Organ Transportation Using UAV

Bhushan S. Kumbhar[1], Shubham R. Kulkarni[2], Saurabh S. Kadam[3], Rushikesh S. Kokane[4], Chintamani R. Upadhye[5]
[1, 4, 5] Dept of Mechanical Engineering
[2, 3] Dept of Instrumentation Engineering
[1, 4, 5] Sharad Institute of Technology College of Engineering, Yadrav, Maharashtra, India
[2, 3] Padm. Vasantraodada Patil Institute of Technology, Sangli (Budhgaon), Maharashtra, India

Abstract- *A research is conducted on the factors that need to be taken into account when transporting and preserving human organs. An unmanned aerial vehicle (UAV) designed specifically for carrying human organs that can do so quickly and without endangering the organs. This drone has the longest range due to its highly capacitive batteries and battery sweeping technology. In this paper, specific considerations and safety measures related to the storage and transportation of delicate human organs are discussed. Additionally, an organ safety gimbal mechanism, as shown in the designs below, is enabled. As you can see, the gimbal mechanism gives the organ storage box—which will mount beneath the drone—extreme stability.*

A gimbal is a pivoting support that enables rotation of an object around an axis. One way to enable an object mounted on the innermost gimbal to remain independent of the rotation of its support is to use a system of three gimbals, one stacked on top of the other with orthogonal pivot axes (e.g. vertical in the first animation). Gimbals, for instance, are used on ships to maintain the upright position of gyroscopes, shipboard compasses, stoves, and even drink holders in relation to the horizon despite rolling and pitching

Keywords- Organ Transportation, UAV, Drone, Organ Preservation

I. INTRODUCTION

Multirotor unmanned aerial vehicles are a popular and developing research device for autonomous robotics. Unmanned aerial vehicles, or drones, are self-contained machines with propellers that can be rotated in various directions to control their movements. This vehicle's versatility and maneuverability are well known [1]. A drone can have smart devices like a camera, GPS tracker, LIDAR scanner, distance sensor, and many other as-yet-unknown devices because it is a robot. A drone can fly stationary and have a clear view of the area it is over at a maximum altitude of 8000 meters. Unmanned aerial systems are aircraft that can fly without a pilot or other occupants, also referred to as drones or UAVs. Remote radio wave control of drones is feasible, as well as automatic control. Drones' quick registration and monitoring of a defined area or object without the aid of additional infrastructure is one of their most important features. The initial nations to start conducting UAV research were the United States, United Kingdom, Russia, Germany, and Israel. The Austrians used an unmanned aerial device for the first time in August 1809. In cases like cardiac arrest, where a defibrillator was delivered to aid in treatment, drones were used in the medical field to deliver essential medical supplies.

The discussion above demonstrates the significance of drone technology. A wide variety of technologies enable real-time drone applications. If drones had higher weight capacities, more advanced and dependable technologies, longer flight times, and better maneuverability, they might be much more useful than they are at the moment. Businesses will unavoidably gain from the integration of different drone technologies and the wide variety of sizes and capacities of such drones. Other industries, such as agriculture, waste management and sanitation, traffic surveillance, etc., have a lot of potential for using drones [2]. Therefore, both the public and private sectors should create the necessary infrastructure and policies for real-time drone applications.

1. Drone Technology

Drone technology uses both GPS and the onboard sensors. Numerous drones in use today have cutting-edge features that boost their toughness and intelligence and increase the scope of their applications. Below, the various components of aerial drones are examined:

a) Radar positioning and return home

Multiple Worldwide Navigation Satellite Technologies (GNSS), which include GPS and GLONASS, are included into contemporary drones. This drones have both GNSS and non-satellite flight capabilities. The present position of the drone in respect to the controller is shown through radar positioning, which also aids in precise drone navigation. The drone is directed towards the controller by the Return to Home functionality.

b) Obstacle detection and Collision avoidance technology

The drone is directed toward the controller by the Return to Home functionality. With the help of SLAM technology and software algorithms, such monitors comprehensively scan the area around them to create a 3D map.

c) Gyroscope stabilization

The gyroscope stabilization technology built into drones allows for seamless flight. The fundamental joystick also receives critical navigational information from the gyroscope.

d) Inertial Measurement Unit (IMU)

A gyroscope or many altimeters are used by the IMU to measure the current acceleration rate. It accomplishes this by using the gyroscope to detect variations in a number of rotational characteristics.

e) Motors and propellers

The drone may move through into air, float, or fly in every orientation thanks to these technology. Depending on the information obtained from the flight controller and electrical speed regulators, they allowed the drone to hover or fly.

2. Materials and Equipment

1) Arduino UNO
2) USB A to B cable
3) Optional (to run Arduino on battery power instead of USB cable):
    a. 9V battery b. 9V battery snap to barrel jack plug
4) PING ultrasonic distance sensor
5) Male to male jumper wires
6) Male to female jumper wires
7) Push button
8) 10 kΩ resistor
9) Piece of paper or cardstock

3. Connect the Arduino

The information on the breadboard should be erect and facing you. Then, as depicted in Figure 1, join all of the following (click for a bigger version of the diagram). You can substitute a circuit diagram in its place if you know how to interpret one.

Circuit board positively bus to 5V pin of Arduino.

- Arduino ide grounded connection to Arduino GND pin.
- From the left positive bus to the right positive bus on the arduino.
- According to left main board to the right base board, in breadboard.
- Arduino ide neutral connection to PING detector GND pin (use male-female jumper wires to connect to the PING sensor pins).
- Arduino positive usb to 5V pin of the PING sensors.
- Ping Microcontroller logical pin 7 to the SIG pin of the sensor.
- Transistor with the big metal button pointing left, in holes F8, F9, and F10.
- Device in holes F8, F9, and F10 with the large metal button facing left.
- Hole G10 to Arduino digital pin 10.
- Uno logical pin 10 to hole G10.
- Resistors in F16, F17, and F18 holes.
- J16 hole to optimistic route.
- Arduino microcontroller input A0 through hole J17.
- J18 hole to basement transit.
- Push button includes pins in holes E23, E25, F23, and F25 that spans the breadboard's center space.
- Hole A23 to Output Pin 3 of Microcontroller.
- Through hole J23 to the main channel, a 10 k resistor.
- Base transport to hole J25.
- The drone's positive wire to J1. Wires from the drone can't be pushed into the breadboard by itself since they are too flexible. Make the connection by crimping or twisting them onto a little length of jumper wire.
- Negative wire for the drone to J9.
- Negative (black) wire of 4 AA battery pack connected to ground circuit.
- Red (positive) cable from 4xAA battery pack to F1.

The positive wire from the battery pack should not be connected to the positive bus on the breadboard! By doing this, a short circuit will be formed between the Arduino's 5 V and the battery pack's 6 V electricity.

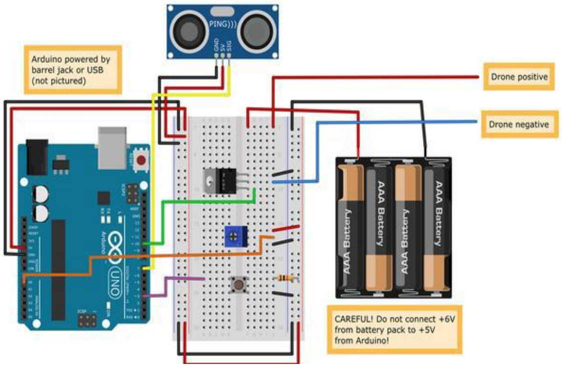

Fig 1. Breadboard diagram for Arduino drone control circuit.

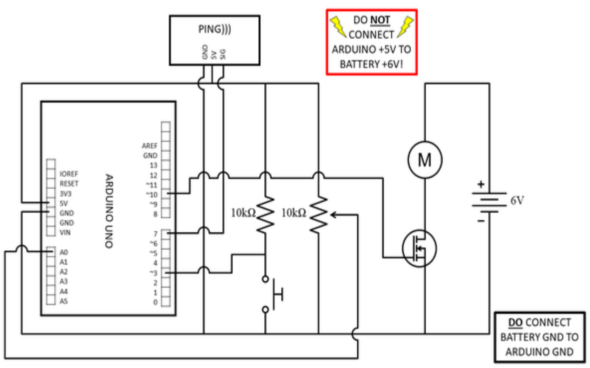

Fig 2. Circuit schematic for Arduino drone control circuit

II. COLD STORAGE TECHNIQUE

The Best Technique compatible to the idea of Arial transportation of Organ Preservation and Transportation is Cold Storage Preservation technique. HTK solution is designed to perfuse and flush donor liver, kidney, heart, lung, and pancreas prior to removal from the donor, as well as to preserve these organs during hypothermic storage and transport to the recipient. The HTK solution works on the principle of inhibiting organ function. A Solution called as Collins Solution is used most often for cold storage preservation technique for kidney.

1. Current OCS (Organ Care System)

Fig 3. Human Organ Transportation Unit

HOT Unit Specifications:

- Approx. Size: 700*470*445
- Capacity: 15 lit.
- Temperature Sensor used: Thermocouple E-type – Ni-Cr/Constantan
- Temperature Range: -40 to 900oC
- Sensitivity: 68µV/oC

Specially designed for transportation of blood and organs Possibility to be powered by D.C. current from ambulances and cars Compact, elegant and practical. High quality of insulation for reduced power consumption Integrated lock provides good product safety Adaptor for 230V AC supply. Organ damage is prevented by creating a homeostatic cellular environment until it is transplanted into the receiver's body.

The main aim of this is to prevent the damage to the cells of the organ which are to be the core element of any organ.

Currently this is done by following techniques:

- Providing adequate hydration.
- Slowing down the metabolic process of the cells through hypothermia.
- Minimize ischemia and reperfusion injury to stabilizing cell permeability.
- Reducing catabolism and anabolism.

Some Organs with Preservation Considerations

1. Kidney

Viable up to - 24 to 36 hours.
The ideal temperature range for preservation is between 2 and 6°C.
Average Weight – 0.3kg (For an Adult)
Methods most commonly used: -
Static Cold Storage (SCS)

2. Heart

Viable up to - <6 hrs.
The ideal temperature range for preservation is greater than 4°C, ideally between 5-10°C.
Average Weight – 0.3kg (For an Adult)

Cardiac arrest followed by static cold storage in a crystalloid heart preservation solution (HPS). Histidine–

tryptophan–ketoglutarate (HTK) solution, University of Wisconsin (UW) solution and Celsior solution are most commonly used for heart preservation.

Sorbothane: For reduction of external vibrations, a special material called as Sorbothane (synthetic viscoelastic urethane polymer) can be used as a shock absorber and vibration damper.

Sorbothane is a visco-elastic material, meaning that it exhibits properties of both liquids (viscous solutions) and solids (elastic materials), with a relaxation time of two seconds. Because visco-elastic behavior is desirable in shock and vibration applications, many materials claim to be viscoelastic; however, many of these materials have only trace viscoelastic properties.

The Below Graph shows the data about the Shock Absorption Ratio of Sorbothane in comparison to other materials.

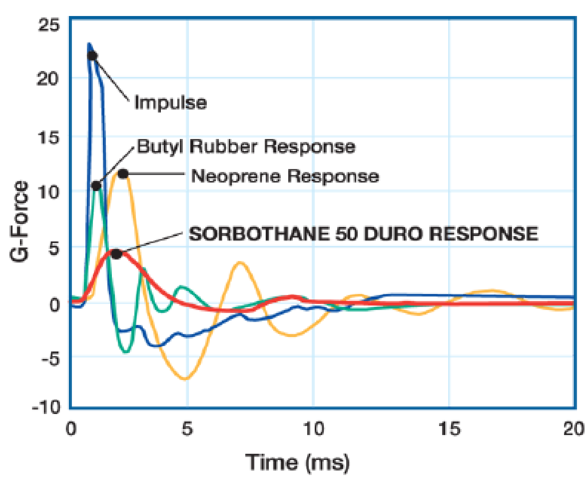

Fig 4. Time Delay for Impulse (Shock) Response of Selected Material

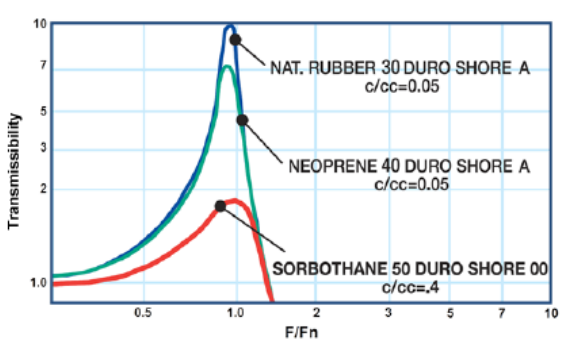

Fig 5. Ratio of Excitation Frequency to Natural Frequency

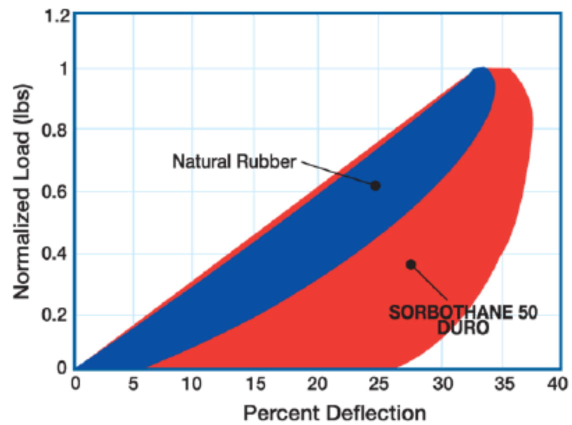

Fig 6. Hysteresis (Mechanical Energy Converted to Heat Each Cycle)

- Sorbothane Performance Curves Sorbothane turns mechanical energy into heat.
- As the material is deformed, molecular friction generates heat.
- A gradual deceleration affords better protection of delicate equipment.
- Impact Absorption This graph shows the high hysteresis necessary for efficient impact absorption.
- By comparing the area under the curves, its clear Sorbothane removes more of the impact energy from the system.
- Sorbothane can decelerate parts and reduce peak forces during sudden stops in minimal sway space.

III. ORGAN PRESERVATION TECHNOLOGY

The removal, storage, and transplantation of a solid organ from a donor profoundly alters the homeostasis of the interior milieu of the organ. Organ Preservation techniques has been proven to be a revolutionary development in the field of Physiology (Study related to Human Body). An organ even with partial functionality can be used from a deceased body. There are several reasons for the need of organ preservation arises. Manier times it is due to two bodily working conditions such as Ischemia and Reperfusion Injury. There have been various ways developed in this era of scientific development. The ways differ from functionality of the organ to the environment suitable for it. Various kinds of devices have been built to preserve organs which even consist of building a machine to keep the organ alive as in the body. The main aim of this is to prevent the damage to the cells of the organ which are to be the core element of any organ. Currently this is done by following techniques: Providing adequate hydration. Slowing down the metabolic process of the cells through hypothermia Minimize ischemia and reperfusion injury to stabilizing cell permeability. Reducing catabolism and anabolism.

- **Ischemia**: A condition where there is a restriction of blood or oxygen in any part of the body.
- **Reperfusion Injury**: Reperfusion injury, sometimes called ischemia-reperfusion injury (IRI) or re-oxygenation injury, is the tissue damage caused when blood supply returns to tissue (re- + perfusion) after a period of ischemia or lack of oxygen (anoxia or hypoxia)

Techniques of Preservation

1. HTK

HTK solution is intended for perfusion and flushing of donor liver, kidney, heart, lung and pancreas prior to removal from the donor and for preserving these organs during hypothermic storage and transport to the recipient. HTK solution is based on the principle of inactivating organ function.

2. Hypothermic Machine Perfusion (HMP)

It is used as an alternative for the cold storage preservation. A dynamic cold preservation method at 4°C which ensures homogeneous and continuous supply of metabolic substrates to the graft during the ex vivo period.

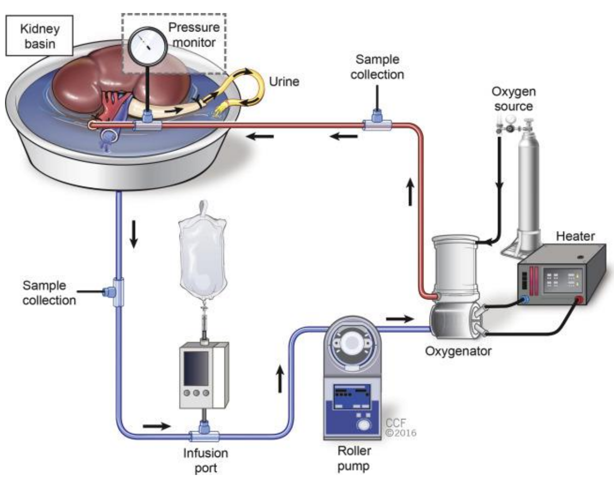

Fig 7. Hypothermic Machine Perfusion System [3]

3. Normothermic Machine Perfusion (NMP)

A method of organ preservation, provides oxygen and nutrition during preservation and allows aerobic metabolism.

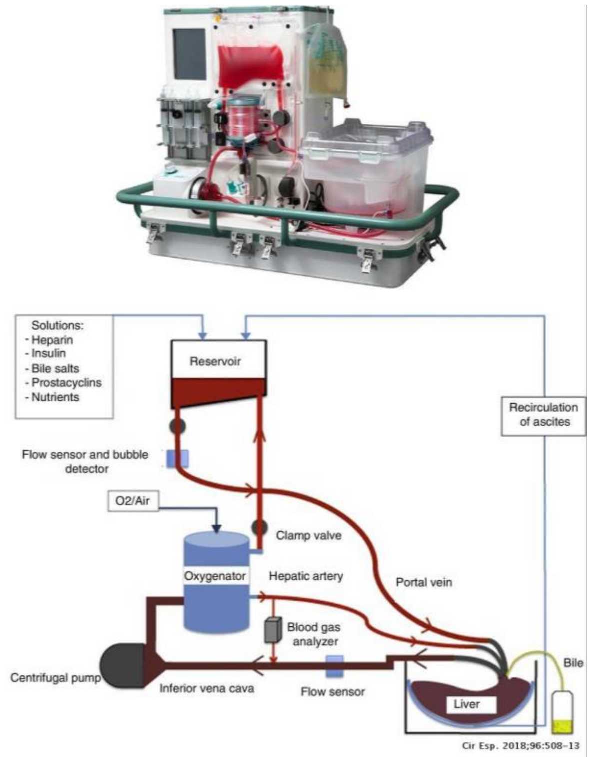

Fig 8. Normothermic Machine Perfusion System [4]

4. Oxygen Persufflation (OP)

This technique achieves good oxygenation of the whole kidney without perfusion or elevated gas pressures by using a part of the vascular system for gaseous oxygen: the veins. Thus it does not contact arteries or capillaries but reaches the whole organ by diffusion from the venous system.

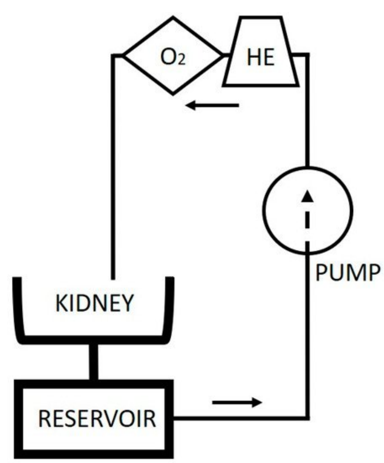

Fig 9. Oxygen Persuffliation System [5]

IV. ORGAN TRANSPORTATION DRONE

In the 60 years since organ transplantation commenced, significant progress has been made in the field of organ transportation. An interconnected system of couriers and commercial aircraft makes up the current organ transfer infrastructure. As a result, the timing of organ transplants is frequently dependent upon the airlines (especially for kidney, pancreas, and occasionally liver transplants). This dependence can be very limited, and in many circumstances the accumulated delay due to this intricate network completely excludes transplantation. Because of a novel drone-based strategy that does not rely on shoddy-timed commercial flights or prohibitively expensive charters, organs might be donated more quickly and more people could benefit from transplants.

1. Estimated Data for Drone

Estimated Weight of Organ Transportation Drone	
Drone Weight	8000 gm. Approx.
Preservation Box (Without organ)	10000 gm. Approx.
Organ Weight	Average 1500 gm.
Total Weight	**Around 19500 gm.**

In most cases, we should plan for a 2:1 thrust to weight ratio, to allow your drone to hover at just half throttle. The higher the thrust to weight ratio, the easier it is to control your drone in elaborate aerobatics.

Required Thrust	
Power-to-weight ratio	2:1
Number of motors Required	6
Total thrust	39,000 gm.
Thrust per motor	6500 gm.

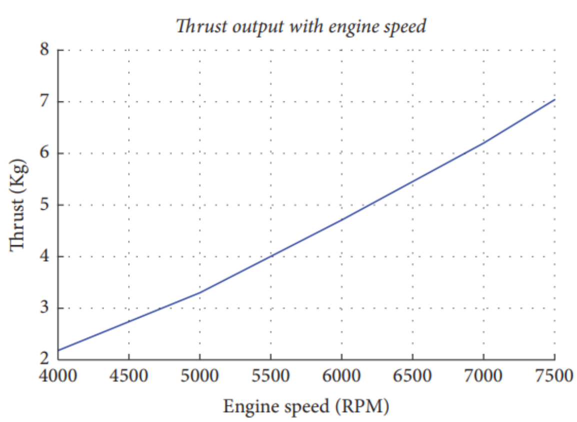

Fig 10. Data showing trust to engine speed in rpm ratio

2. Gyroscopic System

Device for measuring or maintaining orientation and direction For other uses and non-rotary gyroscopes, see Gyroscope (disambiguation) A gyroscope A gyroscope in operation.

When rotating, the orientation of this axis is unaffected by tilting or rotation of the mounting, according to the conservation of angular momentum. In the case of a gyroscope with two gimbals, the outer gimbal, which is the gyroscope frame, is mounted so as to pivot about an axis in its own plane determined by the support.

The chandler toy is still produced by TEDCO today. In the first several decades of the 20th century, other inventors attempted (unsuccessfully) to use gyroscopes as the basis for early black box navigational systems by creating a stable platform from which accurate acceleration measurements could be performed (in order to bypass the need for star sightings to calculate position).

Gyroscopic effect is obtained from the inertial property of the flexural standing waves. VSG or CVG A vibrating structure gyroscope (VSG), also called a Coriolis vibratory gyroscope (CVG), uses a resonator made of different metallic alloys. Its motion is influenced by the principle of gyroscopic precession which is the concept that a force applied to a spinning object will have a maximum reaction approximately 90 degrees later.

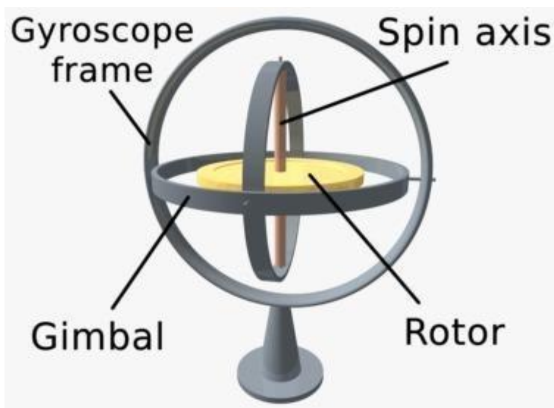

Fig 11. Gyroscope

3. Gimbal

Pivoted support system Illustration of a simple three-axis gimbal set; the center ring can be vertically fixed A gimbal is a pivoted support that permits rotation of an object about an axis. Official rocket documentation reflects this usage. Similar sensing platforms are used on aircraft. In inertial navigation systems, gimbal lock may occur when vehicle rotation causes two of the three gimbal rings to align with their pivot axes in a single plane.

In portable photography equipment, single-axis gimbal heads are used in order to allow a balanced movement for camera and lenses. This proves useful in wildlife photography as well as in any other case where very long and heavy telephoto lenses are adopted: a gimbal head rotates a lens around its center of gravity, thus allowing for easy and smooth manipulation while tracking moving subjects. The word lock is misleading: no gimbal is restrained.

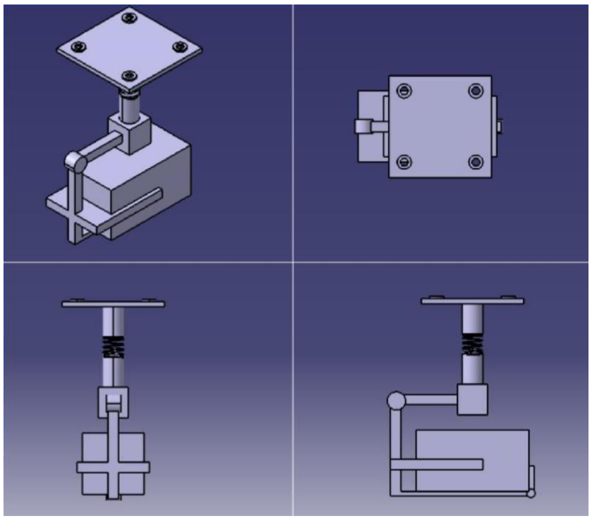

Fig 12. Gyroscope design for organ transportation box

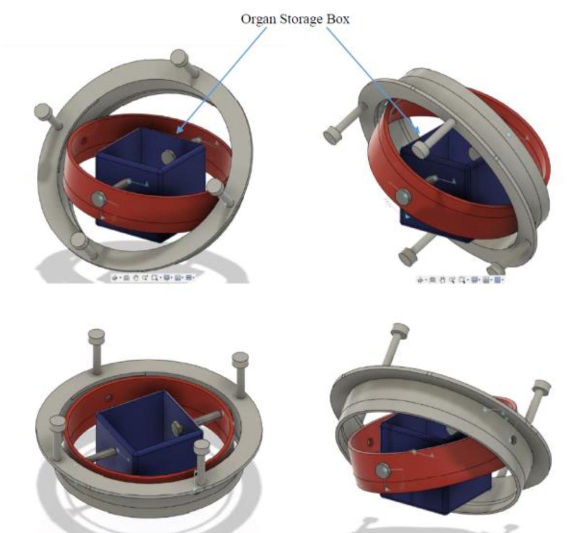

Fig 13. Gimbal design for organ transportation box

V. CONCLUSION

In accordance with the research, it is determined that it is feasible to create a real drone for transporting organs by combining medical technology to preserve organs for as long as possible with engineering technology to create a drone that can lift and move the organ without endangering it. The organ can be kept for a very long time, but the issue is that the drone's range is constrained by the battery's capacity. Using a technology known as battery sweeping, the range can be increased by switching from an empty battery to a new battery, is one way to increase the range. This drone technology would be the answer because it can transport the organ much more quickly than the current transportation modes, which is crucial for saving a human life when organs are being transported.

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