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Landmine detection using unmanned helicar

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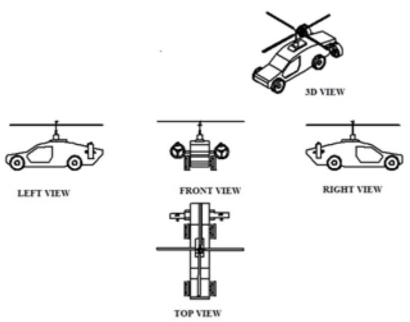
Abstract : ***In this project, A new concept of enrolling the unmanned helicar for detection of landmines by referring the methods for detection of buried landmines in the soil. This is an innovative idea for detecting deadly landmines using UAV helicar, it consist of two modes of searching operation for landmine detection. the two modes for searching landmines are Metal detector mode and IR scanning modes which helps in detecting the deadly buried mines under the soil. The model of UAV helicar is designed on the basis of UAV design configuration and calculations are done as per the required level to fly the UAV helicar with well equipped metal detector and IR camera.***

Keywords **-** . *Metal detector, IR Camera, GIS, GPS, Hovering, Meatal detector mode*

I. INTRODUCTION

UAV helicar is installed with metal detector probe and IR camera for detecting the deadly landmines buried in the ground. The metal detector mode is made ON during the ground run of helicar and the IR camera is used during hovering operation of UAV helicar, so that the marking process of deadly landmines can be done using the GIS technology at the ground terminals.



UAV Helicar model isometric views

II. LITERATURE SURVEY

2.1 UAV

The concept of unmanned aerial vehicles was first used in the American Civil War, when the North and the South tried to launch balloons with explosive devices that would fall into the other side's ammunition depot and explode. This concept was also used by the Japanese for around a month in World War II, when they tried to launch balloons with incendiary and other explosives. The idea was that high-altitude winds would carry them to the United States, where the dropping bombs would cause panic. Apparently, both these ideas were not effective.

The United States did use a prototype UAV called Operation Aphrodite in World War II. It was an attempt to use manned vehicles in an unmanned mode. However, at that time, the US did not have the technology to launch or control the aircraft.

Today's UAVs owe much to the design of the cruise missiles that were used in World War II by the US and British forces. At the close of World War II, Chance Vought Aircraft, a company with no missile experience, was contracted to develop new machines. What won Vought the contact was that the proposed test missile would have a landing gear, which would help save cost. This was the beginning of the UAV.

2.2 APPLICATION

Agricultural industry

UAVs equipped with fertilizer and pesticide dispersing equipment can be used to spray over large fields.

Crop monitoring

Right now, only over 10% of the crops in the US are being monitored by aircraft. Use of UAVs would greatly increase the region or area under surveillance.

Environmental control / weather research

Weather balloons are being used to monitor the weather on the ground.

Mineral exploration

UAVs are being used in aerial survey and ground survey to find minerals on desolate and hard-to-reach regions.

Coast watch

UAVs are being used by the coast guard for monitoring coastlines.

Telecommunications
UAVs are finding use in telecommunications applications as mobile relay platforms, as well as in disaster zones for emergency telecommunications.

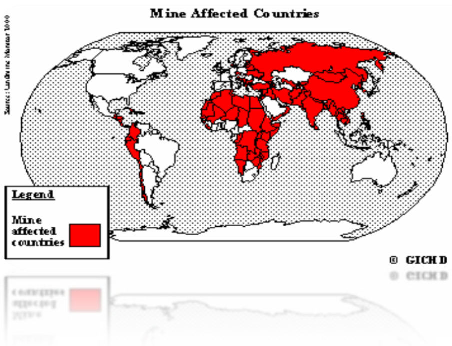
News broadcasting
UAVs are finding use in providing aerial video feeds for news events where reporters cannot get to in time.

Remote sensing of marine resources
Marine labs are using UAVs to detect the presence of resources under the sea that are inaccessible to humans.

Unexploded artillery detection
UAVs are now being developed that can detect unexploded artillery, especially dangerous mines.

2.3 landmines and its detection technologies

One of the most deadly legacies of this century is the use of landmines in warfare. Anti-personnel landmines continue to have tragic, unintended Consequences years after a battle and even the entire war have ended. These mines continue to be functional for many decades, causing further damage, injury and death. Currently there are over 100 million landmines buried around the world. There also 10 new mines being placed for every mine that is successfully cleared. Around the world, and it can be seen that the most affected areas are in the Asian and African regions. Landmines are basically explosive devices that are designed to explode when triggered by pressure or a tripwire. These devices are typically found on or just below the surface of the ground. Landmines are easy to-make, cheap and effective weapons that can be deployed easily over large areas to prevent enemy movements.



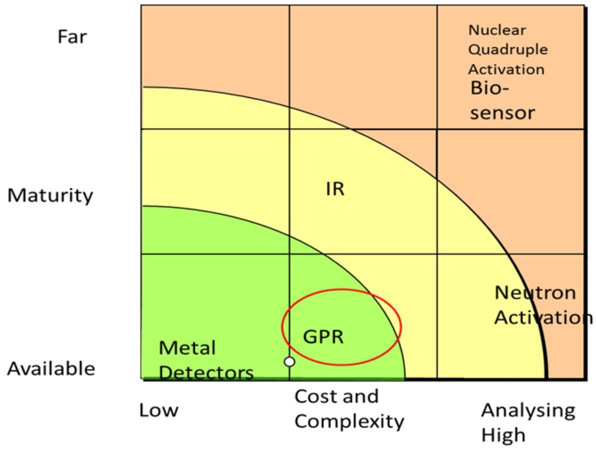
2.4 Current Technologies

Various techniques are used for the detection of landmines. There are five main areas the current technologies fall under. The five areas are:
1) Metal Detector Technologies
2) Electromagnetic Methods
3) Acoustic/Seismic Methods
4) Biological Methods
5) Mechanical Methods

III. LANDMINES DETECTION TECHNOLOGIES SELECTED FOR UAV HELICAR

3.1Reason for selecting Metal detector

TECHNIQUES	Metal Mines	Low-Metal Mines	TNT Mines	RDX Mines	Dry Soil	Wet Soil
Metal Detector	X	X	X	X	X	X
GPR	X		X	X	X	
Acoustic		X	X		X	X
Fluorescent polymers	X	X		X		X
NQR		X		X	X	X



Metal detector in market rating

3.2 INFRARED CAMERA

3.2.1 Sensing and thermal imaging

Infrared sensing and imaging is one of sensing technologies can be used for mine detection under some specific thermal conditions. The development of the IR camera which could be used for this purpose is briefly described below.
As follows from working conditions the sensing system should satisfy some principal requirements. There are:

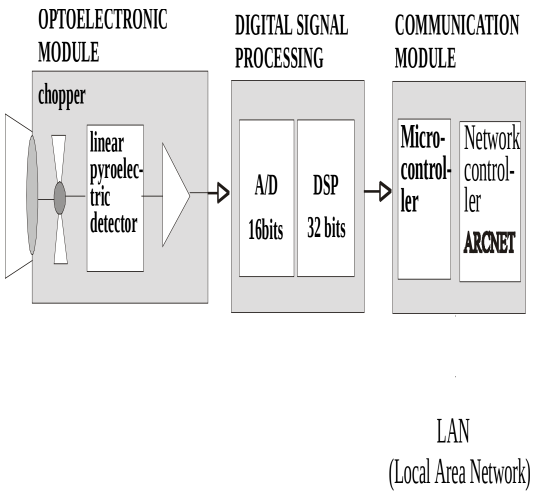
- Robustness and long term operation
- Direct digital images and adequate sensitivity
- Ability to work in fusion with other detection systems

Based on theoretical analysis and design specifications the first version of the system was built and some experimental measurements have been made.

Main functional parts of the thermal imaging system

The system consists of four basic modules, they are:

- optoelectronic module
- modules for analog and digital signal processing
- communication module



Main functional parts of the thermal imaging system

Moving by the detector inside the camera in vertical direction. The range of scanning zone is programmable, within 1 to 128 raws.

- Moving by the whole camera using external drives. This mode enables to scan the whole round scene, if desired

What concerns to the performance specification the camera satisfies following parameters

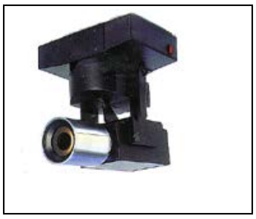
- Spectral range of sensing
  λ = 8 - 12 μm
- Image dimensions
  128 x 128
- Number of temperature levels
  16 bit (16389)
- Adjustable measuring range of temperatures
  0 -80 (or 50 – 1200) ^{o}C
- Image frequency
  2 Hz
- Sensitivity (NEDT 20 ^{o}C with averaging 32x)
  0, 04 ^{o}C
- Range of working temperature
  -10 - +50 ^{o}**C**
- Embedded signal processing (peak)
  120 Mflops
- LAN interface (ARCNET)
  5 Mb/s

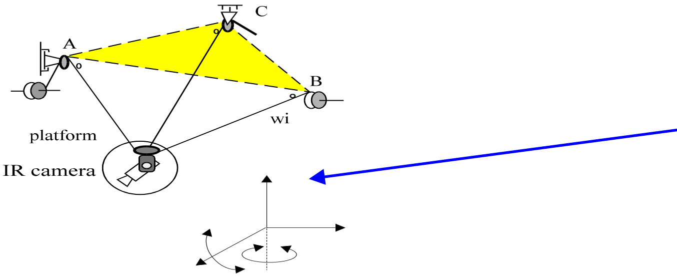
IV. FIXITATION PLATFORM DESCRIPTION AND DETECTION OPERATIONS IN UAV HELICAR

4.1 FIXATION PLATFORM

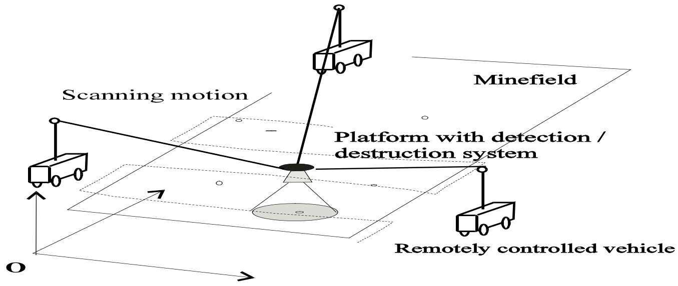
Fixation of a sensing system (we intend to use the IR camera with two additional rotations) allows mapping the subspace in a given position of the platform.

Performing scanning motions it is possible to create the map of all objects detected and recognized as mines.

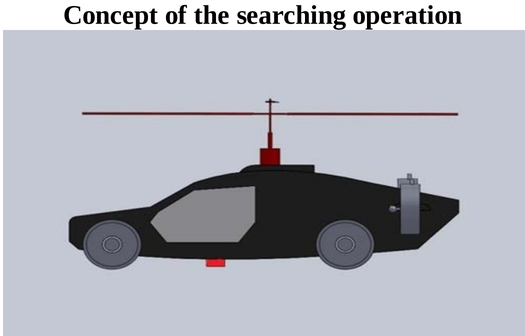




Searching system with IR camera



Concept of the searching operation



Side view of UAV Helicar installed with IR CAMERA

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4.2 MARKING OPERATION BY HELICAR

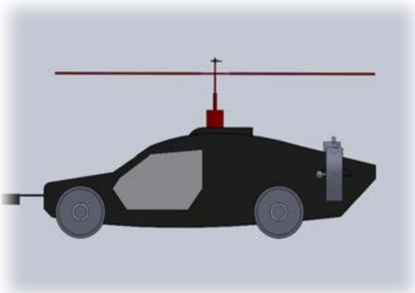
Since our model is equipped with multi sensors like metal detector &IR camera

We have considered operating the multi sensors on two different situations like

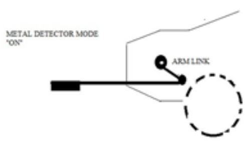
- Ground operation
- Hovering operation

4.2.1 GROUND OPERATION:

In this situation we will activate the metal detector mode for marking and detecting the landmine. When the metal detector mode is "ON", servo actuator is activated and makes the arm link to move ahead as shown in figure.



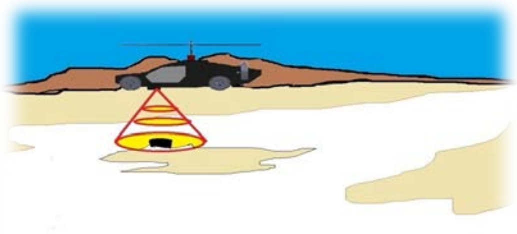
Metal detector mode on our model



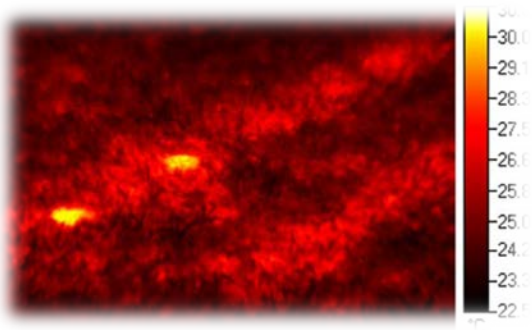
Arm link movement in forward direction

4.2.2 HOVERING OPERATION:

In this situation we will switch "ON" the IR camera mode, in this mode the IR rays are made to hit on the landmines and the image captured by the camera is converted to thermal image. The required height for detecting the landmines using hovering operation is up to 3m with 115 watts/ g power and the result is shown in figure.



Hovering operation



IR camera image result

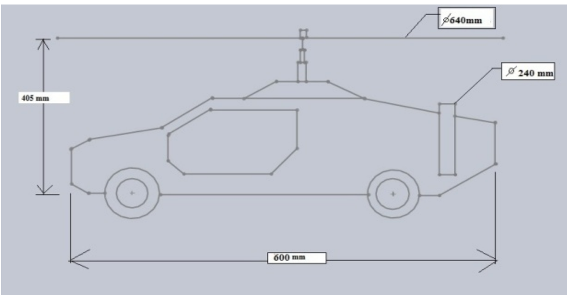
V. WEIGHT ESTIMATION OF HELICAR MODEL

PARTS	QUANTITY	WEIGHT(kg)
WHEEL	4	0.044
METAL DETECTOR	1	0.15
IR CAMERA	1	1.2
BATTERY	1	0.05
ESC	1	0.03
ARM LINK	1	0.011
AVIONICS BOX	1	1.2
TAIL ROTOR	2	0.174
MOTOR	2	0.1
Spy camera	1	0.033
TOTAL WEIGHT		**2.992**

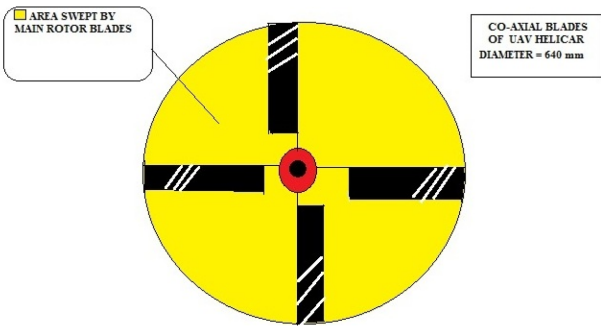
VI. HELICAR SPECIFICATION

LENGTH	600 mm
HEIGHT	405mm
WIDTH	230 mm
MAIN ROTOR DIAMETER	640 mm
TAIL ROTOR DIAMETER	240 mm

ENDURANCE	10 TO 20 min
POWER	2000 to16,000 rpm
POWER OUT	16,000 rpm
MAX OPERATING RADIOUS	200mm
MOTOR DRIVE GEAR	10T
MAIN DRIVE GEAR	170T
TAIL DRIVE GEAR	40T
AUTOROTATION TAIL DRIVE GEAR	**170T**



UAV HELICAR SPECIFICATION



MAIN ROTOR SPECIFICATION

VII .CALCULATIONS

7.1 CG CALCULATION:

Assume the reference line on the shaft of the main rotor of the Helicar model, as shown in the figure

W1:- T0TAL MOMENT ACTING ON FRONTAL SIDE OF UAV HELICAR

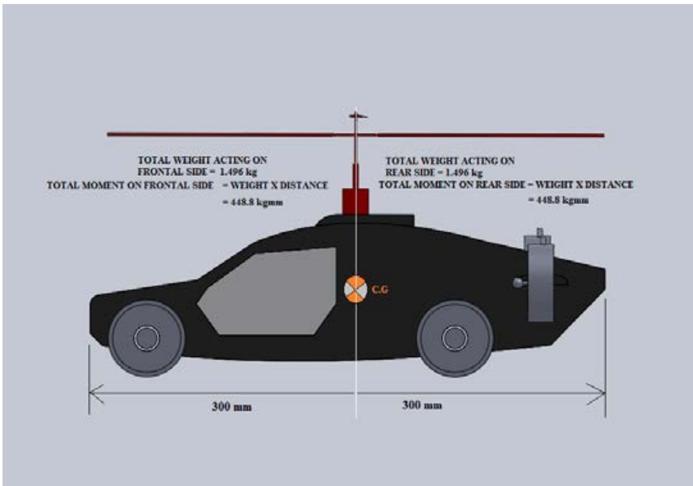
PARTS	WEIGHT (kg)
Wheel	0.02
Payload	1.383
Electronics component	0.08
Arm link	0.011
TOTAL	**1.496**

Total moment on W1= 448.8 kgmm

W2:- TOTAL MOMENT ACTING OF REAR SIDE OF UAV HELICAR

PARTS	WEIGHT(kg)
Avionics box	1.2
Tail rotor	0.174
Motor	0.1
Wheel	0.022
TOTAL	**1.496**

Total moment on **W2 = 448.8 kgmm**
C.G = (total moment÷total weight) =300mm



C.G point of UAV Helicar

7.2 THRUST CALCULATION

By Froude momentum theory

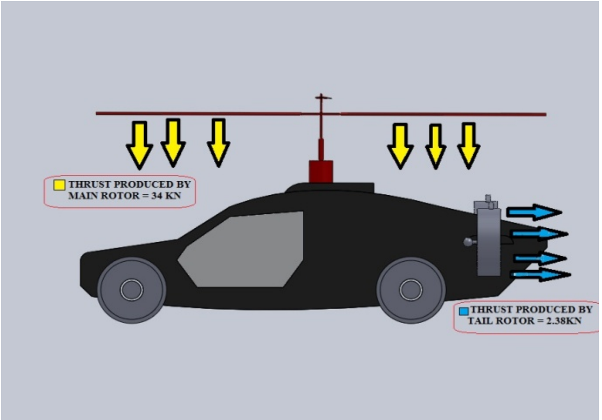
For main rotor

m• = 82.59 kg/s
T = m• × v∞
= 82.59 × 418.88
T = 34595.29 N
T = 34 KN

Similarly for tail rotor

m• = 5.72 kg/s
Vi = 104.75 m/s
v∞ = 2Vi = 209.52 m/s

T = 1194.15 × 2
= 2388.3 N
T = 2.38 KN



Thrust Description Of UAV Helicar

VII. CONCLUSION & FUTURE ENHANCEMENT

8.1 .CONCLUSION

This project helps in detection of deadly landmine in war field using UAV helicar. Further development of such kind of UAV will help in minimizing the casualty in war fields. it also helps the task forces to move forward for their anti-terrorist operation with clearance of landmines in their path ways. In future development a low cost simple system to detect landmines can be adopted and locate them in a localized map. Users can access the locations of the detected landmines by using a desktop application / web based application. The helicar used in this project is of very primitive type with Bluetooth GPS installed for sending information in terrain region. This system in future will make easier for the soldiers to get a clearance of landmine from the ground control.

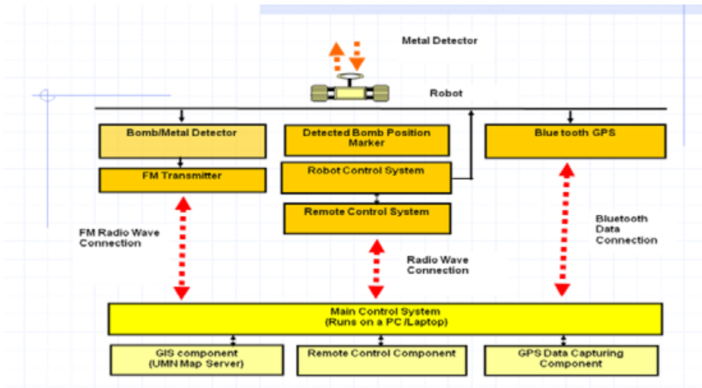
8.2. FUTURE ENHANCEMENT

Helicar is designed to detect landmines in a remotely controlled way. User can navigate the helicar and locate the landmines and update them into a GIS database. Updated locations can be viewed by a desktop application or a web based GIS system. Locations of detected landmines can also be accessed by mobile phones via GPRS and SMS.

The helicar can be controlled by the developed software, which will program the parallel port and communicate with the robot via radio signals. Developed software program uses button and mouse control to navigate the helicar.

The developed software will indicate the real-time location of the robot and the location is transmitted via Bluetooth connection to the control station from the Bluetooth enabled GPS .which is attached to the helicar? Other supportive GIS layers like roads, railway, administrative boundaries, forests, tanks and etc will also be displayed on the control screen. These supportive layers will be helpful to the user to get an idea about the surrounding area, which is contaminated with land mines.

When the robot detects a landmine it sends the signal to the control station (software developed). Then the system will add a Point Feature with predefined attributes such as Latitude, Longitude, Time, Amplitude of the Signal and etc in to the Shape File, which gives the details about the detected landmines. Position of the Robot will also be added to the predefined Shape File, which will indicate the current position of the robot. Therefore user can handle the helicar and navigate the robot by looking at the map on the screen.



The System Architecture of the ROBOT

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