eVTOL – Electric Vertical Take-Off and Landing

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Abstract— *eVTOL denotes for Electric vertical take-off and landing and, as the name proposes, we speak of an aircraft or airplane that takes-off, hovers, cruises and lands vertically.*

We are aware of Urban Air Mobility (UAM). The term itself suggest that it is capable of plummeting traffic congestion and also there is negligible emissions and having on demand service operational in 3D space. eVTOL can hover, cruise from a standstill without the requirement of a runway and has the manoeuvring proficiencies of an aircraft giving it an advantage over outdated aircrafts and copters. The project aims to achieve the transition from vertical take-off to horizontal cruising by swivelling of rotors and the transition is seamless. Initial take off will be achieved purely from the thrust generated by the rotors. The horizontal cruising will be achieved by the combination of lift provided by wings and the thrust generated by rotors. The mathematical model of the eVTOL aircraft is applied to test stability. The project aims at achieving the concept by various formulations which will be vital for the coming generation of electric mobility vehicles. The project aims to provide solution to the problems caused by congestion on the road which is a hinderance to ambulances as they become inefficient in providing timely emergency medical services to passengers because of the delay.

Keywords—eVTOL, Electric vehicles, Air mobility,

I. INTRODUCTION

eVTOL- Electric vertical take-off and landing; and it alludes to airplane that can take off, float, voyage and land vertically. eVTOL features vertical take-off and landing (VTOL) competency, electrification of lift and thrust (rotating a propeller/rotor with a motor), and automation of controls and can drift, journey from a halt without the need of a runway and has the moving capacities of an airplane giving it an advantage over customary airplanes and copters. The eVTOL can be designated as a vehicle that fits somewhere in between a drone and a conventional airplane. Envisioned applications for passenger transportation include usage as air taxis, for emergency response (first-aid, police, rescue), and for leisure activities. As for the transportation of goods, eVTOL would offer larger capacity for freight transport than ordinary drones. The progress from vertical take-off to even cruising is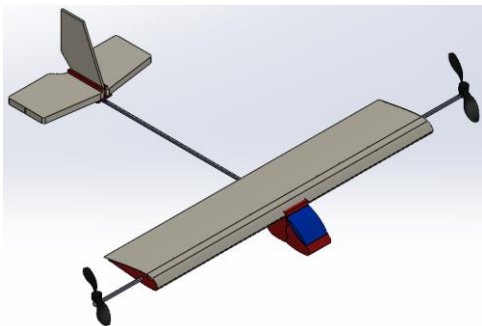 accomplished by the turning of rotors and the change is consistent. Introductory take off is absolutely from the pushed created by the rotors. The even cruising is accomplished by the blend of lift given by wings and the push created by rotors. The pivoting of rotors is managed by the Electronic Speed Control (ESC), KK 2.1 Flight Controller, Li-Po battery. Fuelling the growing momentum behind development are advancements in battery and motor technologies along with related control technologies, led by the automotive industry, and autopilot technologies cultivated in the drone industry, as well as technology advancements for reducing aircraft weight with carbon fibre composite materials.

II. PROBLEM DEFINITION

Around the world, mainly in the metropolitan cities remarkable hours of people has been gone in wane on daily bases and the only reason or blame is the increase of congestions on the roadways. International based data in the year 2018 collected the information stating that these congestions on roads result in approximately 4 billion gallons of fuel wastage unnecessarily. On an average around 45% of carbon dioxide emission is the by-product of transportation and of this around 80% is the result of commercial vehicles and trucks that are traversing on the roadways daily.
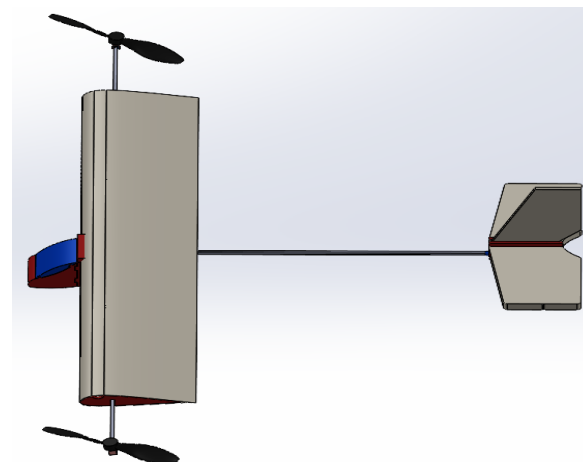
- The manufacturing of the skyscrapers for providing numerous homes is to adjust the increasing population and their accommodation in the compact spaces, in the similar manner the evtols or flying cars will provide aid in resolving the traffic problems and also one will be able to rejoice the 3D space, by reducing the traffic.
- The routes with fixed overcrowding will be made less predominant as these evtols can travel on geodetic paths. Various companies have been working hard on creating prototype that will result in successful intercity possible. Because of electric propulsions and utilization of sustainable energy there is no or zero emission in the environment which is great achievement. Pollution is under control since the propulsions use electric hardware which have zero operational imminent. Also the aim is RTA i.e. required time of arrival with the help of energy efficient arrival for a multi-rotor air taxi. Using the

optimal control problem formulation and numerical solutions one can achieve the most efficient travel path. This is of utmost importance considering safe and efficient future of eVTOL operations for passengers and cargo delivery.

III. RESEARCH OBJECTIVES

- To provide an alternative transport system to avoid congestion
- By using sustainable energy and being fabricated with renewable parts, it also caters to the environmental needs of society
- To improve the design of current eVTOL
- To achieve enhanced steady and controllable take of landing on in other words improving the aerodynamics
- Seamless transition between take off, cruising and landing modes
- Smoothly operated energy transmission considering the safety standards by utilizing batteries
- Improve passenger safety
- Keeping the future energy clean and regenerative

IV. METHODOLOGY

We manufactured a 3D model of the design constructed on the software so that we could understand the sensitivity and strength of the model practically. The planning of the designing and manufacturing has been done as arithmetically as possible. Arithmetic means given equal distribution all the domains effectively. Consequently, they offer amazingly quick comprehend times, require no underlying theories, and assurance an all-around ideal arrangement. Some key vehicle parameters, for example, void weight division and battery vitality thickness, are held consistent between vehicle configurations. Then different analysis parameters lilke the cruise testing, hiver testing and trajectory optimization, voyage lift- to-drag proportion, and drift circle stacking, are changed between configurations, utilizing delegate esteems for a given configuration.

Later we did not bind ourselves with a constraint weight parameter but we were expandable with difference in

weights as the formulae were easily solvable changing the values and keeps the elements constant. Even the calculation of the Centre of Gravity was a challenge as it had to be precisely the coincident point of the fuselage and aerofoil in order for the model to work appropriately.

Deciding which material for the body had been really excruciating as we need a material which would have light weight and enough forte to withstand the air resistance when it hovers and manoeuvres and also the weight of the battery and rotors and propellers. Even the part including tilt mechanism was very challenging as maintaining the tilt at an angle of 45 degree at a constant is really difficult to achieve.

Tools Required

- Solidworks
- MATLAB
- ANSYS
- Autodesk Fusion 360
- Creo
- Arduino IDE
- Raspbian
- 3-D printer
- Laser cutting
- Glue Gun
- Weld gun

Material

- Raspberry pie-3
- KK 2.1 Flight Controller
- ESC- Electronic Speed Control
- Transmitter Receiver 560 Mhz
- Servo Motor
- Flex sensors
- Li-po battery
- Balsa Wood
- Foam

- Aerofoil
- Propeller
- Flight Controller

V. EXPECTED OUTCOMES

- Fully functional eVTOL model

- Successful transition between take off, cruising and landing of eVTOL by swivelling of rotors.

- To achieve maximum possible flight range.

- To suggest an alternative transport system to avoid congestion.

- To reduce the carbon emissions.

- To improve the design of current eVTOL.

- Improve aerodynamics.

- Efficient circuitry and improved battery utilisation.

- Improve passenger safety.

VI. CONCLUSION

Through this project we have discussed the importance for eVTOLs and its industrial and commercial uses, eVTOLs are the future of transportation, with the increasing dangers of climate change and improvements in research and development and in engineering of the various parts required for the manufacturing, eVTOLs are no longer a surreal dream but a reality, since we have undertaken this project, we were able to design and create various prototypes and CAD models, create stimulations are solve mathematical calculations regarding it. We have proved that eVTOLs can vertically take-off from standstill using rotors for the thrust, and manoeuvre in the horizontal direction can be accomplished by a mixture of lift given by the wings and the push created by the rotors, the ideal idea for an eVTOL is to make it autonomous without a pilot, which will have sensing capabilities to avoid any obstacles without crashing, and with the global eVTOL Aircraft market growth which is growing in a considerable rate, all the existing issues about eVTOLs can be rectified, like flight range, aerodynamic properties, passenger safety, better battery utilization, etc.

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