SpySee

A Modern-Day Reconnaissance Robot

Registration No.: **DRUSE-TH14-751**

PART- A

1. Title: - SpySee A Modern-Day Reconnaissance Robot

2. Abstract

The propose of this project is to make a robot which will help our soldiers in reconnaissance operations. We are using advance technology in the process like Artificial intelligence, Deep Learning, Facial Recognition, Android and much more. The robot will feature an 8 MP Camera, GPS, Night Vision Filter and user will be able to control the robot remotely as well as autopilot mode. The main role of the bot will be to infiltrate the enemy base and gather as much possible information about the enemy establishment.

The robot will stream the video from camera to an android app, all the functions of robot will be controlled through the app only. The robot will be based on Raspberry pi which will handle all the communication, control and computation of the data received from the app and will apply deep learning algorithms to recognise the objects, faces, voice and its path. The physical appearance of the robot will make it hard for the enemy to see or capture the robot, it will also feature a self-destruct mode in case of capture. This will be inspired from camouflage techniques and its body will be based on reliable tank design so that it can move effectively and efficiently in any terrain.

Features like night vision and GPS will make it more productive in gathering information. Once assigned the route bot will surveillance the subject whether its day or night. The final prototype will also feature a drone which can be launched for aerial view of the enemy base. The robot will feature many different functions such as person follower, enemy base mapping, heat sensors etc.

3. Questionnaire

a) Our motivation behind participation

We always wanted to be a part of India's development and serve our mother land, I (team leader) even tried to get into Indian Army but was rejected in the SSB interview round. We have grown up in a world where USA and Russia have the most advanced defence technologies and our country spends a huge sum on purchasing these technologies from them, we want to see India to compete with these powers in every aspect, we want our country to be the next superpower in the world. We want to be part of our nation's journey to become a superpower. And through this competition we are just starting to do that by developing technologies that will be life saving for our soldier in the coming future.

We have got this opportunity to contribute to our nation's defence organisation, as engineer we are enthusiastic and passionate about this chance and will give our best. We are like minded members of this team and want to serve our country in every possible way that exists.

By participating and winning this competition we will be recognized in this field and meet people like us, this will help us further develop skills in developing defence technologies.

b) Our specialized knowledge and expertise

Our team consists of four members each having different skill set and area of expertise, three of us are students of Electronics and Communication Engineering and one is from Information Technology Engineering.

We are specialized in:

- ✓ Artificial intelligence
- ✓ Machine learning
- ✓ Embedded systems
- ✓ Computer vision (OpenCV)
- ✓ Java, Python, C, Bash, C++, HDL
- ✓ Android App Development
- ✓ PCB Designing and simulation (OrCAD)
- ✓ Mechanical Modelling (AutoCAD)

c) Previous awards and recognitions

We have recognitions and awards in inter college and at national levels:

1) AIR 13 in ROBOCON 2017
2) First in Project Exhibition Innoteck 2016
3) First runner-up in Innoprakalp-2017
4) 2nd stage in E-YANTRA(Ongoing)

d) Plan of exhibition

We are looking forward to develop a fully functional prototype with technologies like Artificial Intelligence, Computer Vision and Deep Learning. We are beginning with proposing our idea and its working in detail with supporting CAD model renderings and code insights of machine learning codes, android app and at second screening we will present our working prototype.

PART – B

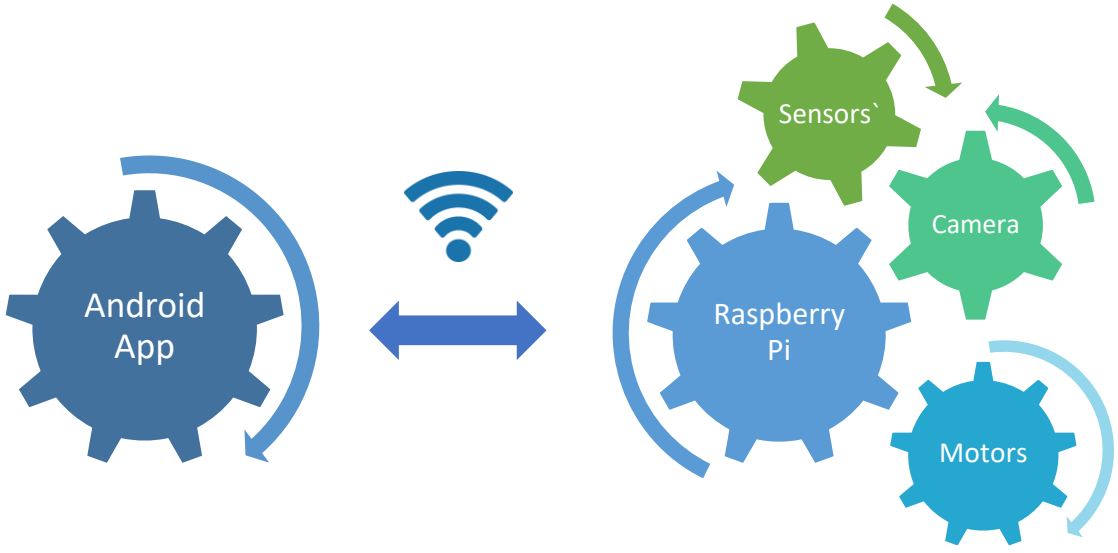
4. Technical Proposal

I. INTRODUCTION

We are proposing our idea along with its underdevelopment CAD design and Android app insights. This project is based on the principle of fusion of technologies for the betterment of our armed forces and we have integrated a whole lot of such innovative technologies into it. We have tried to present a prototype that will be ready to be used in the current scenario.

The robot will use Artificial Intelligence to implement some of the most complex and advanced features such as face and voice recognition. The prototype will rely on raspberry pi for computational power and Android app for providing control of its features. All the controls and data will be handled using the SpySee android app. The robot will feature a 360-degree 8MP camera which will be mounted on the detachable quadcopter so that it can be used for aerial view as well. The bot is so designed that it will feature a long-lasting battery for long missions.

The working of the robot is explained with the help of block diagram:



All the data communicates between android app and raspberry pi and user can control all the functions from the android app, in-fact all the code can be altered via app remotely. When user selects a location, or drives the SpySee manually the app transmits the appropriate commands to the raspberry pi where it executes them and process the data received from various sensors and the user, it then relay the video feed from camera and other sensors back to the app in real time. In this way user can control its various feature.

The project can be classified into three categories namely hardware or mechanical, electronics and software, where hardware comprises of all the mechanical part and its functioning, electronics include all the electronic parts and sensors and their working, and software part includes all the coding and algorithms of app side and raspberry pi side.

During designing all the components i.e. electronics boards, algorithms, mechanical model etc, we have tried to optimise the design for maximum power saving and less time consuming to increase the efficiency.

II. SALIENT FEATURES

The prototype will feature many distinguishable and useful features which will add capabilities to its assigned operations. These features will be built on various modern techniques and algorithms.

The features are as follows:

1. Versatile tank body mechanical design with a mounted quadcopter.
2. Light Aluminium body to reduce cost and power consumption.
3. Suspensions to enhance mobility and versality.
4. Adjustable ground clearance height to further enhance manoeuvrability.
5. Live video streaming.
6. 360-degree ground view with automatic variable camera quality according to connectivity.
7. 360-degree aerial view by launching quadcopter from robot.
8. Video recording in case of low connectivity.
9. Night Vision in case of low visibility in addition to headlights.
10. Fully controlled mode via Android app.
11. Self-destruct mode to avoid capturing by enemy.
12. Auto-pilot mode in case of low connectivity or no connection which can be set for land or self-destruct.
13. Face recognition.
14. Voice recognition.
15. Infrared Detectors.
16. Capability to automatically count number of people.
17. Path assignment and recognition using GPS and computer vision.
18. Various modes of connectivity in case of covert missions (Email, SMS etc).
19. Auto detection of available wireless connections and support tools in case of network attack on enemy base.
20. Automatic detection of different objects such as supplies, vehicles, ammunition etc.
21. Auto Mapping of enemy base.
22. Collison avoider in case of user ignored it.
23. Entire code can be rewritten and fully modified remotely via app.
24. Different colour and appearances for different terrains to decrease visibility.
25. Long Lasting battery option for rechargeability using solar cells.
26. Availability to be controlled via internet or satellite link.
27. Can be modified to carry explosives to neutralise enemy or distract enemy.
28. Future capability of carrying a small modified gun.

Some of the above-mentioned features will not be fully achieved. For example, self-destruct feature explosive destruction will not be featured.

III. HARDWARE

We have developed a CAD model of our proposed robot which will be based on a tank design. The software we have used is Autodesk Fusion 360 Actual Design renderings are given below, although the robot will be in military paint but here it is coloured to show its design:

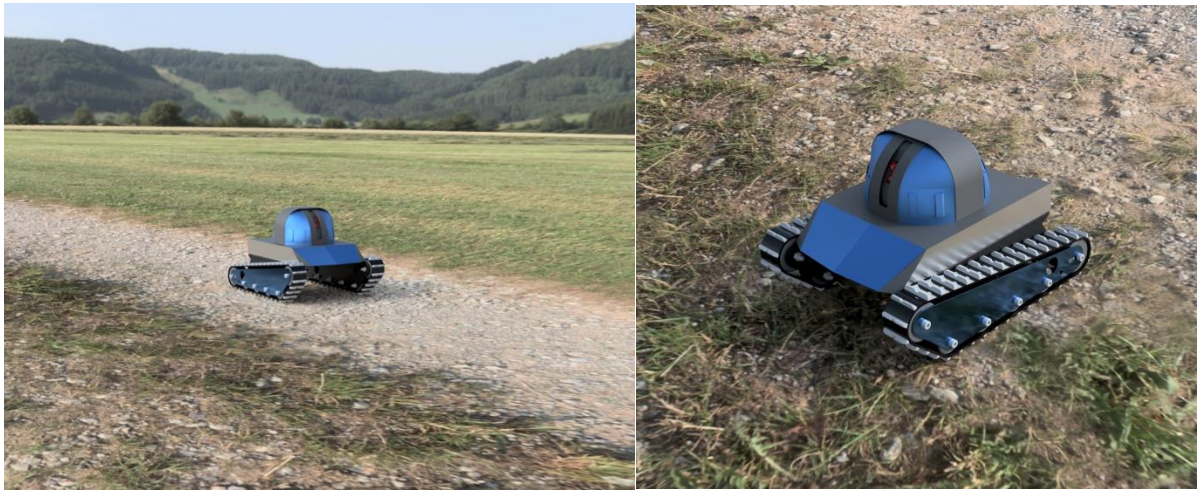


Fig: Renderings of the CAD Model

The robot will feature a Raspberry Pi and other sensors and motors, all these electronics will be mounted inside the mechanical structure. The size drawings of the robot are given below:

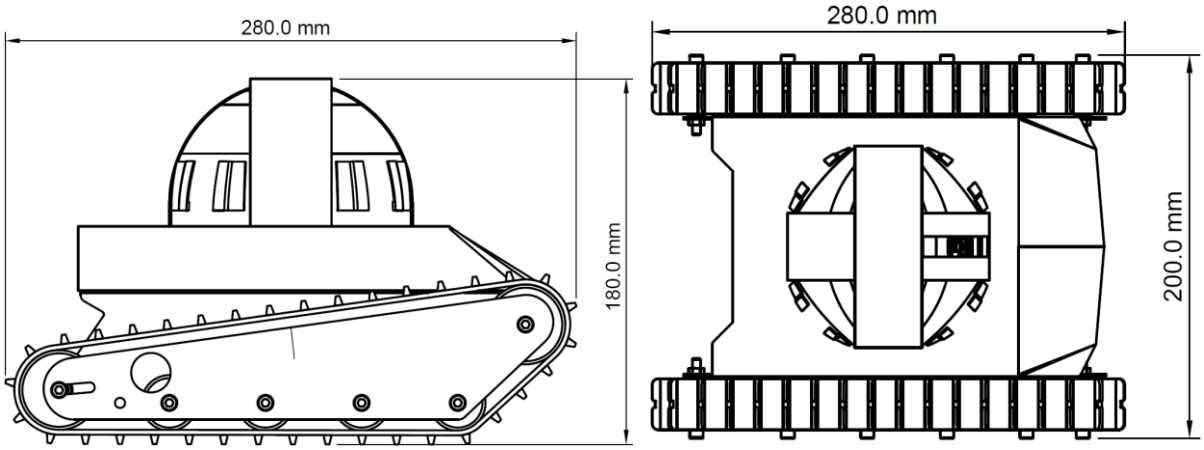


Fig: Dimmentions of the robot

The head mounted on the tank chassis will rotate 360-degree and will house an 8MP camera for video capturing. In this way the operator will always get a 360-degree view just away a command. The robot will feature a 16000 mAh li-ion rechargeable battery this will be enough power to operate the robot for a week. All the electronics will be printed circuit boards designed through Cadence OrCAD.

IV. SOFTWARE

The software part of the robot includes all the software coding and feature inclusions and the implementations of various algorithms. It has two main parts namely Android app and

Raspberry Pi side programming. All the features mentioned above will be either implemented on Raspberry pi or on SpySee android app.

i) Raspberry Pi Side:

This side of programming is the main control engine of the robot, from here all the functioning takes place. The app interacts with the pi continuously to request for feature implementations and video feed. Raspberry Pi will handle all the deep learning and computer vision script's load along with handling all the communication and manoeuvres. All the programming will be in python.

The Program at raspberry pi side will be divided into several segments all running on different threads i.e. the program will use multithreading, these will include motion engine, camera control engine, communication engine, computer vision engine, Deep Learning engine etc, all of these will we controlled by a main control engine which will manage the entire functioning of the robot.

ii) Android App Side:

The app will feature all the controls for above mentioned features, we have already developed some basic features of it such as video streaming and moving the robot remotely. An actual screenshot of the app's screen is shown below.

Fig: Screenshot of SpySee Android App

The app will auto connect to the hotspot created by the robot to communicate with the raspberry pi using UDP protocol. The connection will be secured with WPA2 PSK security protocol and will be secured with an administrative password. The will also host the feature to connect to the raspberry pi Raspbian OS for screen casting to control the raspberry pi remotely and upload scripts. This app will be supported by any device running Android 5 or above.

5. Proposal for second level of screening

If we made it to the second level we will exhibit a working prototype with enhanced mechanical model to meet the feature update demand. We will also upgrade its software firmware to add more features to it.

These features are as follows:

1. **Mechanical Design:** The robot will be built upon versatile tank body design, which will be able to move around in any terrain easily and efficiently. The model will be entirely designed and manufactured by our team using CAD software. This will be powered by two 12V DC motors, which will be enough considering the light weight of the body.

2. **Adjustable Ground Clearance:** The robot's height will be adjustable i.e. its ground clearance will be re-adjustable in case where any obstacle come around its path.

3. **Light Body:** The robot will feature aluminium body to reduce cost and power consumption, this will enhance the power backup of robot which will feature a 16000 mAh rechargeable battery.

4. **Android App:** We will present an app named SpySee for controlling the robot and accessing all the features mentioned, with proper application of security protocols. This app will be supported on android versions above Android 4.4 Kitkat, this will make the robot very easy to control by any android device running Android 5 and above.

5. **Video streaming:** The robot will provide live video feed to its connected app continuously, from the 8 MP camera mounted on the robot.

6. **360-degree View:** The camera mounted on the robot will be fully controlled via app to provide a 360-degree ground view with automatic variable camera quality according to connectivity and various options to control the camera and robot motion using on-screen controls and handset's motion sensors.

7. **Video Recording:** In case of low connectivity the robot will be able to record the video and relay it back when the connectivity is restored, for this the robot will provide sockets to attach external storage devices also.

8. **Collison Avoider:** The robot will feature several functions to avoid collisions and sound making manoeuvres in case user ignored it, the robot will move in the most suitable way to avoid detection and damage to its structure.

9. **Camouflage:** The will come in colour prints which are not easily detectable by eyes, and feature different appearances for different terrains to decrease visibility and avoid detection.

10. **Face Recognition:** This feature will be added to the robot to increase its authentication protocol and to recognise people through its camera, this feature can be very useful if provided with a database of criminal face patterns, this will locate suspects in real time.

11. **Night Vision:** During low visibility this feature will come into effect and operator will be able to see through its camera without even turning on headlights to avoid detection, an option for headlights will also be available though.

12. **Self-destruct Mode:** The robot will feature a self-destruct mode which will delete all the memory and there will also be an option for explosive destruction of the robot, this will be helpful in avoiding capturing by enemy personals.

13. **Motion Detectors:** This feature will be a complementary feature to the low power consumption mode in which robot will be using very less power for long term missions, these detectors will be to turn on the camera in case of detection of any moving object, or otherwise the robot will be in sleep mode.

14. **Person Counter:** The robot will apply computer vision and artificial intelligence to count the number of people from the video feed of camera, this will be fully automatic and there will be option to tag their position on a map using GPS, this will be helpful in analysing any hostile situation.

15. **Object Detector:** The operator will be able to set the robot to look for specific objects such as weapons, vehicles, supplies etc, and the robot will use Deep Learning and computer vision to automatically such as supplies, vehicles, ammunition etc., this will be very helpful in determining the enemy force status and plan missions accordingly.

16. **Low Power Mode:** There will be situations in which the robot will have to stay functioning for long time, this feature will come into action in such cases by manipulating the power consumption with reduces features, this will be achieved by reducing the feature and turning of devices to save power of 16000 mAh battery.

6. Proposal for the third level of screening

If we qualified for the third level of screening we will exhibit a working prototype aim to further increase the reconnaissance capabilities of the robot in addition to the previous mentioned features, we will modify its mechanical design to introduce more features and upgrade the software to support these features.

The feature upgrade will include these features:

1. **Detachable Quadcopter:** We will modify the mechanical structure of the robot to mount a launchable quadcopter from the robot, this will increase the robot's capabilities many folds. This quadcopter will be very useful for monitoring areas where robot is unable to reach.

2. **Suspensions:** We will add suspensions to its mechanical design to make it more robust. This will help the robot to achieve even higher speeds.

3. **Auto-pilot Ground Mode:** In case of low connectivity or no connection the robot will be able to follow the mission as specified before launching it, m which can be set for safe return, wait for connection, self-destruct, continue the mission assigned and return.

4. **Auto-pilot Aerial Mode:** The quadcopter will be able to sustain its flight and continue its mission in case of low connectivity, in the way specified earlier, the quadcopter will be able to fly and perform its functions, land safely or self-destruct itself. This will be useful in low connectivity situations or capture scenarios.

5. **360-degree Aerial View:** The quadcopter will feature a camera to relay live video or photographs, the quadcopter will be launched from the robot automatically. This will be achieved by self-unfolding wing mechanism. This will increase the reconnaissance capabilities of the robot.

6. **Wireless Jammer:** The robot will be featuring various wireless exploit tools such as auto detection of open wireless networks to intrude into them, jammers to obstruct enemy communication connections, etc. This feature will only be accessed by a wireless network specialist as these features are sophisticated. These features will be very useful in its missions for obvious reasons.

7. **Remote Code Flexibility:** Any authorised person will be able to change the entire code of the robot remotely, which is very useful in many scenarios. This will further extend the robot's capabilities, this meanest that robot can be upgraded remotely and tolls can be installed remotely without even accessing it physically.

8. **Guidance System:** The robot will be able to recognition its path using GPS and computer vision, the operator of the robot will be able to assign a location as GPS co-ordinates and the robot will be able to reach there on its own, this will further increase its autonomous behaviour.

9. **Connection Modes:** The robot will feature various connectivity options in case of network unavailability or in case of covert missions, these options include Email, SMS etc., this will increase the reach of the robot missions further.

10. **Auto Mapping:** The robot will feature an option to auto map the enemy base of location using Computer vision and Artificial intelligence. This will reduce the operation sophistication and will decrease its dependence on operator. This feature will be useful in any given hostile situation.

11. **Solar Cells:** There will be option to mount solar panels to increase the mission time period, this will charge the robot's battery and those will last longer to support longer missions.

12. **Voice Recognition:** We will add Voice recognition capability to the robot to facilitate its security protocols, where only authorised persons will have access to it, also this feature will enhance its reconnaissance capabilities to track voice features of suspects.

7. Plan for our concept to mature into a realizable prototype

Our idea is to further develop the robot's capabilities and make it able to perform multirole part in our armed forces. We will add following features to make it a realizable prototype:

1. **Satellite Uplink:** As students we don't have access to any of the countries satellite, but we want to add satellite connectivity feature to this robot, this will really make it functional at any place on earth whether there is network or not, this we take the robot to robot to actual operational ability in our armed forces.

2. **Suicide Attacker:** the robot could be modified to carry explosives and detonate them remotely to neutralise enemy or distract enemy. This is also out of our reach but can be very useful in many hostile scenarios. Our soldier will no longer have to face the terrorists face to face to neutralise them.

3. **Remote Weapon:** The robot can be modified to carry a gun operated by a real soldier connected remotely, this type of robots are the face of future warfare and we would like to develop this feature for our country. The soldiers will only have to operate the robots from a safe place and the robots will do to work.

In addition to these features we want to develop a software backbone for our armed forces for future warfare, this Software will have all the new technologies like Computer vision, Deep Learning, Artificial Intelligence and features inspired by these technologies. Our idea is to develop a universal Software that can be mounted and configured according to the mechanical design of the robot or a vehicle. In this way development costs for developing future advancement of our armed forces can be bought down. For example, the software we are developing for this particular robot can be modified to fit onto a real tank and that can be operated remotely. In this way any Existing Vehicle or robot can be controlled remotely. This clears the path for automation and decreasing the casualties.

This technology has enormous applications in the near future, countries like USA, China and Russia are already integrating robots with Artificial Intelligence into their armed forced. And we want to develop a software system that can handle any hardware provided in its limits. Like in war-fields robots in place of soldiers will fight for us, these robots will be controlled remotely by our soldiers. USA is currently using a similar technology in its drones, we just want to scale that up for every vehicle, robot, drone, or other hardware.

For another example, this robot can be modified to work at Line of Control and the software will be the same just the mechanical structure will be modified to sustain in LOC terrain. We propose an automated border monitoring system operating with very less army personals. We want to save our soldiers through modern technology.

This century will belong to the Artificial Intelligence in direct or indirect manner, we want to see Indian Armed Forces leading in this area in the coming future. Our existing software have the building blocks of such a software and we would like to work on our stated idea if granted support.