Contrivance of Jamming Technology in Eliminating Landmines by Pursuit of Automation with the Aid of i-Amt Robot

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Abstract - For several centuries there has been a widespread concern for the safety of soldiers who serve the nation and civilians too. Each and every year the number of soldiers we are losing because of these venturesome land mines is exceptionally high, which still need to be taken care of. Even though there are many technological developments in mine detection by application of robots, properly established methods for demining of landmines haven't come up. In order to save the lives of soldiers by effective detection and elimination of the land mines, we are introducing jamming technology in robots. This technology makes use of coffee granules upon application of Positive pressure. This technology along with bio-mimicry of a human arm is an enhancement. We describe the mechanical design and implementation of this gripper and quantify its performance in the robot designed by us termed as i-AMT (All terrain Mine Terminator). We have made use of the infrared sensor, ultrasound sensor which increases the ability and consummate this robot's effectiveness in detection along with jamming technology helps in potential termination of the land mines and thus help in saving the soldiers life.

KEYWORDS: i-AMD, jamming, coffee granules and sensors.

I. INTRODUCTION

The robot has made our life very comfortable and lucid, so does i-AMT in the extreme conditions of war field. i-AMT has two separate distinguished units, a detecting and eliminating. The detecting unit consists of Infrared and Ultrasound sensors which enable mine detection. The eliminating unit comprises of Jamming Arm and secondary scoop arm. i-AMT is remotely controlled by soldiers at a safe distance from the mine. Detection Reliability of i-AMT for Anti personal and Antitank landmine is between 60-95%.Making of a landmine is Century old practise which makes them a viable threat, mainly deployed for disrupting enemy movements. The mines are buried in specified places called mine fields, which makes the enemy follow a laid trap or prevent them from entering prohibited area. So we have proposed i-AMT which is an all-terrain mine detecting and eliminating robot which can give a helping hand to the soldiers by eliminating the landmine from any terrain without causing detonation. Even during worst cases, it guarantees human safety.

II. TYPES OF MINES

There are two types of landmines AntiPersonnelMines (APM) and AntiTankMines (ATM). These mines are responsible for causing severe damage to the military forces and the civilians around the globe.
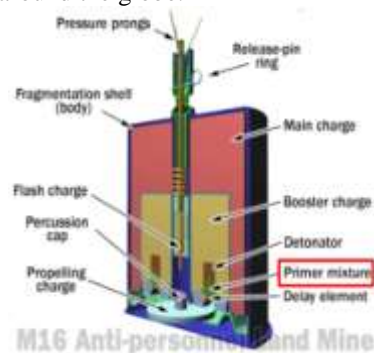

fig2.1: Cut Section of Landmine

The above figure shows the general layout of an APM. The topmost portion of the mine consist of pressure prongs and release pin ring, they are found just below the soil. The explosion material is contained inside the fragmentation shell. When a soldier or civilian steps on the pressure prongs a spark is discharged through the flash charge which cause detonation due to ignition of primer mixture. The reaction produced here is highly exothermic. The size of APM is very smaller than ATM. APM is classified into following types they are blast, bounding fragmentation and directional fragmentation. For several years, the humanitarian

demining work has been constantly obstructed by these blast type mines. The bounding fragmentation is heavier than blast type which can devastate relatively a greater area.

The anti-tank mines are generally designed to destroy the armed vehicles. Compared to anti-personnel mines the explosive charge is much large and the fuse design is such that it can only be triggered by vehicles. The detonating pressure is very high compared to anti-personnel mines. Now a days ATMs are much developed in the sense of the power of explosive, shaped charges and more advanced detonation triggers are being used.

fig 2.2 APM MINE   fig2.3 ATM MINE

Type	PRB-M35	PMN	VALMA RA-69	MON-100
Dimension1	H58mm, D64mm	H56mm, D112mm	H105mm, D130mm	H82mm, D236mm
Weight	158g	600g	3.3kg	5.0kg
Case	Plastic	Rubber	Plastic	Steel
Sensitivity	8kg	8kg	10.8kg directly, 6kg through trip wire	Depend on fuse
Lethal Range	□	□	Radius 27m	100m by 9.5m arc
Nation	Belgium	Former Soviet Union	Italy	Former Soviet Union

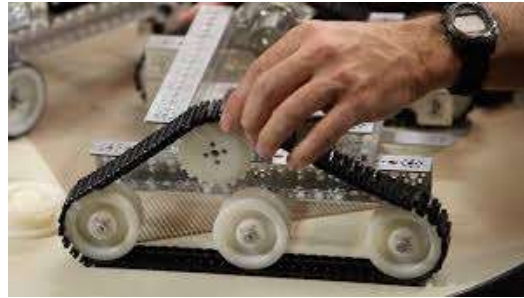| Type1	APM	ATM	UXO
Weight	Light (100g ~ 4kg)	Heavy (6kg ~ 11kg)	Various
Size (diameter)	6 ~ 15cm	13 ~ 40cm	Various
Target	Human	Vehicle	None intentional, but can be anything
Case Material	Plastic	Plastic, metal	Mostly metal
Detonatable Pressure2	500g	120kg	Unpredictable

III. CONSTRUCTION

MANOEUVERING

fig3.1: All Terrain Wheels

Ferritic Stainless steel is used for the manufacturing of chassis because of its ability to withstand large shocks. It is used because of its high density which helps in the stability of the robot. The chassis is supported by a chain linked all terrain four wheel drive to enhance the manoeuvrability. There is enough ground clearance and enclosed within water and dust resistant casing. There is live feed camera to help the controlling soldier get a clear view of the surrounding environment, it is fixed on top just behind the sensors. The camera is available with night vision (0.3 megapixels). It has a radio receiver which is used to control the wheel motors to guide the robot across the terrain. The controlling soldier has the transmitter who gives the command, with the aid of the screen displaying the vicinity of the robot.
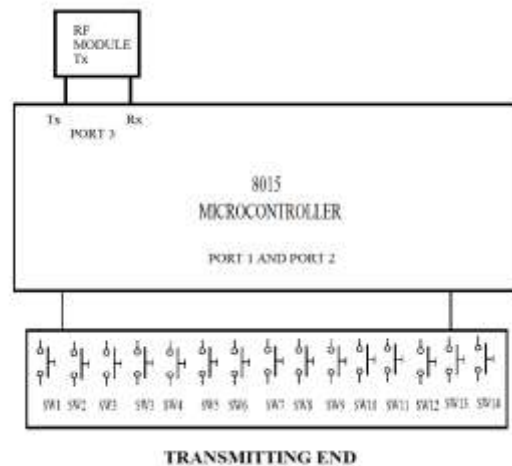
DETECTION

fig3.2: circuit for transmission

SW1   BLOWERMOTOR
SW2   VACCUM PUMP
SW3,SW4   TURN TABLE (CW & ACW)
SW5,SW6   JAMMING ARM (UP,DOWN)
SW7,SW8   JAMMING ARM (FRONT,BACK)

SW9,SW10 SECONDARY SCOOP ARM (UP,DOWN)
SW11,SW12 SECONDARY SCOOP ARM (FRONT,BACK)
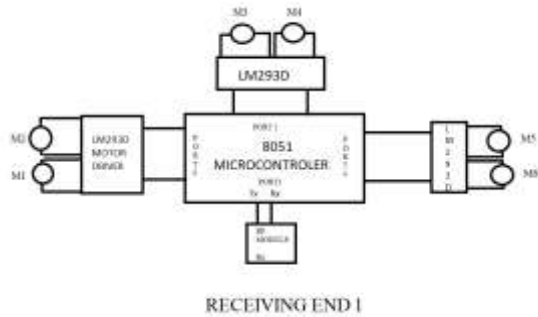SW13,SW14 SCOOP (UP,DOWN)

fig3.3: circuit for receiving end 1

M1 TURN TABLE 360 DEGREE(CW,ACW)
M2 JAMMING ARM (UP,DOWN)
M3 JAMMING ARM(FRONT ,BACK)
M4 SECONDARY SCOOP ARM (UP,DOWN)
M5 SECONDARY SCOOP ARM (FRONT,BACK)
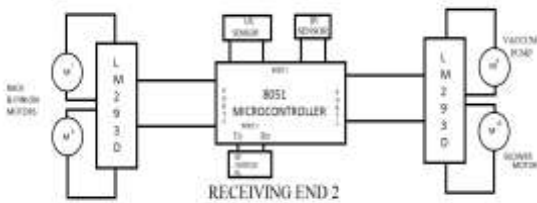M6 SCOOP (UP,DOWN)

fig3.5: circuit for receiving end 2

We have made use of Ultrasound sensors and Infra-red sensors which are placed at the front end of the robot, facing the ground. In addition, to ultrasound sensor, Infrared sensors are used to increase the efficiency of detection. This is to confirm the detection of a landmine. This is Two Way detection system.

fig3.6: ultrasound sensor

ELIMINATION

The elimination consists of a blowing unit, secondary scoop arm and jamming arm (Universal Gripper arm).

The blowing unit consists of a motor with a fan which is followed by an air guide way which is inclined in a manner such that it faces the ground. The robot is lifted with the help of rack and pinion which is used to incline the robot at required angle for the effective blowing of surrounding soil covering the landmine.

fig3.7: Our demonstration for Universal Gripping Arm

Secondary scoop arm is used in extreme cases where the blowing is not enough to remove the surrounding soil. In extreme conditions like wet environment, snow falls the scooping comes handy. Scoop arm consists of spikes beneath the scoop for loosening the soil and aiding in effective scooping. The scoping arm has the specified degree of freedoms.
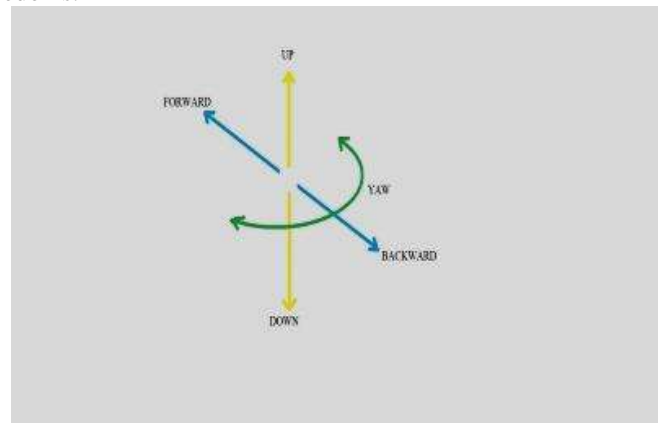

fig3.8:Three degrees of freedom

The secondary scoop arm has three degrees of freedom.
1- Up & down
2- Front & back
3- Yaw

Jamming arm (Universal gripper Arm) is the core of the robot. The jamming arm consists of an elastic membrane (eg. Balloon) which is filled with coffee granules. Coffee is used because of its good binding property under Positive pressure. Positive pressure is created with the help of vacuum motor. When Positive pressure is applied through venturi aspirator these coffee granules interlock with each other hence enable lifting of any object by taking its shape. Since it can lift any object by taking its shape it is referred to as Universal Gripper.

The degree of freedom is provided by individual servo motors. These servo motors are connected to a receiver microcontroller which is programmed to receive signals from the receiver microcontroller using an RF module.

IV. SPECIFICATION

POWER SOURCE -11.1 V, 5200mAh LITHIUM POLYMER BATTERY

MICROCONTROLLER
TYPE: AT89C51, VOLTAGE 5V,40 PIN, 4 PORT

SERVO MOTOR
VOLTAGE 6-9V
(eliminating system)SPEED 45RPM (6V)- 60RPM (9V)
TORQUE 12Kgf-cm (6V) – 30 Kgf-cm (9V)

BLOWER MOTOR
VOLTAGE 12V,SPEED 20,000RPM,
POWER 6 WATTS

DC MOTOR
VOLTAGE 12V,SPEED 200RPM,
TORQUE 50 Kgf-cm

VACCUM PUMP
VOLTAGE 12V,POWER 6 WATTS
SUCTION PRESSURE 120 KPa
SUCTION CAPACITY 5L/min

ULTRASOUND SENSOR
VOLTAGE5V,
CURRENT CONSUMPTION 15mA
FREQUENCY 40KHz

INFRARED SENSOR
VOLTAGE5V,
CURRENT CONSUMPTION 15mA
RANGE 10-80 meter

RADIO FREQUENCY MODULE
VOLTAGE5V,CURRENT CONSUMPTION 15mA

RANGE 1Km

MONITORING SYSTEM
NPC MINI WIRELESSCAMERA-0.3 MEGAPIXEL
NIGHT VISION

RADIO FREQUENCY CONTROLLER
4 CHANNEL,FREQUENCY 2.4GHz
VOLTAGE 12V

V. WORKING

MANOEUVERING

The robot is controlled by the soldier. The robot has got a live feeding wireless camera empowered with night vision which gives the soldier a clear picture of the terrains the robot is manoeuvring. The robot has been equipped with all terrain wheel which guides the robot through all harsh environments. The robot is controlled by 2.4 GHz frequency which gives a space of 1 km between the soldier and the robot.

DETECTION

The robot has been incorporated with ultrasound and infra-red sensors. The Ultrasound sensor sends constant signals of frequency 40 KHz at a rapid rate. When an Ultrasound signal strikes an object the speed of the signal varies and is recorded by the receiver. These recorded values of speed are compared with the known values by the microcontroller. When the speed matches the speed of landmine metal it sends a positive signal. Once a positive signal is obtained from the ultrasound sensor for better efficiency infra-red sensors are used to confirm if a landmine is present. Once both sensors give a positive confirmation the controller gives the command to control the jamming arm and the secondary scooping arm over a radio frequency.

Material	Speed (m/s)
Steel	5000
Lead	1300
Water	1460
Soft tissues	1500
bones	2500 - 4900

ELIMINATION

Once the mine is located the controller depending on the live feed received decides to switch on the blower motor or not. During the time of blowing the robot is lifted by means of rack and pinion mechanism. The primary function of the blower is to blow away the top soil covering the mine. If the operation of the blower is not enough to separate the landmine from the soil, in that instance secondary scooping arm comes into action which scoops away

the surrounding mud in all terrain. Once the landmine is exposed the jamming arm (Universal Gripper Arm) comes into play. By application of Positive pressure, the soldier lifts the landmine from its position and drops it in a safer place. Thus, the landmine is eliminated.

VI. DESIGN AND ANALYSIS

The figure below shows the proposed jamming arm (universal gripper arm) designed using Solidworks 2014 by Dassault systems.

fig6.1:Jamming arm

This is the proposed model of the secondary scoop arm drawn using the same SolidWorks 2014 by Dassault systems.
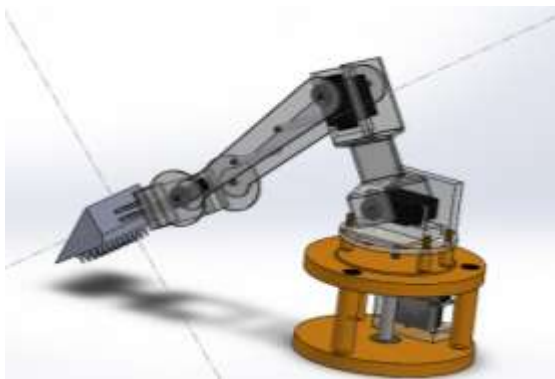

fig6.2:Secondary scoop arm

Analysis of the jamming arm (Universal Arm gripper) is done using ANSYS R15 by Ansys.Inc.
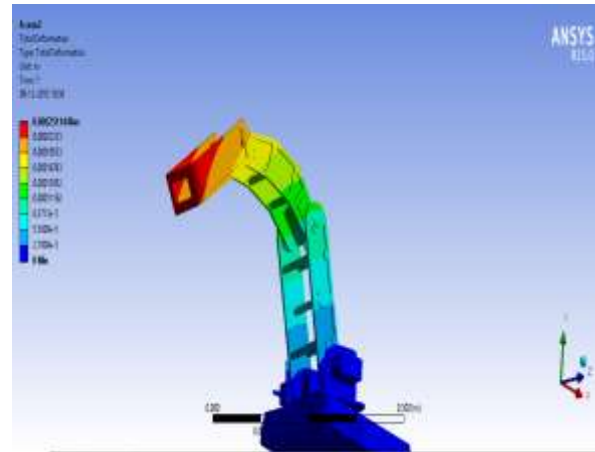

fig6.3:Jamming arm analysis

Analysis of the secondary scoop arm is done using the same ANSYS R15 by Ansys.Inc
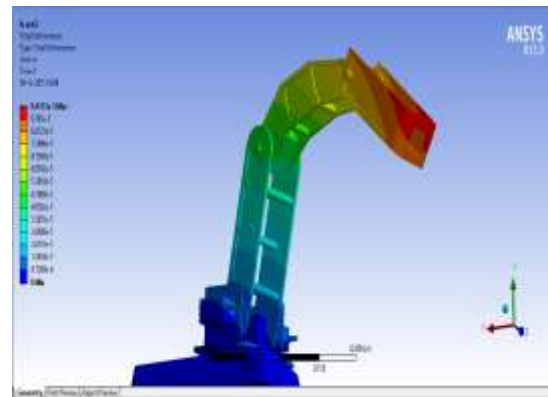

fig6.4:Secondary scoop arm analysis

The total deformation analysis of both the arms is done considering point load. We have considered point load because it is concentrated load and the load applied is at the intersection of the final part hence we get the maximum value of the deformation on the arm. Jamming arm (Universal Gripper arm) is capable of lifting around 15 kg and by applying a point load of 15 kg gives a deformation 0.25 mm maximum. Similarly, in the secondary scoop arm is capable of lifting 500 grams of soil but we have considered a max load of 750 grams and performed the total deformation analysis, the maximum deformation 9.4177 e^{-5} m.

VII. CONCLUSION

One of the major threats to the mankind in war field is landmine which still does not have a stable detection and demining methodology. We have shut off the necessity of demining, by eliminating the landmine with the help of jamming technology. Our proposal demonstrates the minute working and in-depth view of jamming technology. Its vast potential has been considered by us and we have effectively

made it serve our purpose of eliminating a landmine. Infrared and ultrasound sensors have been used to get a high and mighty detection unit. We perceive that our i-AMT holds key for safe detection and elimination of land mines thereby helping mankind and soldiers to continue their sincere service towards their country and its people. Since the pressure applied over the mine doesn't exceed 8kg, the detonation doesn't occur while lifting. Even during worst case scenarios if the mine explodes due to mishandling human safety is guaranteed since the robot takes all the damage.

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