Aerial to ground multi-rotor convertible reconnaissance vehicle to evacuate wounded soldiers from war site.

Abstract: Anti-terrorist operations always rely on elements of stealth and surprise and hence the personnel carrying out these operations always require a greater level of support in the form of surveillance and quick aerial as well ground based support. As an entire medical setup and team cannot reach a soldier wounded in a battlefield, an alternative approach to provide medical assistance to the soldier is required. Designing a multi-rotor air vehicles which can be used to deliver goods and provide aid from a civilized area to war-torn terrain. The main idea for this project: to design a portable bot, stable enough to retrieve the wounded/unconscious soldier back to the medical setup. The convertible bot would have a soapbox opening mechanism with a hinge on one side and would be made of bulletproof material, can be called as trolley bag. It would be deployed in proximity of the location where the wounded soldier lies. It would then travel along the ground to the soldier. Upon reaching the soldier, the drone will open into a box and another soldier will carefully handle and lower the wounded soldier into it which will have the required medical facilities and bring him into the safety of the box. The box would then close and it would once again extend its arms and deploy its rotors and lift itself to a safe landing location or extraction point.

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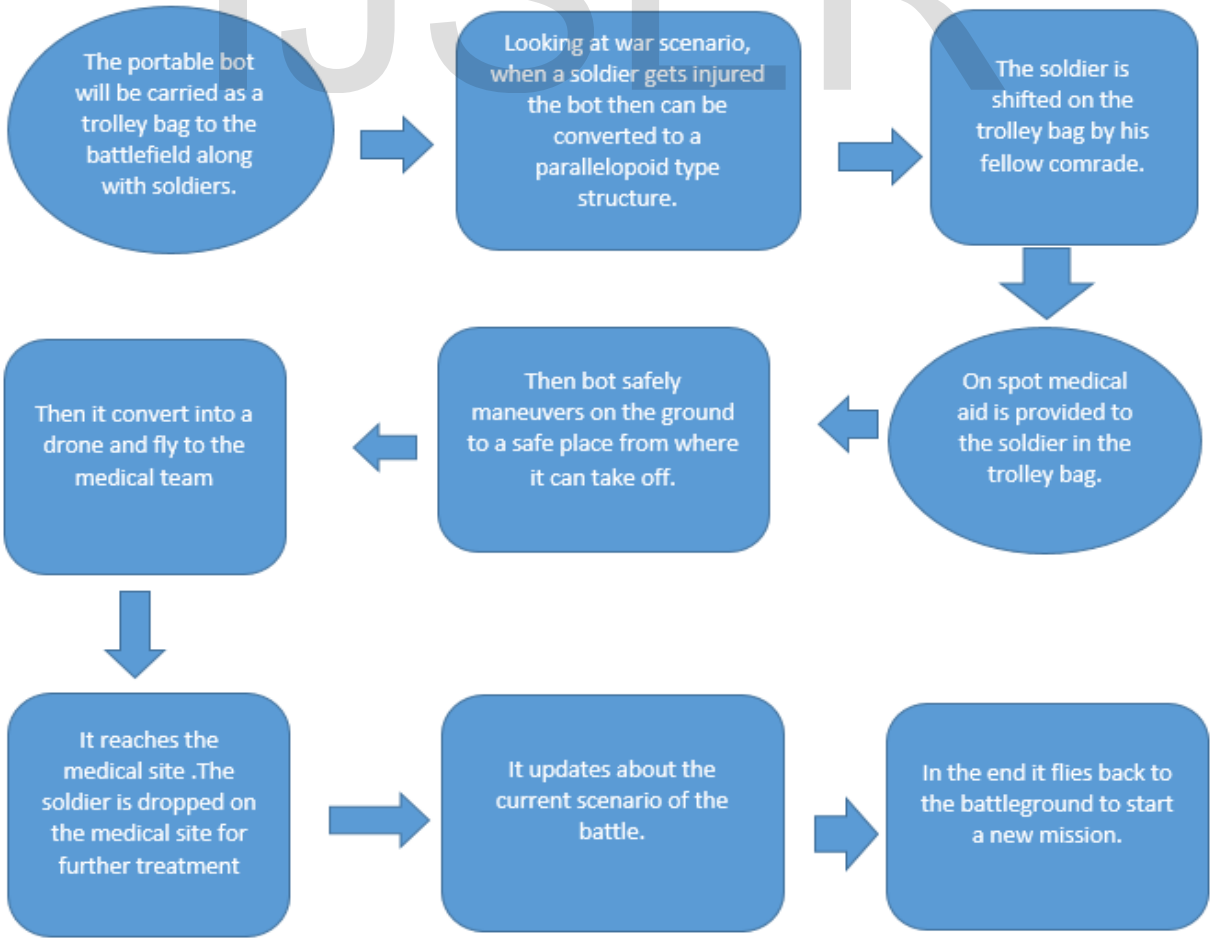

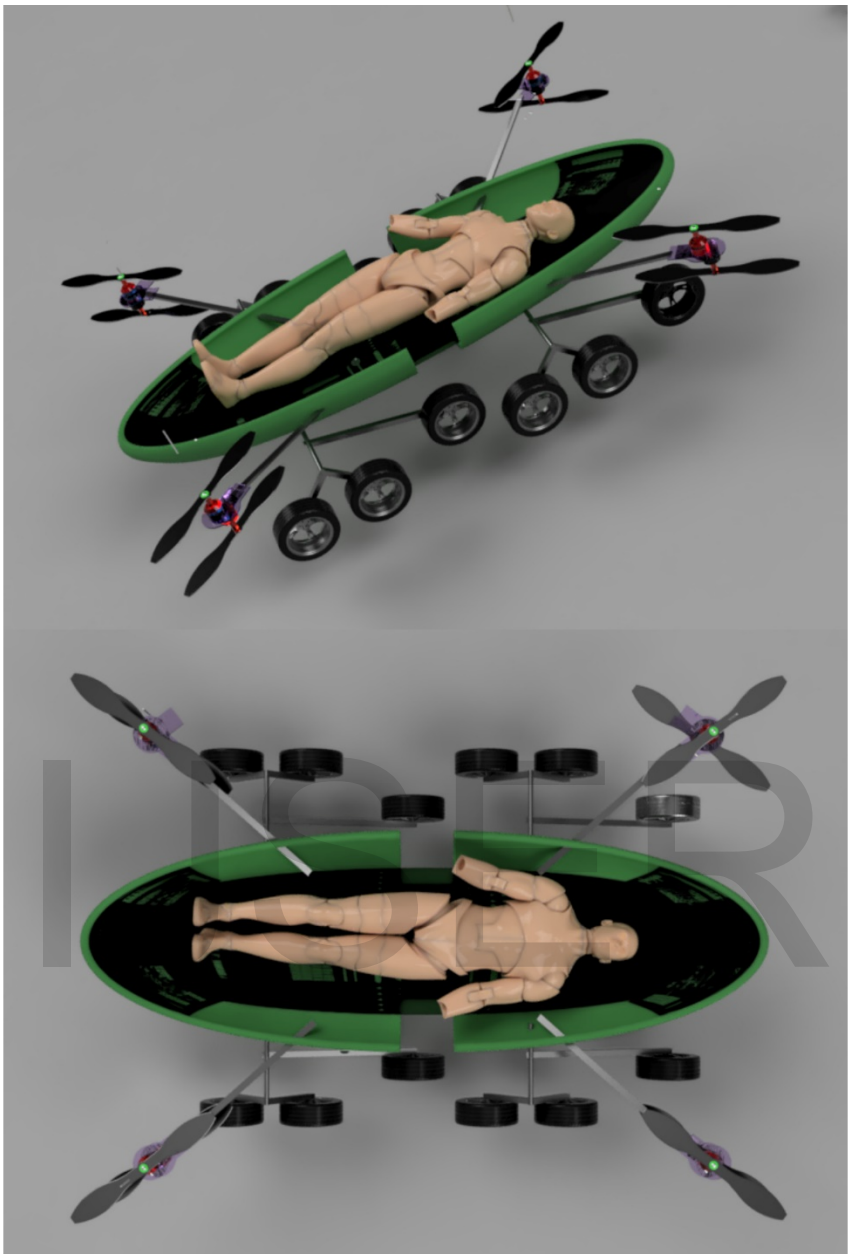

Figure-2: Top view and lateral view of the model

1. Introduction

There are a variety of civil usage contexts for “drones” or multi copters, unmanned aerial vehicles or remotely piloted aircraft systems. The use of drones is recently gaining particular interest in the field of search and rescue. Particular skills are still required to actively operate in a mission without crashing the drone with their effective and efficient employment in real missions. [1] However, multi rotor air vehicle are commonly used in both military and security forces in situation where the risk of sending man forces is unwarranted, to avoid loss of life, for search or rescue and provide medical aid.

Advanced UAVs uses radio technology for guidance, allowing them to fly missions and return to safe landing location. Drones and mobile technologies are an ideal way to overcome these issues in border patrol activities. Even though drones bring numerous technical advantages (i.e., short response time, being able to access dangerous areas, and no on-board pilot required) for the border patrol mission, a relatively short flight duration is the main concern for the full implementation for patrol at this time. [2]

Health services and medical resources in under-served communities are limited to motor transportation and in-person interactions. However, drones may be a feasible option in providing these services in a more effective manner. Current research has explored the use of drones for natural disaster relief, search and rescue missions, and transfer units. However, there is limited research on how drones could be used as telemedicine and transfer units. [3]

2. Literature Review

Medical evacuation is a necessary task needed to be performed by any battalion in the heat of the battle. Since evacuations ensure the safekeeping of the lives of soldiers along with keeping the number of troops from dwindling down, they serve for the greater good for a country.

Evacuation procedures in practice right now may be considered primitive as they rely on the co-ordination of multiple personnel to retrieve a wounded soldier from the front lines. Generalized flow of the retrieval can be described by the following: cover fire is provided by a soldier in the front lines; a medic races to the front and grabs the wounded; he pulls the wounded along with him to the backlines; if and when returned to the backlines the medic gives a generic treatment at best. Another procedure in current use is of a helicopter or a UAV are sent to retrieve the wounded by a dangling cord. In this case, the helicopter/UAV being a large target is easy for enemy artillery to strike and hence the success rate for this also drops.

Now when analyzed, various faults and very low probability of actually saving the wounded is found and hence more efficient evacuation procedures are required. Technological advances have been made in evacuation, which have been listed below:

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S.no.	Previous Solutions	Approach	Disadvantages
1.	DP-14 HAWK [5]	Small enough to fit in a utility van, it can be assembled and ready to fly in just thirty minutes. ➢ an internal payload bay of 23 cubic feet ➢ Autonomous	The structure of drone being this large, expose it to the heavy cease fire
2.	IAI's Helicopter DRONE [6] (AIR HOOPER)	➢ It is unmanned. It can carry from 100 to 180 kilograms ➢ Uses IC engines	➢ It is more a helicopter than a drone. Large size will expose it too. ➢ IC engines are not a good option for future UAVs.
3.	The Doppelgänger [7] (CONCEPT)	➢ The Doppelgänger would be equipped with six propellers with a diameter of 1.2 meters each. ➢ Powered by hydrogen fuelled engines. ➢ The drone holds the injured soldier with its spider like fangs in mid-air to medical staff.	➢ The soldier this way is completely exposed. There is no bullet proof protection for the injured soldier

Table – 1: Previous designs and their disadvantages

Our proposal is to send a **Portable Convertible Drone** into the frontline for retrieval, small enough to be pulled along with the battalion, but useful enough to evacuate a soldier from the battle.

1.1. Problem Formulation

The purpose of this proposal is to perform a task by a convertible and portable drone retrieving the wounded soldier to a safer landing place from the war site of heavy cross firing. Dangerous frontline operations call for a safe and efficient method to locate and evacuate wounded personnel. Multi-rotor air vehicle are used to address this critical need and help save lives, and benefit from it.

The main problem lies in finding a solution that compromises the potential need for drones in battlefield without getting traced by the opponent forces whether in means of less visible or having a bulletproof body structure which would protect both drone and wounded soldier and evacuate it to designated point.

1.2. Objectives

The main objectives of this project are:

a) To build a portable bot, which could be carried manually in a battlefield to provide medical assistance and carry goods safely.
b) To construct a convertible bot, which can transform itself to a multi-rotor air vehicle and evacuate the wounded soldier, carefully and quickly.
c) Drive the drone to safe place to lift-off and fly to the extraction point for the treatment of the soldier.

1.3. Limitations

This is a rescue and evacuate mission, and the field of military drones is rapidly changing and evolving. It is likely that the technologies involved will have changed [4]. The challenge here is, to make a feasible way to rescue a wounded soldier at war-site without endangering any lives.

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1.4. Approach

The casualty evacuation includes a distress call, which alerted the ground operators. Therein, the unmanned ground vehicle is sent to the site to evaluate the situation. The main idea is to make a prototype of portable and convertible drone, to rescue and evacuate a wounded soldier from the battlefield.

The first step to achieve this idea is the deployment of drone from the base to the frontlines. This will be achieved by providing a trolley-like system which will enable a soldier to pull the bot along with him initially.

The second step will be the admittance of the wounded soldier. When commanded, the bot will sideways open up, hence increasing the length to twice its original value, and decreasing the width by half of its original value. Further, a box like mechanism will open up where the soldier may lay safely till safely retrieved.

The final step will be the retrieval of the bot back to the basecamp/medical setup. Once the soldier is inside, the bot will travel a short distance back on land to evade frontal firing, then take-off by deploying the propellers outwards.

3. Methodology

3.1. Overview of Approach

The problem statement: Any squadron in a battle zone are faced with the decision of what to do with the wounded unconscious soldier, also since the medical team cannot reach the center of the cross fire to retrieve and save the soldier. To solve this problem, we need a technology which should be able to camouflage itself when needed and it should be capable of taking the unconscious soldier to nearest medical support in time with taking no chances with the safety of the life of the soldier and the machine itself. The solution we are providing here has the following advantages –

- User friendly device (easily accessible from anywhere)
- It is portable and multifunctional.
- It is safe and sensitive to the health of soldier.
- It is very good in handling in cross-country terrines & is able to it autonomously.
- The performance is accurate and stable.
- Assuring the protection of the soldier by using different modes of maneuverability.
- It is able to protect itself by using camouflage technics and different maneuvers.

In conclusion we are planning to implant a tanker like wheel-belt system in a trolley bag made up of a light-weight bulletproof material with a sleeping bag inside with essential pharmaceuticals inside, which can run on cross-country terrain in heavy crossfire where flying or hovering at low height is not an option as flying objects are an easy target for the opposing side. Available technologies like infrared, ultrasound etc. will be used to make it perfectly autonomous to maneuver cross-country terrains. The ground maneuvering ability will also increase the accuracy and decrease the time of admitting the soldier into the medical setup within the machine then it will make its way to the nearest safety nest by hovering towards it after picking up the wounded.

3.2. Current Analysis

Nowadays situation is a bit different, as some forces in world are having unmanned evacuation UAVs to save the lives. But as seen in previous years that not for maximum times these techs are helpful. And in heavy cross fire, it is just a matter of seconds that the opposite party will destroy the flying target at the time of admission of unconscious soldier. Places for that kind of situations can be a sandy, icy, rocky land or it can be a damaged city, so depending on the situation there should be two types of vehicles, one with tracks & other with normal wheals. Both have advantages and disadvantages over each other, but as the evacuation has to lift off in the end, it has to have minimum weight.

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3.3. Requirements

To provide minimum weight, use of light weight material is necessary.

Electric (BLDC) motors can provide us the maximum thrust required. On an average, the thrust in 6 motors in hex-copter configuration or 8 motors in co-axial quad configurations is reduce by about 25% in case of co-axial configuration. Also the best & reliable power source available now is Panasonic NPA Lithium ion batteries. **Tesla** is using them successfully.

Part Name	Number of parts	Weight of each part	Total weight	Respective outputs
Motors (Tiger Motor U15 Pro 80kv)	6 – 8	1.3kgs – 1.6kgs	~ 12kgs	*Thrust = ~ 200kgs*
Batteries (18650 Li ion battries)	400	0.05kgs	~ 20kgs	*Endurance = ~ 20 Min.*
Frame (using NIJ Level 3)	~	~	~ 40kgs	*Protection*
Inside materials (e.g. sleeping bag & medi-kits etc.)	~	~	~ 4kgs	~
Electric components	~	~	~ 2kgs	~
DC motors (For ground maneuvers)	8 – 12	0.4kgs – 0.6kgs	~ 5kgs	*Torque = ~ 20Nm*
Wheels	8 – 12	~ 0.4kgs	~ 4kgs	*Ground Maneuvers*
Total Weight			**~ 87kgs**	

Table – 2: Empty weight specifications

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So the total empty weight is less than 90kgs allowing a Soldier having weight approximately about 90kgs to get safely evacuated.

3.4. Plan for Interpreting Results

Our idea for rescuing soldier is Evacuation UAV shaped like a trolley bag which will be used for carrying wounded soldier from the battlefield. The trolley bag will unfold to form a sleeping bag like structure covered with bulletproof sheets, in which the soldier will be admitted. Depending on the situation, the evacuation UAV will fly like a drone to a safe landing location & than it will perform maneuver on the ground to reach the desired location without taking any chance of being target. The structure is provided with small wheels, arms which can fold and unfold containing the flying maneuvering system. It will be controlled remotely & autonomously. The soldiers can carry it to the battlefield by toeing it like a trolley bag. When a soldier gets injured during heavy cease fire, then his fellow comrade will manually/autonomously transform the trolley bag into its open structure, placing the soldier in the bag, after tightening the straps around soldier, the Drone will walk through ground to a

safer location and will extend its arms fitted with electric propulsion system and will lift-off back to the medical team at its designated point.

4. Expected Results and Conclusion

It can be seen, from the research done and specified in the literature review, that various countries are trying to find a solution to avoid risking further human lives in the heat of the battle while also trying to retrieve a wounded soldier. Therefore a better method for our country has also become a necessity.

One such better method can be the proposal presented in this Technical Report which has been described in detail. The significance of the bot/drone is that it provides an alternative to the classical techniques of soldier extraction such that loss of life is minimalized while also staking our country's claim in the technological realm of the ever-changing military approach.

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5. References

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