Ornithopter

College Name

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ABSTRACT

- The main objective of our team is to design a remotely controlled ornithopter.
- Ornithopter is nothing but an aircraft, a machine which is designed in such a way that it achieves flight by flapping wings just like a bird does.
- **Leonardo da Vinci** made the first real studies of flight in the 1480s. He had over 200 drawings and sketches that illustrated his theories on flight. His ornithopter flying machine was an aircraft that would fly by flapping its wings, a design he created to show how humans could fly.
- Now there are three different major types of ornithopter as follows: -

1. Free Flight Ornithopters - These ornithopters are the simplest and least expensive to build.
2. Remotely Controlled Ornithopters - Many ornithopters are powered by electric motor, battery and controlled remotely by radio control.
3. Manned Ornithopters: A few manned ornithopters have made successful flights.

- Our team will design in the category of unmanned remotely controlled ornithopter, which aims to have a net zero carbon emission supply chain making it a sustainable ornithopter delivering its purpose based on the problem statement.

PROBLEM STATEMENT/ CHALLENGES

Military Surveillance

- Tracking Person of Interests wherever possible.

- Person of Interests are defined as people who are on watchlist of either military or intelligence agencies or both.
- The western, northern and eastern fronts of our country are host to lot of terrorist and illegal activities, hence it becomes necessary to track the trouble causers.
- The present drones present in fleet of Indian military are too big and fly high such that they are primarily used to surveil on enemy's military camps and the spying on their weapons, however it is quite difficult to surveil near the ground.
- Quadcopters and other swarm drones that have come up in the recent past are easily identifiable and thus can be eliminated at first sight.
- Therefore, need for an unmanned aeriel vehicle arises which can hide in plain sight, provide real-time ground coverage and surveil on our enemies and person of interests.

SOLUTION

Ornithopter for surveillance?

- For effectively using our copter, we define the areas of surveillance: -

1. Tracking Unknown Identities near and across Border Areas.
2. Identifying Terrorist Basecamps.
3. Surveillance on illegal activities such as human and cattle trafficking.
4. Identifying and surveilling enemy spies.
5. Surveilling protests.
6. Tracking thefts in civil areas.
7. Tracking wildlife to contribute to scientific society.

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SOLUTION

- Ornithopter for Tracking Unknown Identities near and across Border Areas?

Our team came up with a solution of making an ornithopter for surveillance purpose.

The Process: -

1) Several copters would fly in shifts to keep a 24/7 surveillance across borders.
2) Any unusual behaviour will be detected at first sight.
3) Since live video feed would be provided in real-time to the ground-station, action against the perpetrators can be taken immediately by the forces.
4) Wherever possible, we will replace our copters with on-site stationary cameras to increase the coverage of surveillance.
5) These on-site cameras can provide a warning to which our copter can fly to and validate whether it is a thing to act or not.

The Targets: -

1) Our target is to achieve minimum endurance time of 1 hour while covering a minimum straight line distance of 25km covering an aerial area of 1962.5 km^2.

CONCLUSION

- Concluding, our team will be focusing on several aspects of development of ornithopter in the following order: -

1. Design of the copter such that it supports and replicates the flight of our chosen specie of bird to a minimum extent.
2. Identifying and experimenting with different combinations of electronics and fabrication materials to achieve maximum efficiency.
3. Developing & enhancing computer vision algorithms.
4. Focus on creating a net zero carbon emission supply chain to achieve maximum sustainability and achieving both targets of preserving environment and efficient military and environmental surveillance.

WORKING PRINCIPLE

- Nature is a great source of inspiration for each on us – "Birds" have inspired us to make magnificent flying machines.
- Our team, too got inspired by birds, however we wanted to make a bio-robot, specifically an UAV which looked like a bird.
- Just as a basic UAV, here too we are dealing with basic electronics such as radio controller, motor, etc.
- The basic framework of our working model is based on the design and dynamics of a bird, hence we did it into three major sections: -

1. Fuselage
2. Flapping Wings
3. Tail

WORKING MODELS

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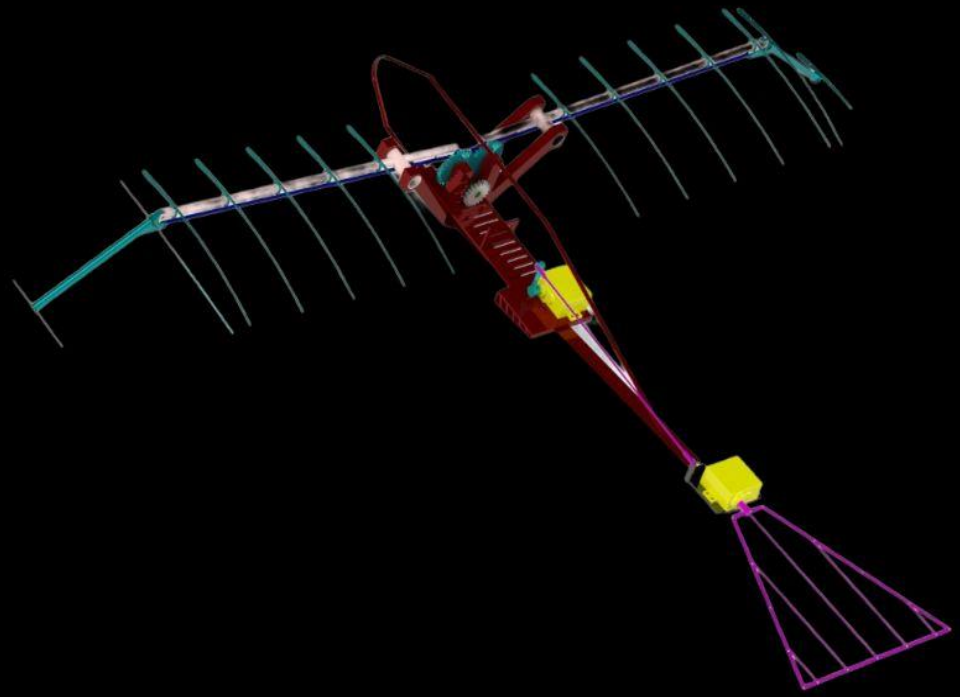
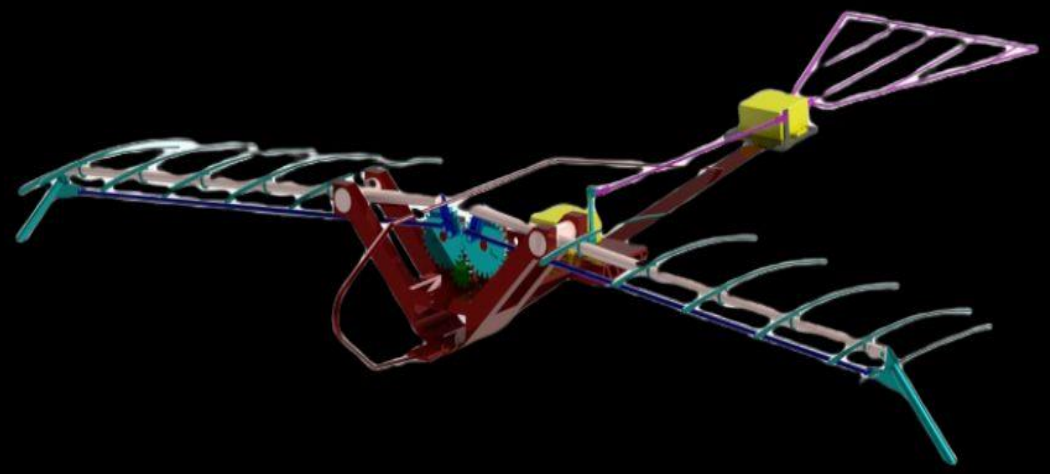


WORKING MODELS



WORKING PRINCIPLE

Fuselage

- The bodies of all birds are shaped like teardrops or a boat.
- The streamlining is achieved by specially arranged feathers which reduce drag.
- The critical part of a ornithopter is the drive mechanism which converts the rotary motion of motor into the flapping motion of wing which is possible because of a gear mechanism.
- An important consideration to be taken is that the gearbox needs to withstand large amount of force and at the same time needs to be light in weight.
- The fuselage must hold the vital electronics and other mechanical items in their respective places.

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WORKING PRINCIPLE

Flapping Wings

The design is consists of symmetric flap & folding wings on either sides of the fuselage.
A gear mechanism is taken into play to facilitate the symmetric flapping and folding of wings.
Notably, there are two gear mechanisms available for our design consideration: -

1) Single Motor – Where a single motor facilitates the movement of wings using two gears attached to it.
2) Dual Motor – Where a pair of synchronous motors facilitate the motion of wings using gears attached to them.

If design and efficiency allows, a hybrid system can also be considered.

WORKING MODELS

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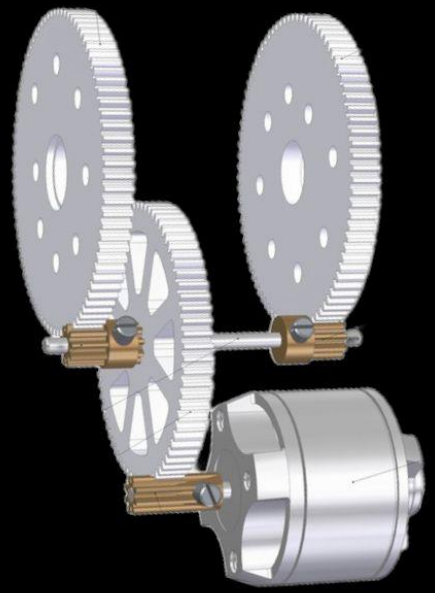

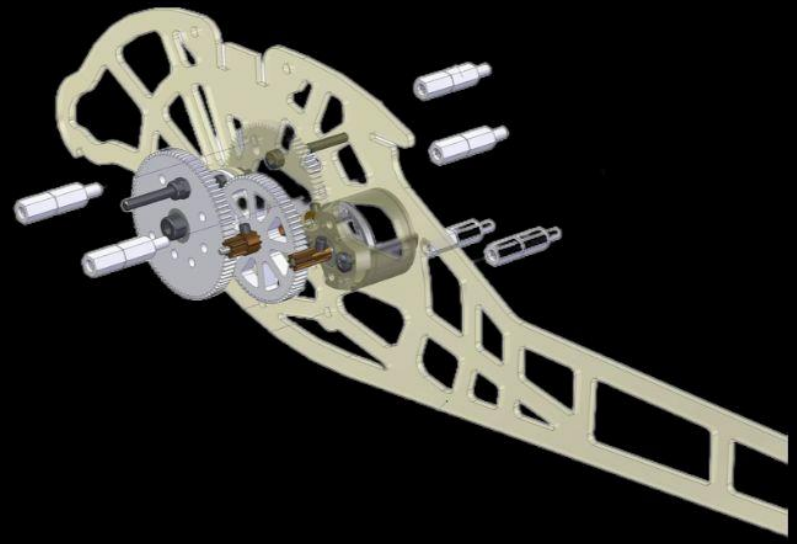

WORKING PRINCIPLE

TAIL

- The tail section mainly acts a rudder and adds to the stability of ornithopter.
- The tail section also helps in reducing and adding drag at the time of takeoff and landing respectively.
- The tail of the ornithopter is responsible for steering purpose, in order to gain the needed movements of the bird.
- Typically, the ornithopter will have a horizontal stabilizer in the back. The tail usually provides a downforce to keep the nose up, and therefore the tail incidence or angle relative to the wing is much more than you would find in an airplane.
- This angle is typically about 15 degrees, but it may be less or more depending on where the center of gravity is located and other aspects of the ornithopter design.

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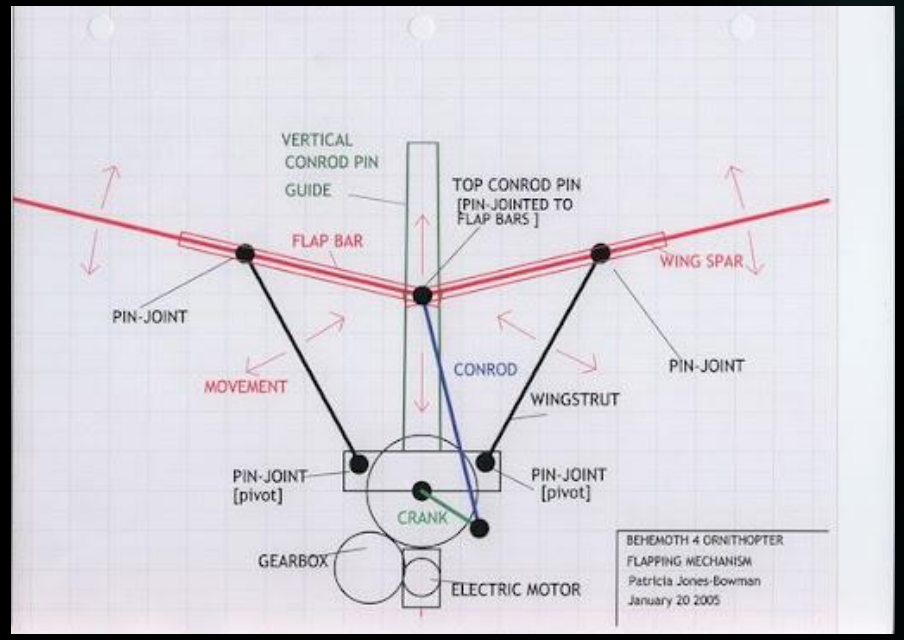
SCHEMATIC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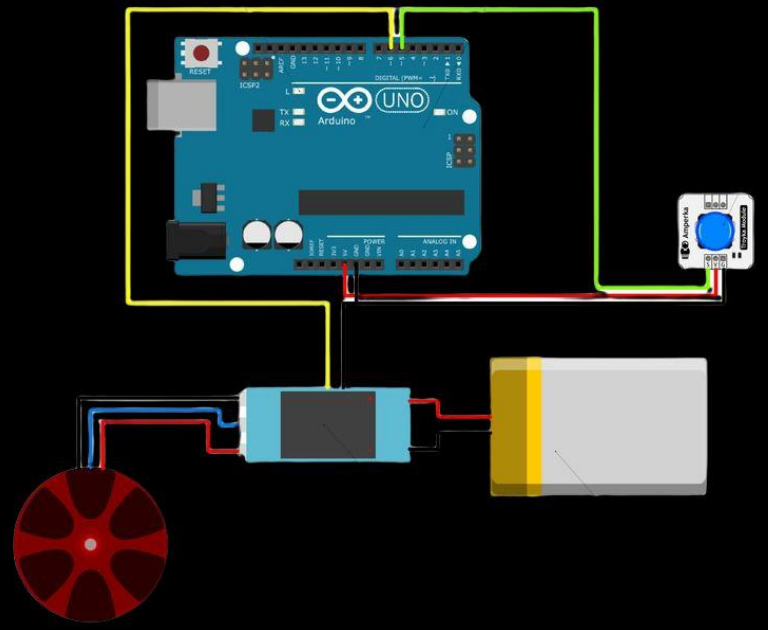
CRANK
GEARBOX
ELECTRIC MOTOR
BEHEMOTH 4 ORNITHOPTER
FLAPPING MECHANISM
Patricia Jones-Bowman
January 20 2005


UNO
Arduino

COMPONENTS NEEDED

Fabrication: -

Sustainable and lightest material to be used

Electronics: -

1. Outrunner Brushless DC Motor
2. Coreless DC Motor
3. ESC
4. Transceiver Module (Transmitter + Receiver)
5. Flight Controller
6. Lipo battery
7. Power Module

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SYSTEM LOGIC

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- Coreless DC Motor

A type of Direct Current motor, which is different in construction than that of the usual can motor. Instead of a large rotating iron armature, it is made from lightweight material with the magnet wire wound around it. They are designed for rapid acceleration.

- Outrunner Brushless DC Motor

The term **outrunner** refers to a type of brushless DC electric motor primarily used in electrically propelled, radio-controlled model aircraft.

This type of motor spins its outer shell around its windings, much like motors found in ordinary CD-ROM computer drives. In fact, CD-ROM motors are frequently rewound into brushless outrunner motors for small park flyer aircraft.

SYSTEM LOGIC

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- ESC

An electronic speed control or ESC is **a**n electronic circuit that controls and regulates the speed of an electric motor. It may also provide reversing of the motor and dynamic braking.

- A Receiver

The receiver on a UAV is an electronic device that uses built-in antennas to receive radio signals from the drone controller. This information is then sent to the flight control board, or flight controller, which puts the information into action by controlling the drone as indicated by the original radio signals.

- A Transmitter

A transmitter is a different kind of antenna that does the opposite job to a receiver: **it turns electrical signals into radio waves so they can travel sometimes thousands of kilometers around the Earth** or even into space and back. Antennas and transmitters are the key to virtually all forms of modern telecommunication.

SYSTEM LOGIC

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- Flight Controller

The flight controller is the brain of a drone. A small box filled with intelligent electronics and software, which monitors and controls everything the drone does. Everything a flight controller does can be classified within one of three categories: Sensing, controlling, and communicating.

- Lipo battery

The main advantages of LiPo battery cells in our concept of UAV, ornithopter are that they have about four times the energy of density of nickel cadmium or nickel metal hydride batteries. LiPo batteries are very lightweight and pliable, and can be made to almost any size or shape.

- Power Module

Power modules provide a regulated power supply for the flight controller, along with information about battery voltage and current. The voltage/current information is used to determine the consumed power, and to hence to estimate remaining battery capacity. This in turn allows the flight controller to provide failsafe warnings and other actions in the event of low power.

ANALYSIS

- Our team has taken analysis of the project report into 4 major parts:-

1) Define

2) Design

3) Implement

4) Analyze

- We define our project as a game-changer in the field of defence and defence systems. Blending in with the environment gives it an upper-hand in surveillance, even in difficult conditions.

- Intelligence is the key to winning battles and wars for which currently human operatives work, however some situations require remote surveillance on the targets where currently in use drones fail.

Here, our ornithopter comes into play by blending in with the environment and remotely surveilling the target with arousing suspicion.

ANALYSIS

- We designed our model by taking reference to nature. We selected "The Greater Spotted Eagle" as our source of inspiration. The Eagle is mostly found in the Thar Desert and has its biological features such as weight and size in accordance with our thought model.
- Our ornithopter requires a ground-station to control it. The word "control" here means to remotely control the flight of ornithopter and extract live video-feed.
- Implementing the design, our team can surely make a working prototype to further refine the final product and enhance the intelligence gathering capabilities of our defence forces.
- Thereby, I share this game-changer product, where it serves the idea of gathering perfect intelligence without arousing suspicion.

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SYSTEM DIAGRAM

Predicted model

CONCLUSION

- Finally our team came up with the conclusion that, we depict our machine- an ornithopter as a scope to enhance intelligence gathering capabilities of our military in future.
- By making continous hours of flying and surveillance, it might help change the tide of war and diplomatic decisions to be taken.
- Our team has tried its best to replicate the biological design of the selected eagle and kept it in a budgeted amount, however the nature gets creative in its own manner, which forces us to open our minds to discover new avenues in terms of design, selection of electronic equipment and coding of perfect algorithms.
- We have made sure to utilize each and every resource available to us in an efficient manner and as we continue to iterate our prototypes, we aim to develop our own electronics in order to reduce the cost of building which is usually taken up by the big brands manufacturing them and make tailored approaches to present a perfect product at the end.

FUTURE CONCEPT

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REFERENCES

Website
Ornithopter – Wikipedia