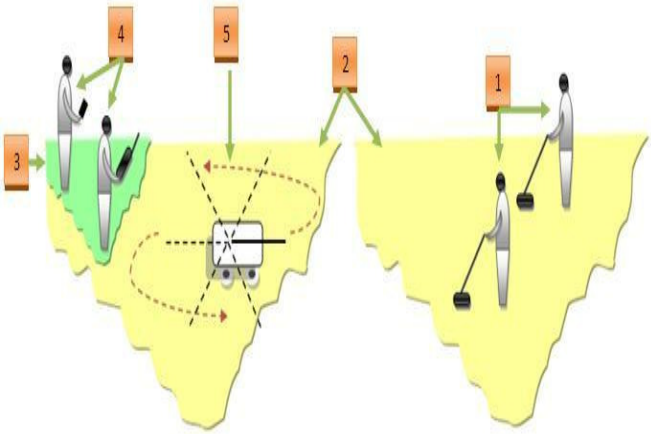

Fig.6 (1)The traditional technique of the landmine monitoring team,(2)landmine/Fenced Field or Suspicious area, (3) Safe area, (4) The landmine monitoring team is using a new technique, (5)The RC truck as a carrier for GSM sound tracker, GPS tracker, smart cellphone plus advanced metal detection application .

After detecting landmine and producing high peep by the metal detector as shown in section (4.1), comes the role of GSM sound tracker, the GSM is a unit built-in the GPS device, when GSM sense of high peep produced by metal detector GSM stimulate the GPS device to do two main functions a)pick-up the landmine coordinates, b)directly contacts the monitoring team with SMS via an inserted pre-paid SIM card using the mobile networks, the SMS contains the landmine locations.

4.3. The monitoring process and pinpoint the coordinates process strategies

Monitoring programs is important to provide real time connection between the two smart cellphones to display changes that occur on the cellphone unit that act as mine detector with the other cellphone with the monitoring team, if the shared data shows that magnetic field intensity is more than 49µT or 490mG, the monitoring team have to expect

receiving two SMS in a consecutive terms , each SMS contains the same coordinates for one landmine site as shown in section figure 7 .

4.4. Handle with the coordinates and results

After confirming the presence of metallic landmine nearby the metal detector by the real time tracking system, the landmine monitoring team receives SMS from the GPS, The SMS contains the landmine coordinates (Latitude, Longitude), that are showing the location of the explosives, the main advantage to the IM instant message is a store-and-forward service, meaning that when GPS send a text message to the landmine monitoring team, the message does not go directly to landmine monitoring team's cellphone, the advantage of this method is that team's cell phone doesn't in range, the message is stored in the SMSC Short Message Service Center (for days if necessary) until the landmine monitoring team moves into range, at which point the message is delivered. The message will remain stored on the team SIM card until they process it. If the landmine monitoring team‘s smart cellphone was connected to the internet, immediately they can handle with the received coordinates via Google earth application that includes a flight simulator so that you can view the Earth from a unique perspective or Google Map application for exploring the surface of the Earth and underground locations. The monitoring team also can store coordinates in a spatial databases by using Spatial Database System, preparing to use the stored spatial data in the next step ―Landmine clearance‖.

After the completion of the design and construction of a spatial database and its data storage that have been obtained in the phase of data collecting, comes the next stage to provide spatial database to the sovereign bodies concerned for landmine clearance stage, to Liberate Alamein from the curse of the sand "Landmines".

5. CONCLUSION

The paper presents an advanced solution and a new direct approach for remote sensing based on the concept of metal detectors to detect the metallic landmines in El Alamein region. The advanced solution solves three main problems a) The absence of maps that show landmines locations that planted in the Egyptian western desert from WWII, b)The lack of funds, c)The limited use of technology. The solution based on an integrated technologies by using the wireless communications, cellular technologies and the packet oriented mobile data service to obtain a full control from a safe distance for landmine monitoring team in fenced minefields or suspicious regions. GSM sound tracker, GPS tracker, smart cellphones plus advanced applications.

6. REFERENCES

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