Drona-Chariot: A Medical Equipment Carrier Drone

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Abstract*— Caring for trauma victims in harsh environments poses numerous difficulties, especially when a rescue effort is delayed. Human-containable medical equipment may also be consumed by a single victim, making replenishment impossible prior to evacuation, especially in long-term on-site supply scenarios. This project aims to build an unmanned autonomous aerial vehicle that successfully delivers remote places with life-sustaining medical supplies where it is impossible or impractical for vehicles or pedestrians to approach. We are looking forward to simulate the delivery of customizable medical devices such as tourniquets, bandages, analgesics, and blood products. Simulated victims were placed at remote locations. The flight was pre-programmed around the idea of grid coordinates and was flying out of sight on autopilot. A high-altitude drone was used to live-record data, including height, flying time, and route. In numerous instances, drones have successfully and precisely delivered medical supplies more quickly than alternative ways without putting people or manned vehicles at risk. The critical care of military and civilian injuries is aided by this technology.

Keywords—Drone Delivery of Medications, healthcare scheduling and logistics, Unmanned aerial vehicles for human health, medication quality and compliance.

I. INTRODUCTION

Delivery of medicinal supplies to persons with and without care requirements, particularly in distant places, has substantial hurdles due to the present COVID-19 epidemic, ageing populations, and growing workforce shortages in the health care industry. Therefore, it is more crucial than ever that medical supplies are delivered expertly. Urgent medical requirements could be addressed by a delivery system based on drones. Unmanned aircraft known as drones are widely employed globally for a range of tasks, such as military operations, delivery, and medical research. Agriculture, medical, development, industry, commercial shipping, justice systems, traffic monitoring, and education are among the fields where drones are employed extensively. In the fields of healthcare and medicine, drones are frequently utilised for telemedicine, medical transport, public health, and disaster relief.

Drones are used in the health sector to monitor the number of individuals in need, find potential hazards, and engage in epidemiological investigations. In telemedicine, drones are utilised for telesurgery, offsite patient diagnostics, and patient treatment. Drones are also utilised in the transportation of medical supplies such as defibrillators, medication (such as pharmaceuticals and vaccinations), blood preservation, organs, and other medical equipment. Medicinal unmanned aerial vehicles have been encountered as a more affordable substitute for air transport for medical supplies when compared to helicopters. In regions with mountains, deserts, woodlands, limited access to roads or long-distance areas, or regions hit by significant natural disasters, drones in healthcare have a high potential.

To enable quick transportation of medical supplies from healthcare facilities to hospitals and emergency rooms, we created a drone-based medical supply delivery system. The drone will make it possible to send up to 1 kg of medical supplies directly to hospitals and emergency rooms while avoiding local traffic.

II. BASIC TERMINOLOGIES

Medical equipment carrier drones are the unmanned aerial vehicles (UAVs) or Remotely Piloted Aerial Systems that are designed to transport medical supplies and different equipment to remote or hard-to-reach areas. These drones have several key components that are important to understand when discussing their capabilities and operation. The first is the drone itself, which is a small aircraft equipped with rotors or propellers that allow it to fly. The drone is typically controlled remotely by a human operator who uses a remote control or a computer interface to direct its movements. In addition to the drone, medical equipment carrier drones also have a payload, which refers to the medical supplies and equipment that the drone is carrying. The payload can vary depending on the specific needs of the mission, but may include items like blood, medication, or medical devices. Finally, medical equipment carrier drones are often equipped with advanced sensors and GPS technology that allow them to navigate and avoid obstacles during flight.

III. EXISTING SYSTEM

Drones are increasingly being used in the medical field to improve patient outcomes and access to care. One of the most important applications is the delivery of medical

supplies and equipment to remote or hard-to-reach areas. Drones can quickly transport critical supplies such as blood, medication, and medical devices, helping to ensure that patients in need have access to the care they require. For example, in Rwanda, the company Zipline uses drones to deliver blood to hospitals and health clinics in rural areas. The drones can carry up to 1.8 kilograms of blood and can make deliveries within 30 minutes of receiving an order.
Drones are also being used for medical imaging, which can be especially useful in emergency situations where quick and accurate diagnosis is essential. Researchers in Australia, for example, are using drones equipped with high-resolution cameras to capture images of skin lesions, which are then analyzed using machine-learning algorithms to identify signs of melanoma. This might significantly increase the precision and speed of diagnoses, which would ultimately result in better outcomes for the victims or the patients.

Ultimately, drones are being used to support disaster relief efforts, with some models equipped with thermal imaging cameras that can help to locate survivors in the aftermath of a natural disaster. In the aftermath of Hurricane Maria in Puerto Rico, for example, drones were used to deliver medical supplies and equipment to areas that were cut off from traditional transportation networks.

Overall, the use of drones in the medical field is rapidly expanding, and is expected to play an increasingly important role in improving patient outcomes and access to care. As technology continues to advance and new applications are discovered, the potential for drones to revolutionize the way we deliver medical care will only continue to grow.

IV. Problem Statement

The young demographic has been moving quickly over the past two decades from isolated villages in hilly regions to medium and major cities. Some of these settlements lack the most basic medical infrastructure since they have not yet been connected by roadways. Health workers' visits to these settlements primarily remain on paper, and the elderly are now receiving little in the way of substantial medical care.

Our aim is to build a drone that will allow for instant delivery or upto 1kg of medical supplies like blood bags, vaccines, syringes, etc. without being impacted by local traffic, to hospitals and catastrophe centres.

V. Proposed System Architechture

The system architecture for a medical equipment carrier drone must be designed to ensure the safe and efficient transport of critical medical supplies and equipment.

The architecture typically includes a ground control station that allows operators to remotely control the drone, as well as a communication system that enables real-time monitoring of the drone's location and status. The drone itself must be equipped with advanced sensors and avionics systems to ensure safe and stable flight, and must be capable of carrying delicate medical equipment without causing damage or compromising the equipment's functionality.

To ensure the security and privacy of patient information, the drone must also be equipped with encryption and authentication technologies that protect data during transport. Finally, the system architecture should incorporate redundancy and fail-safe mechanisms to ensure that the drone can safely complete its mission even in the event of unexpected equipment failures or adverse weather conditions.

By carefully designing the system architecture for a medical equipment carrier drone, it is possible to create a reliable and efficient transportation system that can help to improve patient outcomes and access to care.

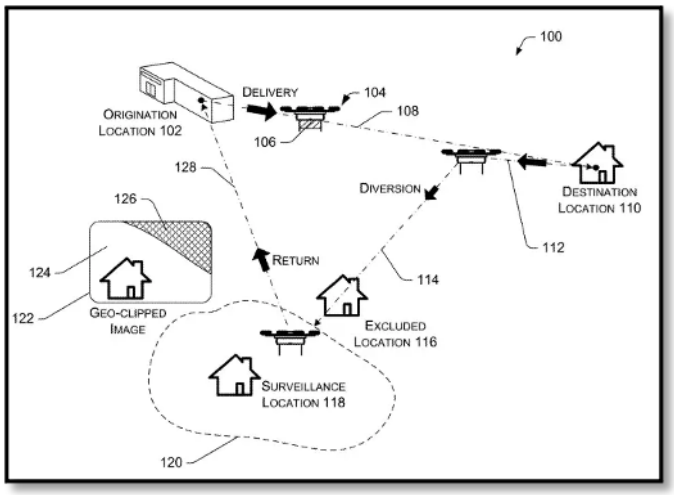

Fig 1: System Architecture

VI. Methodology

To address the critical need for medical supplies in remote areas and the out-of-balance supply and demand for medical care services, a medical supply delivery drone has been developed to transport the medical equipment from the healthcare facilities and centres to the rescue areas, without being hindered by traffic.

We employed an unmanned, rotary-wing drone to model the delivery of a 1 kg load of medical supplies, including tourniquets, bandages, and blood-related supplies. The UAV has a 400gramme airframe and a maximum cruise endurance of 25 minutes with a full payload. It can carry a payload of up to 1kg while operating at full endurance. Casualty was placed at a remote location after we gained approval from the institutional review board. Prior to take off, the tactical medical professional positioned with the fictitious casualty provided grid coordinates that were used to pre-program the aeroplane. To ensure effectiveness, interviews with blood banks and hospitals were conducted to collect general data on demand and efficiency measurements. Although some believe that the drone system may be ineffective, many people believe it can help the country's health sector during times of crisis.

Advantages:

1. Reducing the traffic on roads.
2. Reducing greenhouse gas emissions.

3. More flexible route options.
4. Lower the expense of maintaining roads and bridges.
5. It is quick and dependable.
6. Excellent over short distances.

Disadvantages:

1. Weight restrictions apply to packages.
2. Limited flying duration.
3. Regional limitations.

VII. Software and Hardware Requirements

Here we will discuss everything we will need in order to execute. Below we list the necessary hardware and software requirements.

Software Requirements:

1. C/Python programming for network simulations
2. Online Simulation Software
3. WayPoint Marker
4. PX4.io (Open Source Drone Controller)

Hardware Requirements:

1. UAV Motors
2. UAV Camera
3. Riddled Basket
4. Radio-Controlled Remote Controller
5. UAV Propellers
6. UAV Controller
7. Radio Frequency Receiver
8. UAV Frame
9. Electrical wirings and Circuitry
10. Mounts and Attachments
11. Base Constructions
12. Supporting Constructions
13. Screws and Fasteners
14. UAV Batteries

VIII. Use Case Diagram

The use case diagram for a medical equipment carrier drone illustrates the various ways in which the drone could be used to transport medical equipment and supplies.
The main actors in the diagram includes the drone operator, who would be responsible for controlling the drone during flight, and the medical personnel who would be responsible for receiving the equipment and supplies at the destination.
The primary use cases for the medical equipment carrier drone includes:

1. Transporting medical supplies to remote areas: This use case would involve the drone being used to deliver medical supplies such as vaccines, medications, and diagnostic equipment to areas that are difficult to reach by traditional means of transportation.
2. Transporting medical equipment between hospitals: This use case would involve the drone being used to transport medical equipment such as MRI machines, X-ray machines, and other diagnostic and therapeutic devices between hospitals or other healthcare facilities.
3. Transporting blood and other biomaterials: This use case would involve the drone being used to transport blood and other biomaterials from blood banks to hospitals and other medical facilities.
4. Emergency medical response: This use case would involve the drone being used to deliver critical medical supplies and equipment to emergency response teams, allowing them to quickly and effectively respond to emergencies.

Overall, the use case diagram for a medical equipment carrier drone highlights the many ways in which this technology could be used to improve access to medical care and save lives.

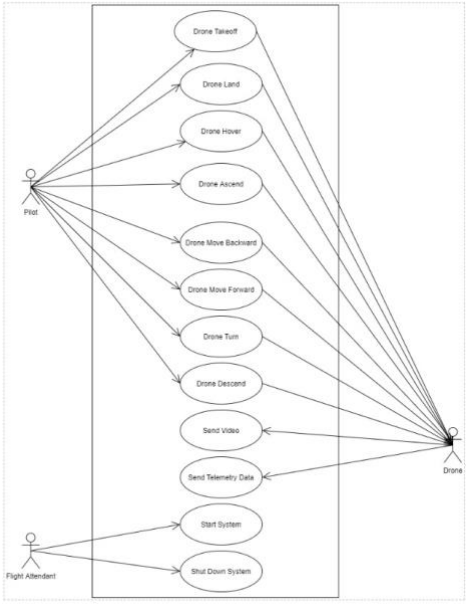

Fig 2: Use Case Diagram

IX. Experimental Results and Discussion

Experimental Results:

The experimental setup involved a quadcopter drone with a weight of 300 grams and dimensions of 30 cm x 30 cm x 10 cm. The drone was equipped with a 3-cell lithium polymer battery with a capacity of 2200 mAh, and it was tested in an open field with no obstacles. The medical kit that was carried by the drone weighed exactly 750gms and had dimensions of 20 cm x 20 cm x 10 cm.

The drone was programmed to fly for a distance of 2 kilometers at a constant altitude of 50 meters above the ground. The test was conducted on a sunny day with no wind, and the drone was controlled using a remote controller.

The results of the experiment showed that the drone was able to fly for 25 minutes with the medical kit attached, covering a distance of 2 kilometers. The drone was able to maintain a stable flight, and the medical kit remained

securely attached to the drone throughout the flight. The average speed of the drone was calculated to be 18 km/h.

Discussion:

Based on the experimental results, it can be concluded that the drone is capable of carrying a medical kit weighing up to 750gms for a distance of 2 kilometers. The drone was able to maintain a stable flight and the medical kit remained securely attached to the drone throughout the flight. This suggests that the drone is a viable option for transporting medical equipment over short distances.

However, it is important to note that the drone's flight time is limited to 25 minutes due to its battery capacity. This may be a limitation in emergency situations where quick delivery of medical equipment is crucial. Additionally, the drone's speed of 18 km/h may not be fast enough for certain applications.

In comparison to traditional methods of transporting medical equipment, such as by car or on foot, the drone provides a faster and more efficient means of transportation over short distances. The drone's small size and maneuverability also make it useful in areas that are difficult to access by other means.

Overall, the experimental results suggest that the medical equipment carrier drone is a promising technology for the transportation of medical equipment in certain situations. However, further testing is needed to determine its suitability for specific applications and to address any limitations that may be encountered.

X. Conclusion and Future Work

The use of drone technology can be crucial in combating pandemics; however, it should be seen as an additional resource rather than a substitute for ground-based transportation. To ensure optimal performance, it is important to integrate drones into local health supply chains and systems rather than utilizing them in isolation. While more data is needed to establish the cost-effectiveness of drone technology, cost should not be the sole (or the most significant) determinant in deciding whether the technology can help to save lives.

This project is beneficial in providing necessary medicines in areas where normal traffic transportation services are unavailable, as well as in areas where the geographical terrain is unsuitable for traditional transportation methods.

Second, critical applications arise in emergency situations such as floods and earthquakes, where residents and doctors require vital medicines that can be easily delivered via our medicine drone delivery system.

Third, this Drone is useful in cities as well. The rising population and massive increase in private vehicles on city streets have increased traffic congestion, making traditional delivery systems difficult to operate effectively. As a result, this drone finds use there as well.

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