Multipurpose Emergency Drone for Urban Search Assistance - *MEDUSA*

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***Abstract*—There are a large number of deaths that take place due to ambulance delays in emergency conditions. We have designed and tried to implement a VTOL(vertical take-off and landing) Hybrid aircraft which can carry necessary medical supplies and deliver them in a timely manner. The aircraft will combine VTOL's versatility, speed, payload capacity, and range of fixed-wing aircraft. The aircraft will be capable of fully autonomous flight with GPS systems embedded.**

***Index Terms*—Emergency Services, VTOL, GPS, Aerodynamics, BLDC motors, Deep learning, Human-Robot Interaction**

I. Ideation

We propose a system to aid emergency response services in the rescue of patients. We have designed a drone with the ability to assess the scene and provide communication between the scene and the emergency service. The drone will also be equipped with basic first aid, and medical refreshments like electrolytes, etc. The drone will also be equipped with a chatbot powered by Natural Language Processing that will provide company to the patient thus ensuring lower stress levels in the patient before help arrives.

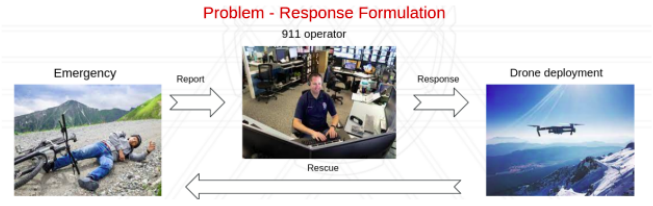

Fig. 1. Ideation

II. Market Research

There are several companies currently offering similar services out in the market. Some companies that are present in this domain are Unmanned Vehicle Technologies(UVT), Flymotion, Skyfront etc. The kind of domains these companies are servicing are public safety, utility, construction, first response, defense, law enforcement, etc. UVT and Flymotion, use commercially available drones like Dji, Teal, etc. Skyfront designs its own drones focusing on long-range and endurance. Their drones, unlike others, are gas-electric hybrid. The ballpark costs for these drones are in the range of $10,000 - $17,000.

III. System

A. System Work-flow

Once the emergency services are made aware of the incident, the 911 operator will pass on the information to the EMTs. In parallel, the 911 operator will deploy the MEDUSA drone with all the necessary care packages loaded to the site of the incident. This drone will reach the location, assess the situation, and send the information back to the base regarding the nature of the incident, the number of people involved, the other external factors involved, etc. This helps EMTs prepare for the kind of incident they're going to address and can come equipped with relevant items to provide a better first response.

B. System Architecture

System design involves two main components. The first component is mechanical system design, and the second is electrical system design. The mechanical system component involves studies related to the aerodynamics of the system, and the electrical component involves studies related to the BLDC motor selection and battery selection.

IV. HRI features

Scene Assessment: This feature is based on an edge deployable optimized and compressed deep learning model which would be a complex and combined network that takes the video input and gives a higher level of understanding of the incident by inferring useful details such as the number of people involved, categorizing the accident (fire, traffic, etc.), segmenting property damage and other. The figure below shows the output of the Deep Learning model.

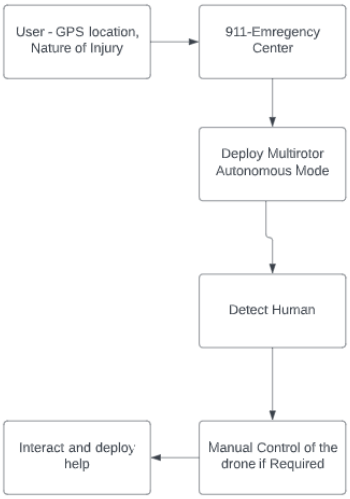

Fig. 2. System workflow

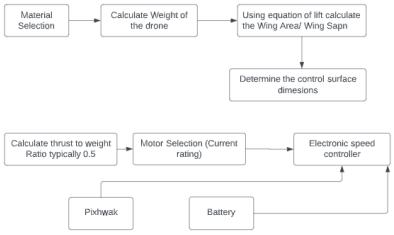

Fig. 3. System design workflow

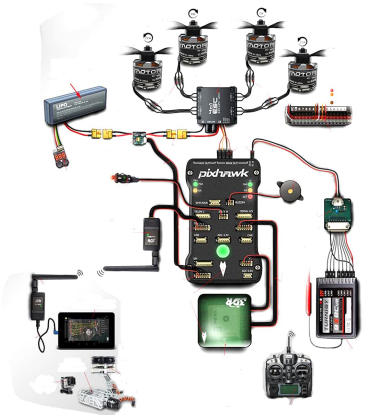

Fig. 4. System hardware

NLP voice bot: This NLP Voicebot gathers details of the accident from the victim (if in condition to speak) and bystanders by asking questions and carries the conversation to create an end-to-end automated voice chat. The questions are based on the prior received from the scene-assessment model.

First aid box: We designed the drone to be able to carry 3 to 5 kg. This self-explanatory feature is a first-aid attachment to the drone. However, in a different, it can be replaced with the necessary package which is suitable for that service/task.

Fig. 5. Cad design

Fig. 6. Example of scene assessment

V. Trustworthiness

Trustworthiness is one of the important factors for a patient in a situation of distress. In this project, we plan to gain this trust based on the underlying technology that we will use to ensure safe and secure help for anyone in need. To achieve this, we divided this goal into 3 categories.

Cybersecure Interaction A patient's emergency-related data should remain private throughout this operation. Hence in our system, the patient data received from the government will be encrypted so that no hacker will be able to steal and read it. To keep the drone safe from RF attacks, we plan to make the drone completely autonomous throughout the operation, with the help of obstacle avoidance and fail-safes. On detecting the jamming signals or malicious activity the drone will change its trajectory and it will return back to the base.

Cyber Resilience To ensure resilient autonomy, the drone will be running multiple different high-level behavior stacks which will be responsible for making sure the drone reaches its destination safely. To make it resilient, fail-safe systems will run in parallel in separate docker containers. If one of the models stops because of unforeseen error and fails to identify the obstacle or the intended person. The other model will take precedence in decision-making and will give enough time for the other container to restart.

Calming Appearance and Interaction

Physically, the drone will have a body made up of non-metallic lightweight material, which will ensure the drone feels safer to approach for any person. Our drone will have a speaker and microphone through which the user in an emergency can speak to the AI chatbot. The AI chatbot will be specifically trained for helping the person in distress. and will instruct the person on how to apply first aid. This chatbot

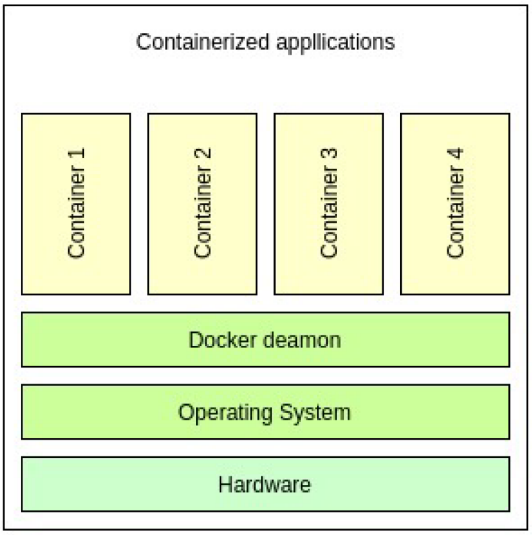

Fig. 7. Cyber Resilience

will converse with the patient till the ambulance arrives, this will make the patient feel connected and safe.

VI. Business Model

Our Go-to-Market strategy is as follows:
We will first start out as a B2B service and once it is scalable we will gradually shift to a B2A service. Our primary target audience is First Responders and United Nations to aid their relief work. Once our operations are scalable we will branch out to the wider public market. We will offer our customers with a pay-as-you-go and choose-what-you-need subscription model for Services like Advanced Fleet Management Services, other customizable features, bells & whistles, etc.

Part	No of units	Cost(in dollars)
BLDC motor	5	900
Servo motors	4	20
Battery 6S	1	100
Transmitter and Radio	1	200
Pixhawk	1	180
Raspberry Pi	1	60
Go pro camera	1	270
Speaker	1	12
Miscellaneous	1	600-800
Total		2342-2542

TABLE I
Bill of material

VII. Conclusion

We have successfully studied design parameters essential for VTOL design. It is vital to note that any autonomous system relies on deep learning models for functioning. We have incorporated deep learning models into our system, considering HRI features. Finally, we also ensured that our system was fully cyber-secure and resilient. From the commercial standpoint, we have conducted market research of our competitors and have sketched out a viable Go-to-Market strategy with a product that has unique offerings and a lower price.