Disaster Management aid drones

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Theme: Disaster Management

Introduction:

We thank Indian Institute of Technology, Madras for providing this opportunity to showcase our idea through “Shaastra AI Challenge”. We have been working in the field of electronics and aviation for the past 2 years and we hope to provide the best solution for the mentioned theme.

Since all the ground modes of transportation and communication came to an immediate halt, it is only the aerial transportation that can be leveraged. Helicopters may not give a clear picture as it flies too high, plus, it is too much difficult to deploy as many helicopters.

Drones, on the other hand, can fly at as low as 30 meters above the ground, and thus, can serve as a handy tool for monitoring the area, assessing the severity of the situation, locating the people who are still trappe2d on their roofs. Moreover, they can be deployed as and when required, in any numbers, at any place.

As we know the recent storm attacks in southern coastal areas happening for quite few years, many people are affected and there is a huge loss to life and property. Even though the government is taking maximum efforts to help the victims, we thought the technology of aviation or UAVs (Unmanned Aviation Vehicles) can provide a major helping hand to aid the needs of victims. The main problems faced are,

- Cannot locate people
- Cannot able to reach the affected areas through land or water to provide relief materials.
- Lack of food supplies to the victims can lead to death.
- Cannot analyze the amount of damage caused to particular area.
- Estimation of injured and dead count is very tough.
- Estimation of number of people in particular area cannot be found out. This information is very important as the relief materials can be sent only if that data is available.
- Lack of communication due to damage caused to network towers.

Applications of Drones in disaster management:

- It can also be useful to locate many people who are still trapped on their roofs in highly water-logged areas as well as in far-off places.
- Can measure magnitude of water logging in flood affected areas.
- Drones can provide a live video feed of the affected areas from an aerial view. The live aerial video can be hosted on internet platforms and can be accessed by anyone. It can help the government in finding out which all areas are severely affected so that they can provide immediate relief and rescue teams there as soon as possible.
- Can make public announcements of important news (News related to forecast, relief details, aid, etc.) via speakers which are attached to the UAVs.
- After having the aerial video and a digital map of the entire affected as well as non-affected but adjacent areas, the helping authorities can set up relief camps in such a way that it can be used by the maximum number of affected people.
- UAVs will be able to analyze the presence of civilians by their voice or screaming sound who might be stuck.

Business Impact:

- Drones can help in creating a digital map and 3D model of the entire region.
- We can measure the area and volume of destroyed property using 3D model and the relevant measurement tools. We can estimate the total cost of damages by multiplying the area/volume with the unit rate of everything. This information will be very useful for insurance companies.

Solution design:

a) *Hardware design:*

We initially thought of using the conventional structure of UAV. But, when it comes to unfriendly weather conditions, for instance if the wind speed is too high in times of cyclone, the UAV might fail. So, we planned to design our own drone/UAV frame via 3d-printing. Hence, we can design the best aero dynamic approach towards various situations and constrains. We are planning to make a hexa-copter design, as it will be more stable than quad copter and it will attain more height and will be capable to withstand high wind speeds. So instead of 4 motors, 6 motors will be present in the UAV so as to provide stability.

The UAV will be capable to lift loads like First Aid Kits, relief materials, speakers to make important announcements, etc.

If A = MOTOR THRUST

B= NUM OF MOTORS

C= THE WEIGHT OF THE CRAFT ITSELF

D= HOVER THROTTLE %.

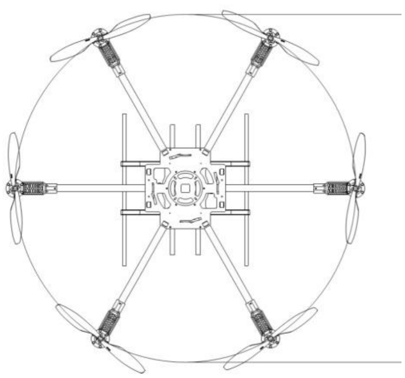
SO, PAYLOAD CAPACITY = (A * B * D) – C

(650g *6) -1000 kg = 3900-1000 = 2900 grams

2900*2 =5800 so approx. 6000/6

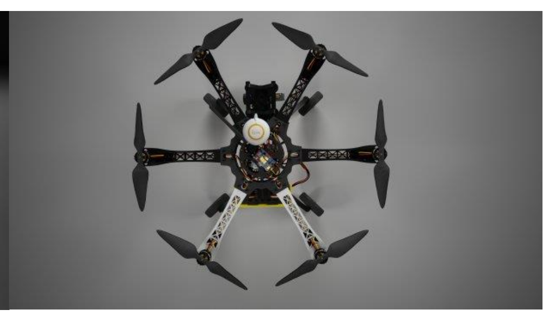
Thrust = 1000 grams for each motor at maximum throttle

This thrust will be enough reach the height of 3300 feet (1 kilometer) in air



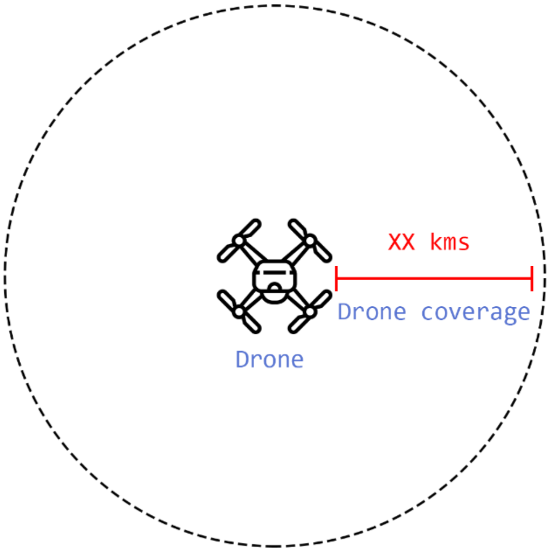
The above mentioned is a basic design for the drones.

The sample images of the hexacopter design



b) ***GIS Mapping:***

GIS stands for “geographical information system.” A GIS is a computer program that can capture, store, organize and display data related to specific parts of the disaster affected zone. Drones equipped with cameras that can transmit various types of GIS data lower costs on multiple levels. GIS coupled with remote sensing provides a basic framework that helps in all the stages of disaster management starting from preparedness, to response and recovery. Through advanced wireless technologies and web-based GIS applications, disaster management by government is enhancing the coordination of response efforts as well as planning for disaster risk reduction.

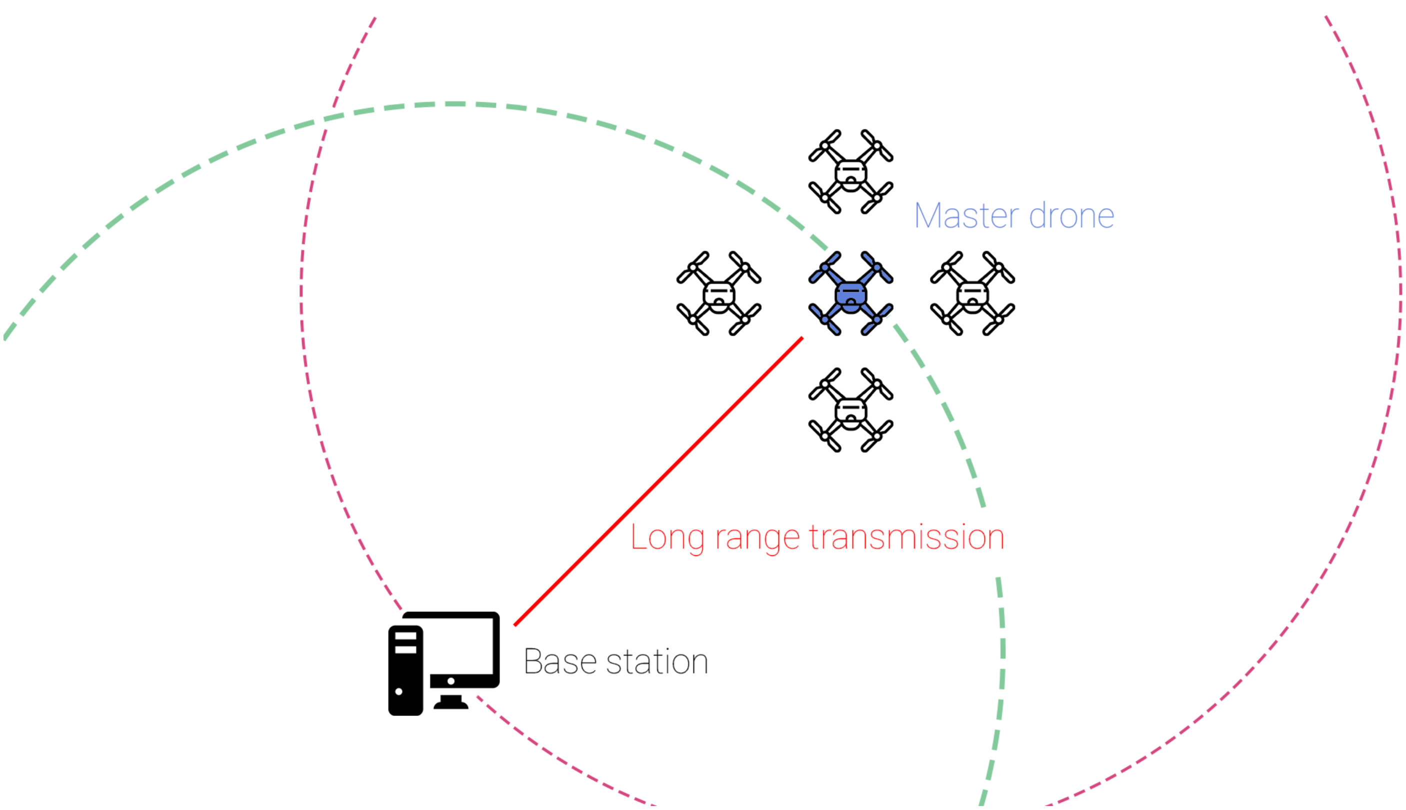


c) ***Communication system:***

i) <u>When UAVs flies as a group:</u>

- Protocol Used is ADHOC
- The base station communicates to a particular UAV which can be assumed as a Sub-Master. This Sub-Master in turn will communicate with the other Nodal UAVs that are surrounding the Sub-Master UAV.

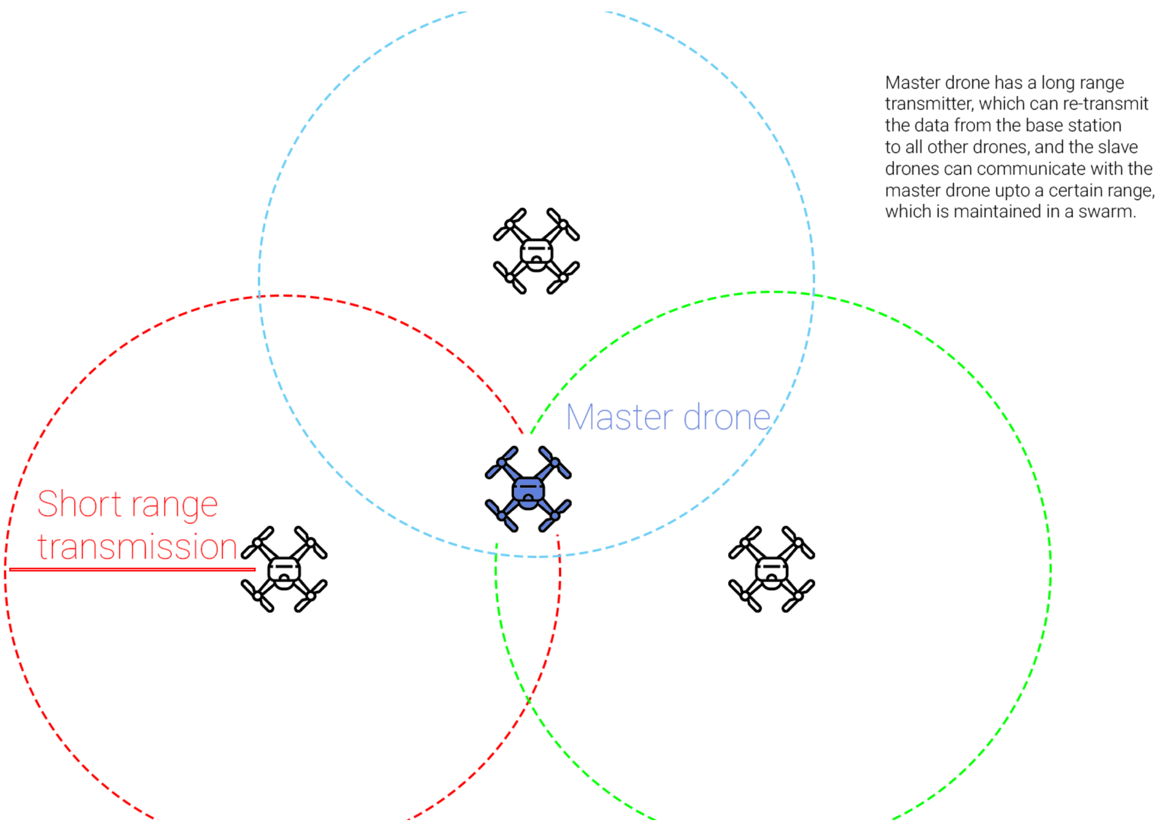
The drone will have a coverage range depending on the type of transmitter and receiver used.



The base station and Master drone will be fitted with long range transmitters and receivers.

The slave drones will have shorter range communications systems to reduce the cost.

Initially the data transmission to the swarm will be sent to the master drone. Then the master drone will be able to transmit the data to all other drones which will be in range since it is flying as a swarm.



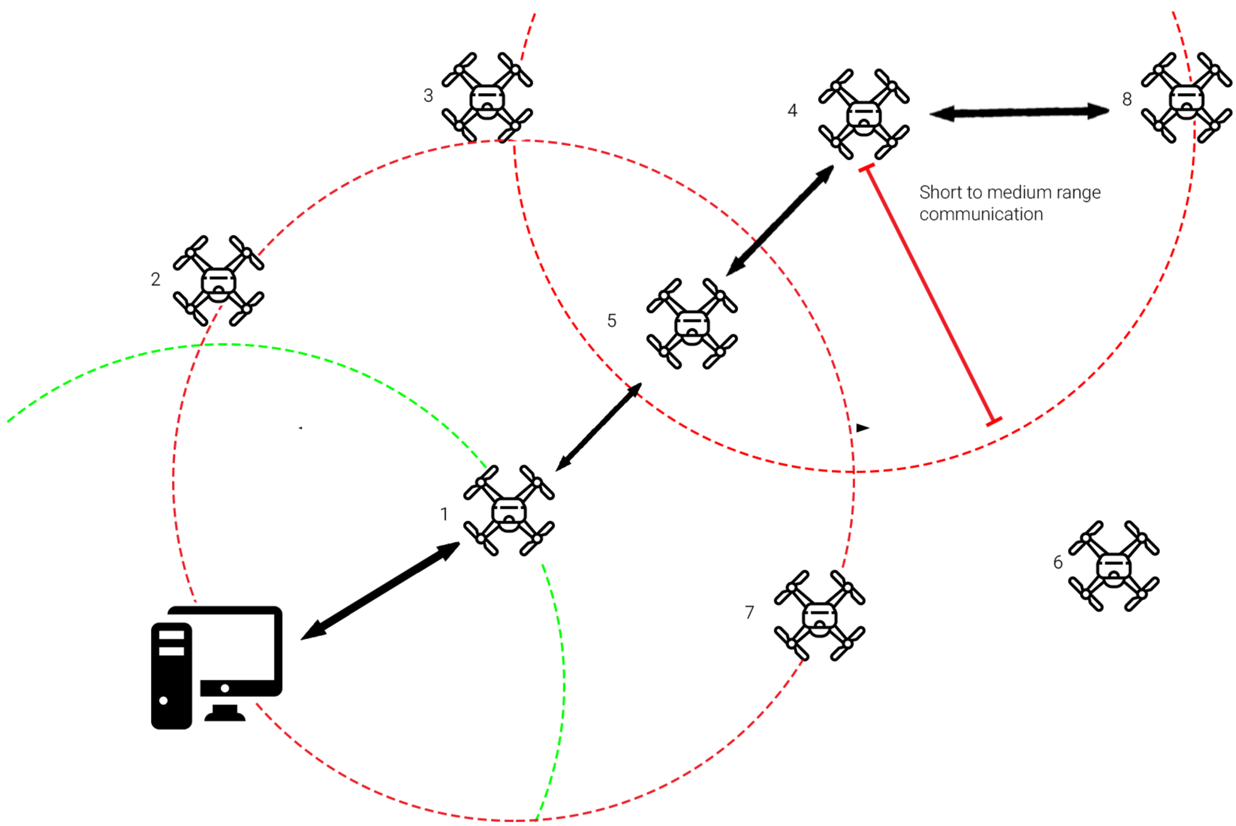
The Master drone can transmit to a large distance, and hence the probability for error in reception by the slave drones in the swarm is significantly reduced

ii) When UAVs flies independently.

- Protocol used is CSMA/CA
- The drones need not necessarily fly as a swarm, sometimes it is desirable to fly them over a much larger radius to gather more information. In that case, it is easy for a drone to go out of the coverage area. The solution to transmitting data to out of range drones is using an optimized connectivity scheme where the data can be made to reach the destination by repeated re-transmission by other drones. The algorithms we are planning to use will make the drones fly such that each drone will be within the coverage of at least one other drone.t This is limited by the coverage area of the transmitter and receiver fitted in each

drone, so the whole swarm can be fitted with appropriate range of communication system based on the area it has to cover.

- The base station will encode the data, which is intended to be sent to a particular UAV (say UAV #8) that is at the out-of-coverage zone. After encoding it in a packet, it spreads the data around (in a secure channel) and any UAV is allowed to receive the data. But only the destined UAV (UAV #8) will be able to decode the data and process it. Therefore, till the data packet reaches the destination UAV, the other UAVs (nodes) will keep on passing the data packet to adjacent UAVs. Once the UAV #8 receives the data packet and decodes it, the other UAVs are notified about this and those UAVs are prepared to receive the next set of data. This process is constantly executed successively.
- To ensure optimal spreading of the data, the data will be tagged with a unique ID, and when any drone receives the data, it will check if it has already received a data packet with the current ID, if not, then it will transmit the data from its end, and store the ID of the current data packet. This will ensure that the data packet is not creating an infinite recursive transmission.



The drone 8 in the above pic is out of range from the base station, but within reach of drone 4, and can communicate with it. The data is initially sent from base station tagged with a unique ID, and will be received by all other drones that are within it's reach. Each drone will check the ID of the data, and if it is the first time it received a data with that ID, it will re transmit the data once, and store the ID of the data to a local memory. The other drones will either receive the data from the base station or the retransmitted data from drone 1. The drone 5 is not within the reach of base station, hence it can only pick up the signal from drone 1, and will perform the same check using the ID.it will then re transmit the data once which will be picked up and re transmitted by drone 4, and will finally reach the destination drone (i.e. Drone 8).

- We are also working on a plan to transmit/receive multiple data simultaneously on the same channel without interference of different signal waves using a concept called "TIME DIVISION MULTIPLEXING". The data occupies the communication channel on a time-sharing basis.
- **Advantages:** In this way, even if the destination UAV, to which the data must be sent, is very far away or beyond the network coverage of Base station, the transmission will be successful. This process can also happen vice versa, that is from out-of-coverage UAV to base station. The range of transmission can be extended to great lengths. And for finding the shortest path from base station to UAV, we can use many path planning algorithms such as A* or Breadth First Search.

Algorithms Used:

Path planning algorithm for autonomously moving the drone from base station to destination :

When the drone has only one active destination while it is flying, it will use the GPS to move straight to the destination. Over its course, it will rely on various sensors to perform obstacle avoidance and self-correct its course periodically so that it doesn't move out of its path due to external factors such as high winds and mild turbulence.

If the drone has to visit multiple places, its coordinates will be given at the launch, and it will calculate the optimal travel route so that it can visit all the locations in the shortest distance possible. We are planning to use the dijkstra's algorithm to move the drone through multiple predetermined points.

Tech Stack used:

HEXACOPTER FRAME:

We have designed a hexa-copter frame using 3d CAD design software. The frame is specially designed to with stand heavy winds during a storm or hurricane, also it is totally water proof so that it can land on waters to deliver food or medicines to the victims and can be stable at sudden attacks by birds and is extremely light in weight.

FLIGHT CONTROLLER:

The most innovative part of the drone is flight controller. It is technically designed with 32-bit microprocessor which can control the drone in all aspects and at all situations. It is fixed with barometer to analyze real time pressure, magnetometer to follow the directions with the help of earth's magnetic field. The device we use is "PIXHAWK". It controls the auto pilot feature of drone and also it is responsible for the pick and drop of the products such as medicines and food items.

ESC (ELECTRONIC SPEED CONTROLLER):

ESC is responsible for the control of motors and speed variations with dynamic response time. It will respond with the PWM functions (pulse width modulation)

BLDC MOTORS:

BLDC motors are particularly chosen to provide adequate thrust to flight at higher altitude. Each motor will provide 1500 grams of thrust.

FPV (FIRST PERSON VIEW) camera:

This type of camera type is used to see the victims stuck at the flood situations like inside a house, under a tree or for real time video streaming of the flood or disaster attacked people. And to scan the place as 3d- mapping.

Telemetry device:

The telemetry device is used transmit and receive data for very long distance. The frequency used here is 433 MHz and 900 MHz in real time. This technique is used for receiving camera data or for performing image processing and real time sensor data manipulation.

IC –ENGINE:

The IC engine is designed to provide hybrid touch of vehicles. The engine will provide about 35000 rpm. So, the main idea is to combine the engine with generator to provide constant power to the drone. We are thus improving the flight time by about 300%. The average flight time with a battery will be 10 to 15 minutes but while combining with an IC engine it will give about 6 hours of flight time. So, this will be very useful for sending the UAVs into the affected zones as it has a longer flight time.

GENERATOR:

The 12v 50A constant power supply will convert the mechanical energy to electrical energy. The generator is designed with BLDC motors for highest efficiency and performance.