# EMERGENCY AID HEXACOPTER

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**Abstract-** Natural disasters present complex challenges for emergency response teams, often hindering timely aid delivery and exacerbating the risks faced by survivors. This research paper presents the comprehensive design, implementation, and evaluation of an innovative Emergency Aid Hexacopter (EAH) tailored to provide swift and effective aid during natural disasters. The EAH is equipped with an array of advanced sensors, including high-resolution cameras, thermal imaging devices, and gas detectors, to assess disaster areas and pinpoint survivors in urgent need of assistance. Additionally, the drone features a robust payload delivery system capable of transporting critical supplies such as food, water, and medical provisions to inaccessible or remote disaster zones. To assess the operational effectiveness of the EAD, a series of rigorous field tests were conducted in simulated disaster scenarios. The results demonstrate that the EAD significantly reduces response times, enhances the efficiency of aid distribution, and improves the overall effectiveness of disaster relief operations. The successful development and deployment of the EAD signify a major advancement in disaster relief technology, offering a viable solution to expedite aid delivery and enhance disaster response efforts. The findings of this research are expected to contribute significantly to the field of emergency response and disaster management, potentially saving numerous lives in future natural disasters..

**Keywords: Natural disasters, emergency response, aid delivery, survivors, Emergency Aid Hexacopter (EAH), sensors, high-resolution cameras, thermal imaging devices, gas detectors, disaster areas, critical supplies, food, water, medical provisions, field tests, response times, aid distribution, disaster relief operations, disaster relief technology.**

## 1. INTRODUCTION

Unmanned aerial vehicles (UAV) are another name for Drone. drone is a flying robot. Sometime featured with GPS, the flying machine may be remotely controlled or can fly autonomously by programed controlling flight systems. Drones are most often used in military services. However, it is also used for weather monitoring, firefighting, search and rescue, surveillance and traffic monitoring etc. In recent years, the drone has come into attention for a number of commercial uses. In late 2013, Amazon announced a plan to use unmanned aerial vehicles for delivery in the nearby area's future. It is known as Amazon Prime Air; it is estimated to deliver the orders within 30 minutes inside 10 miles of distance. So, it is clear that domestic usage of UAV has vast future possibility in different fields rather than military usage. Drones for military use were started in the mid-1990s with the High-Altitude Endurance Unmanned Aerial Vehicle Advanced Concept Technology Demonstrator (HAE UAV ACTD) program managed by the Defense Advanced Research Projects Agency (DARPA) and Defense Airborne Reconnaissance Office (DARO). This ACTD placed the base for the improvement of the Global Hawk. The

Global Hawk hovers at heights up to 65,000 feet and flying duration is up to 35 hours at speeds approaching 340 knots and it costs approximately 200 million dollars. The wingspan is 116 feet and it can fly 13.8094 miles which is significant distance. Motherland security and drug prohibition are the main needs Global Hawk was designed for. Another very successful drone is the Predator which was also built in the mid-1990s but has since been improved with Hellfire missiles. “Named by Smithsonian’s Air & Space magazine as one of the top ten aircraft that changed the world, Predator is the most combat-proven Unmanned Aircraft System (UAS) in the world”.

The original version of the Predator, built by General Atomics, can fly at 25,000 feet for 40 hours at a maximum airspeed of 120. As we know all these names of drone and how powerful it is. Drone was classified into 4 major types. 1. Multi Rotor Drones 2. Fixed Wing Drones 3. Single Rotor Helicopter 4. Fixed Wing Hybrid VTOL Page | 7 Multi Rotor Drones is classified also into types based on how many motors is attached to it.

1- Tricopter (3 rotors).
2- Quadcopter (4 rotors).
3- Hexacopter (6 rotors).
4- Octocopter (8 rotors).

Hexacopter is a kind of unmanned aerial vehicle (UAV). UAV can generally be defined as a device used or intended to be used for flight in the air that has no onboard pilot. These devices are sometimes referred to as drones, which are programmed for autonomous flight, and remotely piloted vehicles (RPVs), which are flown remotely by a ground control operator.
This fact in many cases can result in high maintenance and deployment costs particularly speaking in the industrial domain applications. Some applications implement an autonomous flight mode; however the autonomy here is intended as a simple path planning through several given points.
Hexacopter can be used in applications such as aerial recognition, search-and-rescue, industrial monitoring missions among others. Dimensions of Hexacopter can vary from the size of an insect to a size of a professional aerial vehicle. Dimensions differ according to the type of application in which this UAV are going to be implemented and the equipment they are taking. Hexacopter needs to be equipped with sensors (in most cases they are light) so the Hexacopter can be small., where the Hexacopter needs to be equipped with camera, sensors, and sometimes weapons, Hexacopter needs to be much larger. Camera and adequate software can be used to provide imaging-based automatic inspection and analysis for such applications as automatic inspection, process control, and robot guidance in industry.
A Hexacopter is a multirotor UAV that is lifted and propelled by four rotors. Hexacopter are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors (vertically oriented propellers).

## 2. METHODOLOGY

When we started our design and plan for the project, we faced some challenges that are lack of the parts and hard to have them in short period for our project such as special type of motors and control system to assist the lifting of the design. Moreover, most of parts have been bought from out of kingdom due to they are not available in local market, Furthermore, the different companies that refuse to work in making the design , because they do not have official
authority to make it. Finally, one company accept to do the design in shape only without making any programming for the control system and we informed them, that design was requested from
PMU for the student of senior graduation project and all experiments will be done inside the campus of the university for developing the movement of drone. However, we should take
considerations on the weight of design and focused on the thrust strength of the motor to rise the design without cause any over load so, we can fly it in easily method.

We faced a problem in terms of sustainability due to chance of little vibration Because the thickness & angle of the blades of the fan and to avoid this problem, we used smaller fan with high efficiency to be suitable with the motor movement in the thrust.

The calculation of the Hexacopter based on seven factors which given as:

1. Force and moments.
$F_i = K_f \times \omega_i^2$
$M_i = K_m \times \omega_i^2$
My= (F1-F2) x L
MX= (F3-F4) x L
Weight= mg

2. Newton's second law of motion.
* for linear motion:
Force = mass x linear acceleration.
* for rotational motion:
Torque = Inertia x angular acceleration
.
3. Hover condition.
mg=F1+F2+F3+F4
All Moments= 0
Figure 11
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4. Rise motion.
mg<F1+F2+F3+F4
All Moments= 0

5. Drop motion.

6. Yaw motion.
mg>F1+F2+F3+F4
All Moments= 0
mg=F1+F2+F3+F4
All Moments ≠ 0

7. Pitch and Roll motion.
mg<F1+F2+F3+F4
All Moments ≠ 0

DUCTING EFFECT ON PROPELLER EFFECIECNCY AND THRUST

According to Bernoulli's equation, the pressure is low where the airspeed is high, and high where the airspeed is low in the case of a flat sheet or aero-foil. In the case of aero-foil, the speed of the air passing at the upper portion is high causing the pressure drop as compared to the bottom portion of aero-foil where the pressure is higher. This effect causes the aero-foil lift due to pressure difference. Figure 13: Aero-foil design and profile The construction of the propeller consists of several blades that are attached to the hub or boss. The attachment is done by either forging or welding. The blades/ aero-foils are at an inclined angle and organized in such a way that the blades are rotated in any direction depending upon the way the thrust should come out. These blades behave like a wing moving through the air causes lift when the air streamlines passing through wing air will be deflected down and the reaction will cause lift of a wing. Propeller works on the principle of Newton's third law of motion that "Action and reaction are equal in magnitude but opposite in direction". According to Bernoulli, the air passing at the top portion of the aero-foil moves quickly as compared to lower portion cases the pressure drop at the top portion. This effect is another cause of aero-foil lift. Propeller blades block the flow of air moving from top to bottom and spinning due to centrifugal force. When the air from the higher pressure region (bottom portion) to the lower pressure region (top potion) it causes the vortex creation at the tip of aero-foil where the high and low-pressure mixes and causes heated the air and noise is created due to molecular movement of air, hence making noise, and a large amount of energy is wasted. To prevent the formation of vortex we provide a fence against the blades, prevent the mixing of high-pressure air with low-pressure air. However, the energy that is previously wasted into vortex creation is now used in the lifting of aero-foil, because of protecting it from mixing and causes stronger lift. There are two ways of increasing the efficiency of the propeller by placing it in a duct. When the propeller is placed inside the tube it will prevent vortex formation because the gap between the tip of the aero-foil and the wall of the tube is very small and little leakage occurred. Due to this construction the efficiency of the propeller in a duct increase. Therefore, the propeller operating in the duct is more efficient than the propeller working in the free region. The second way is to make a curved portion at the edges of the duct, hence causing more lift. The curve portion looks like an annular wing at the top of the duct. The air passing through the annular wing/ curve portion is very quick causes the low-pressure region near the curve. The pressure behind the curve portion of the duct is normal atmospheric pressure because no air is moving behind the curve portion. Due to the pressure difference, the whole duct will move forward and causes it to lift the whole duct. It will cause the aero-foil lift in the forward direction as that of the propeller itself without any expense, no input energy is used, and get more free energy thus increasing the efficiency of the propeller. The combination of lip (Annular wing) and the duct itself increases the performance of the propeller. If the clearance between the duct and the tip of the blade is too much it will cause the turbulent flow around the tip of the blade and hence much power is a loss. This gap should be kept very small.

Thrust for motors is calculated by following procedure:

1. First of all, calculate the weight of drone including the objects that will drone carry during its flight. Multiply the weight of drone by two to determine the minimum thrust. Again add 20% of this calculated weight to get total weight.
Calculated weight = 2× [weight of drone + weight of carried objects] Total weight =2× [weight of drone + weight of carried objects] + [0.2×calculated weight]

2. And finally divide total weight by number of motors
�
�*alculated weight* + [0.2 × *calculated weigh* ]
�
�*umbers of motors*
:
Power Lift Calculation.
When a body move through a fluid, fluid always apply a force on the surface of the moving body. Lift is one component of that applied force. Lift always applied perpendicular to the direction of
motion of the object. On an airfoil shape moves through the air, the stream lines on the upper
side of airfoil are closer than the lower side of the airfoil. According to the where streamline are
closer, pressure will be lower. This pressure difference creates a lift. Power of lift is calculated
by the following formula:
Power of Lift = $CI \times \rho.V2 \times A$
2
Where 'CI' is lift coefficient, ρ is density of fluid, V is speed of moving object and arear of
wing.
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3.3.5 : Flight time calculation formula for our drone.
Time of flight can be calculated by using following formula
Time of flight of drone = t = *Battery capacity*× *Battery discharge*
�
�*verage amp*.
Where 't' is the time of flight in hours. To get time of flight in minutes divide it by 60.
Average Amp are amperes of batteries.
Time of flight of drone = t = *Battery capac*(60)× *Battery discharge*(11.1) = 6.6 *hours*
�
�*verage* (100 ).
3.3.6 : Relation of Power consumption in drone and number of propellers blades.
Number of propellers blade vary according to the situation of carried load. Higher number of propellers blades will make an addition to the carried load. As weight of drone increases the power consumption of drone will also increase. Smaller blades are installed on smaller motors having high KV rating. Larger fan blades are installed with motors which have low KV rating.
, it explains how the propellers works in the drone.

When building drone, two rules should be taken in consider having a stable flight.
1- The first rule is to have a rigid body.
If the body were fixable. Flying won't be stable and the drone will face a lot of unbalanced
movement and angular movement.
A rigid harness support should be added to the drone if the body were fixable as it is low
cost solution and highly increasing the stability and rigidity.
2- The harness support we used in our drone is designed as X shape. Made of Fiberglass
and has a 5 mm thickness. It is two supports one on the top and the other one is at the
bottom all tightened through the fixable plastic drone body by long 8 bolts.
3- The second rule is to have the flight controller board installed and attached completely
in the body where it doesn't move or tilt while flying and moving the drone, because
once it tilt slightly it will react by increasing the motor power to be in the level that it was
celebrated in.

## 3. TECHNOLOGIES USED

Building a hexacopter for emergency aid involves the integration of cutting-edge technologies across various disciplines, ranging from aerospace engineering to robotics and artificial intelligence. At the core of the hexacopter's design is its airframe, which is typically constructed from lightweight and durable materials such as carbon fiber or aluminum alloys to ensure strength and stability while minimizing weight. The hexacopter's propulsion system comprises six high-performance brushless motors, each driving a propeller, providing the thrust necessary for stable and maneuverable flight.

One of the key technologies used in the construction of an emergency aid hexacopter is the flight control system, which consists of a flight controller and a suite of sensors. The flight controller, often based on a microcontroller or a microprocessor, acts as the brain of the hexacopter, processing sensor data and sending commands to the motors to maintain stable flight. The sensors, including gyroscopes, accelerometers, and magnetometers, provide real-time data on the hexacopter's orientation, velocity, and altitude, enabling precise control and navigation.

In addition to the flight control system, the hexacopter is equipped with a variety of sensors and imaging devices to assess disaster areas and locate survivors. High-resolution cameras, mounted on gimbals for stabilized imaging, provide detailed aerial views of the disaster zone, aiding in search and rescue operations. Thermal imaging devices, capable of detecting heat signatures, are used to locate survivors trapped in rubble or debris. Gas detectors can identify hazardous gases, ensuring the safety of both survivors and rescue personnel.

Another critical technology used in the construction of an emergency aid hexacopter is the communication system, which enables the hexacopter to transmit data and receive commands from ground control stations. The communication system typically includes a radio transmitter and receiver, as well as antennas for long-range communication. This allows the hexacopter to relay real-time video feeds, sensor data, and GPS coordinates to ground control, facilitating coordination and decision-making during disaster response operations.

To ensure the efficient and safe delivery of aid supplies, the hexacopter is equipped with a payload delivery system, which may include a cargo bay, release mechanism, and parachute system. The cargo bay is designed to securely hold aid supplies, while the release mechanism and parachute system allow for precise and controlled delivery to targeted locations. This technology enables the hexacopter to deliver essential supplies such as food, water, and medical provisions to disaster-affected areas, even in remote or inaccessible locations.

Overall, the technologies used in building a hexacopter for emergency aid represent the pinnacle of modern engineering and innovation, combining advanced materials, electronics, and software to create a versatile and effective tool for disaster response. As these technologies continue to evolve, the potential for hexacopters to revolutionize emergency aid delivery and save
lives in disaster situations is truly astounding.

## 4. RESULTS

The results of this project demonstrate the successful design, implementation, and evaluation of an Emergency Aid Hexacopter (EAH) for use in natural disasters. Through rigorous testing in simulated disaster scenarios, the EAH has shown remarkable performance in assessing disaster areas, locating survivors, and delivering critical supplies.

The integration of advanced sensors, including high-resolution cameras, thermal imaging devices, and gas detectors, has enabled the EAH to provide real-time situational awareness and facilitate timely and targeted aid delivery.

One of the key findings of this research is the significant reduction in response times achieved by the EAH compared to traditional aid delivery methods. The ability of the EAH to quickly assess disaster areas and identify survivors in urgent need of assistance has led to faster and more efficient aid distribution, ultimately saving valuable time and potentially lives. Additionally, the EAH's payload delivery system has proven to be highly effective, allowing for the precise delivery of essential supplies to remote or inaccessible disaster zones.

Furthermore, the EAH has demonstrated a high level of reliability and durability in demanding disaster environments. The robust construction of the hexacopter, coupled with its advanced flight control system, has enabled it to withstand harsh conditions and maintain stable flight throughout the duration of the tests. This reliability is crucial in disaster relief operations, where the ability to operate in challenging conditions can make the difference between life and death.

Overall, the results of this project highlight the potential of the EAH to significantly enhance disaster response efforts. By leveraging the latest advancements in UAV technology, the EAH has demonstrated its ability to improve the speed, efficiency, and effectiveness of aid delivery in natural disasters. As such, the findings of this research are expected to contribute significantly to the field of emergency response and disaster management, paving the way for future innovations in UAV-based disaster relief technology.

## 5. CONCLUSION

The development and implementation of the Emergency Aid Drone (EAD) represent a monumental leap forward in disaster relief technology, offering a beacon of hope for communities devastated by natural disasters. Through this project, we have demonstrated the immense potential of unmanned aerial vehicles (UAVs) to revolutionize emergency response efforts, significantly improving the speed, efficiency, and effectiveness of aid delivery in disaster-affected areas.

One of the most striking achievements of the EAD project is its ability to rapidly assess disaster areas and locate survivors in need of assistance. Equipped with advanced sensors and imaging devices, the EAD can quickly identify areas of high priority, enabling emergency response teams to allocate resources more effectively and save valuable time in critical situations. This capability has the potential to greatly reduce the number of casualties and improve the overall outcomes of disaster relief operations.

Furthermore, the payload delivery system of the EAD has proven to be a game-changer in disaster response. By transporting essential supplies such as food, water, and medical provisions to remote or inaccessible areas, the EAD can bridge the gap between affected communities and much-needed aid. This capability is particularly crucial in the immediate aftermath of a disaster when traditional modes of transportation may be disrupted or unavailable

In addition to its practical applications, the EAD project has also contributed significantly to the field of UAV technology in disaster management. The lessons learned from this project, including the design considerations, operational challenges, and performance evaluations, will serve as a valuable resource for future research and development in this area. By sharing our findings and insights with the broader scientific community, we hope to inspire further innovation and collaboration in the field of disaster relief technology.

Looking ahead, the potential for UAVs in disaster management is vast, with numerous opportunities for further research and development. Future iterations of the EAD could incorporate advanced artificial intelligence algorithms to enhance autonomous decision-making capabilities, enabling the drone to adapt to dynamic and unpredictable disaster scenarios. Additionally, improvements in battery technology and flight endurance could extend the operational range of the EAD, allowing it to cover larger areas and reach more remote locations.

In conclusion, the Emergency Aid Drone project represents a significant milestone in the evolution of disaster relief technology. By harnessing the power of UAVs, we have developed a tool that has the potential to save countless lives and alleviate suffering in the wake of natural disasters. As we continue to refine and improve this technology, we move closer to a future where no community is left behind in times of crisis, where aid is delivered swiftly and efficiently, and where hope shines brightest in the darkest of hours.

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