Technology Demonstration of Nitro Gen- Set

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Abstract:

Drone technology is a globalized blooming technology nowadays, still, the limitation in the Flight Time and Battery Life is an unresolved issue during performance. Multi-rotor drones have limited endurance and speed, making them unsuitable for large-scale aerial mapping, long-endurance monitoring, and long-distance inspection such as pipelines, roads, and power lines. They are inefficient sometimes and require a lot of energy just to fight gravity and keep them in the air. Most drones have a flight time of around 20-30 minutes, which can be a major hindrance when surveying large areas. This means that multiple flights are required to cover larger areas, which can be time-consuming and costly. To unlock the full potential of UAVs in various sectors, researchers and engineers are actively working on resolving this limitation by developing advanced battery technologies and exploring alternative power sources, such as hydrogen fuel cells and solar cells, to extend flight durations and further enhance the versatility and effectiveness of UAVs in these critical fields. To resolve the issue, The Nitro engine is used to drive the set instead of a LiPo (Lithium-Polymer) battery which increases the endurance and decreases the charge time of a drone (instant re-fueling the drone rather than charging it after every 30 min). The engine consists of a gear, dynamo, and voltage. The Nitro engine drives a dynamo using a gear, the dynamo generates power and supplies it to a voltage regulation unit which in turn supplies power to the controller of the drone (flight controller unit) and the propeller motors. This alternative technology is used for better performance of drones.

Keywords: UAV, Precision, Lipo, Battery, Industries, Unmanned Aerial Vehicle, Energy

Introduction

Unmanned aerial vehicles (UAVs) have drawn a lot of attention lately for both military and commercial uses, including minesweeping, weather monitoring, reconnaissance, delivery, and tracking wildfires, agriculture, communication, and other fields [1].

When compared to traditional aerial vehicles, the inexpensive operating time of unmanned multi-copter drones becomes a substantial advantage. Nevertheless, in many applications, the maximum flying time of tens of minutes may be the most restricting aspect. The majority of electrically-powered drones are powered by lithium-based batteries, which have a limiting capacity that causes this constraint. Unlike land vehicles, the maximum flying range cannot be increased only by adding more batteries since there are additional factors to take into account, such as the maximum take-off weight and power consumption limitations [2].

Conventional internal combustion engines (ICEs) are linked to engine vibration, low efficiency, excessive weight, and machine noise, despite the fact that ICE-powered UAVs may attain high power densities and high energy densities. Furthermore, incomplete fossil fuel burning produces harmful emissions into the atmosphere Emissions [3]. The hybrid engine-electric and pure electric propulsion technologies, which exhibit gear promise, might be employed to power these emissions. In contrast to unmodified ICE based UAVs. Adding a station that can change batteries automatically seems like a more practical choice. Numerous experimental systems were documented in scholarly works [1].

One major technological problem for UAV applications is the capacity restriction of an energy storage device. The multirotor is one of the most power-hungry forms of unmanned aerial vehicle. The majority of them have a battery life of under 60 minutes. There are two ways to fix this issue: either recharge the battery or expand its capacity. Nevertheless, given the limitations of current battery technology, there are several drawbacks to this strategy when it comes to expanding battery capacity. The mass of the battery that the UAV must carry will precisely rise as the battery capacity increases [4].

Not much progress has been achieved in increasing the energy density of batteries despite the study of several ways. In order to extend the duration of operation of the UAV, research and development has been concentrated on the process of recharging the battery from external sources. Fuel cell (FC) technology has gained a lot of traction in recent years as the primary power source for electric propulsion systems in airplanes and unmanned aerial vehicles (UAVs). Unlike traditional ICEs, FCs may directly generate electricity by use of electrochemical processes.

The usage of FCs allows for a reduction in the weight of the UAV propulsion systems due to the high energy density of hydrogen or methanol fuel. Because of their poor energy density, lithium-ion batteries can only provide the necessary energy for a short period of time when used in UAVs. The energy density of lithium-ion batteries is 260 Wh kg^{-1}. , yet fuel cells have an energy density of greater than 800 Wh kg^{-1} [5].

PEMFCs are the most efficient fuel cells available; they also have a reasonably quick dynamic response and start-up time, are lightweight, and can function at low temperatures. These factors make them the most popular fuel cells for UAVs to run on. The membrane electrode assembly (MEA), which consists of a solid proton exchange membrane (PEM) dividing the catalytic layers and gas diffusion layers of the PEMFC, is its primary component, Platinum supported by carbon is the most often utilized electro-catalyst, enabling the reactions to occur at low temperatures, while Nafion is the most widely employed membrane [1].

Drones' main drawback is their short flight duration and poor durability, which makes them unsuitable for long-term uses like agricultural and surveillance. These drones frequently have trouble maintaining prolonged flying times, which may make it more difficult for them to efficiently cover big regions. Solving this issue is essential to guaranteeing the viability and effectiveness of drone-based operations in these vital domains. In response to this problem, a creative solution has been developed.

The most basic kind of fuel based on nitrogen is ammonia, which also serves as the main building block for a variety of nitrogen-based chemicals. The Ostwald process of ammonia oxidation results in nitric acid, which when combined with ammonia generates AN. Millions of tons of AN are produced each year as a worldwide commodity, mostly for use as fertilizer. It is important to remember that an aqueous a solution is safe to handle, store, and transport since it is non-explosive and chemically stable [6].

Air-breathing fuel cells, sometimes referred to as nitrogen fuel cells, are a kind of fuel cell that uses atmospheric nitrogen as the oxidizing agent. Pure

oxygen is normally needed for the electrochemical reaction with hydrogen in conventional fuel cells, such as Proton Exchange Membrane (PEM) fuel cells, in order to create power.
Air, which is around 78% nitrogen, is utilized directly in nitrogen fuel cells, doing away with the requirement for an additional oxygen source. This feature could be helpful in some situations as it might lighten the fuel cell system and simplify it. In order to create energy, nitrogen from the air and hydrogen are combined in an electrochemical process in a nitrogen fuel cell. The process is as follows:

$$2H_2 + N_2 \rightarrow 2H_2O + \text{energy}$$

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Nitrogen fuel cells have the potential benefit of avoiding of the logistical difficulty of transporting and preserving pure oxygen [4.] Less power density in comparison to conventional fuel cells that use pure oxygen is one of the difficulties, though.

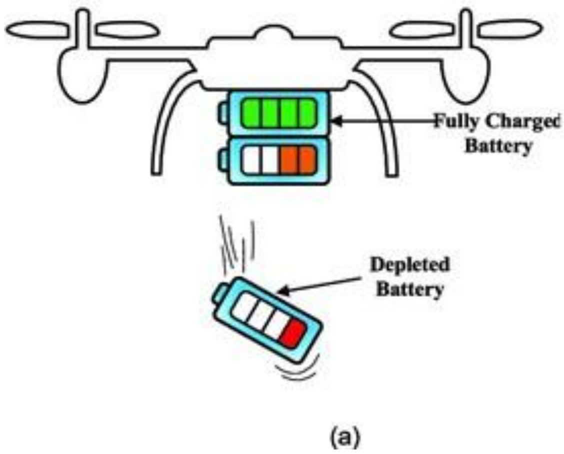

Fig. 1.1 Schematic Representation of battery capacity

One way to increase the autonomy of any fuel cell-based mobile application, including hybrid electric cars, is to save gasoline. In order to enhance fuel cell hybrid systems employing real-time and optimal control for the fuelling regulators, several researchers have studied fuel efficiency. One way to increase the autonomy of any fuel cell-based mobile application, including hybrid electric cars, is to save gasoline. In order to enhance fuel cell hybrid systems employing real-time and optimal control for the fuelling regulators, several researchers have studied fuel efficiency [7].

Its flying range before to take-off is limited by the quantity of electric power carried. The weight of the airplane grows along with the energy storage capacity, even though bigger or more batteries can be installed. As a result, the greater weight requires more power to transport, which may not necessarily extend the flying range. One potential method to get over this physical constraint is to power UAVs with solar energy. A solar-powered UAV collects solar energy that reaches the aircraft surface throughout the day by utilizing on-board solar cells [8]. The engine receives this produced power, which is used to either replenish the on-board battery or operate the aircraft and other electronics. When there are clouds or darkness, the battery powers the device.

The suggested UAV has several uses, including reconnaissance, and can stay in the air for extended periods of time. The UAV's control system is in charge of both the drone's autonomous behaviour and the execution of human orders. The usefulness and performance of electric-powered aircraft have increased recently due to advancements in battery and motor technology. Therefore, it makes sense to investigate hybrid-electric aircraft power plant options. The design of such a setup is examined in this thesis from the perspectives of overall propelling and energy efficiency [9].

The Proton Exchange Membrane (PEM), commonly known as the Polymer Electrolyte Membrane Fuel Cell (PEMFC), is the primary fuel cell type used in mobile applications. It operates on pure hydrogen [10]. Although that form of fuel cell has the finest qualities for usage in drones, UAV makers are also thoroughly researching a number of alternative fuel cell types. PFSA (PerfluoroSulfonic Acid) membranes, marketed under the brand name

Nafion and made by DuPont, are typically employed. PEMs are the best options because of their extreme flexibility. From the perspective of transportation applications, PEM fuel cells have several benefits, including high power density, quick start-up times, high efficiency, low operating temperatures, and simple, safe handling [11].

The article is centred on the creation of a product, namely the external power generating unit installed on the drone, as well as a change in the drone's performance method. An external power producing unit that generates energy/power using a nitrogen engine and transforms it into electrical energy to power the rotors and control unit. The low flight range and longer drone recharge times are the drawbacks of this approach.

Design

Nitro engines, often referred to as glow engines or nitro-powered engines, are a kind of internal combustion engine that are frequently used in remote-controlled vehicles including automobiles, trucks, boats, aircraft, and helicopters. These motors are renowned for their strength, effectiveness, and unique sound. This is a quick overview of nitro engines:

Fig 2.1 Nitro engine

The protein composition of the different algae species mostly determines the presence or absence of N-heterocyclic compounds in bio crude. For instance, according to Duan et al., duckweed bio crude had 8.5 area% N-cyclic chemicals, including 2-methyl pyrazine and 2, 3-Dimethyl pyrimidine. In contrast, 50% of N-cyclic chemicals, including pyrrole, pyrazine, and pyridine, were found in Cyanobacteria bio crude.

N's impact on fuel requirements examining the impact of fuel nitrogen (N) content on engine performance and emissions is the main goal of this study. During this campaign, four fuels with the notation Nx.x were evaluated in addition to diesel fuel. When the weight percentage of N (0.5–4.5 wt %) in the fuel is denoted by x.x. Diesel was mixed with pyridine (17.7 weight percent N) to get the fuel's N content up to the required level. According to the Caltex gasoline certificate which provides supporting [6].

Table. 2.1

CUBIC CAPACITY	3CC
POWER PRODUCED	0.75 bhp
FUEL USED	NITRO FUEL
WEIGHT	160 grams
PEAK RPM	16,000
CUBIC CAPACITY	3CC

A dynamo is a generator of electricity that uses a commutator to produce direct current. Electric motors, alternating-current alternators, rotary converters, and many other subsequent electric-power conversion devices were derived from dynamos, the first electrical generators that could provide industry with electricity. By utilizing Faraday's law of induction, the electric dynamo transforms mechanical rotation into a pulsating direct electric current by means of revolving wire coils and magnetic fields.

A dynamo machine is made up of an armature—a collection of spinning windings that rotate inside the magnetic field—and a stator, a stationary structure that generates a continuous magnetic field. The velocity of the wire within the magnetic field produces an electromotive force because of Faraday's law of induction.

Fig 2.2 Dynamo

This exerts pressure on the metal's electrons, causing an electric current to flow through the wire. One or more permanent magnets may supply a continuous magnetic field on small machines, whereas one or more electromagnets—often referred to as field coils—provide a constant magnetic field on bigger machines.

Table. 2.2

VOLTAGE	DC 220 V
DRIVE SPEED	1500 RPM to 10000RPM
CURRENT	0.28A
TOTAL LENGTH	100 mm
ENCLOSURE TYPE	TEAAC (Totally Enclosed Air to Air Cooled)

Because of the aforementioned drawbacks, the author has created a comprehensive algorithm for choosing the right gear ratio for contemporary passenger automobiles that considers all relevant variables, including vehicle dynamics (including laws governing road design), fuel efficiency, ergonomics, and clutch longevity. The paper is structured such that preliminary calculations based on suggestions from the author's analysis are given first. [7].

Table. 2.3

Gear 1 Tooth	30
Gear 2 Tooth	10
Module	1
Pressure Angle	20
Profile Shaft	0
Clearance	0.05
Gear 1 centred Hole dia (mm)	4
Gear 2 centred Hole dia (mm)	2
Gear centred Distance	20,000
Show gears	1,2

This portion may be completed fast and doesn't need any numerical computations. As a result, it helps mechanics and fans looking for a scientific foundation in this field. Second, in order to evaluate the dynamics and fuel consumption of a selected solution, the gear ratios are computed and quantitatively confirmed.

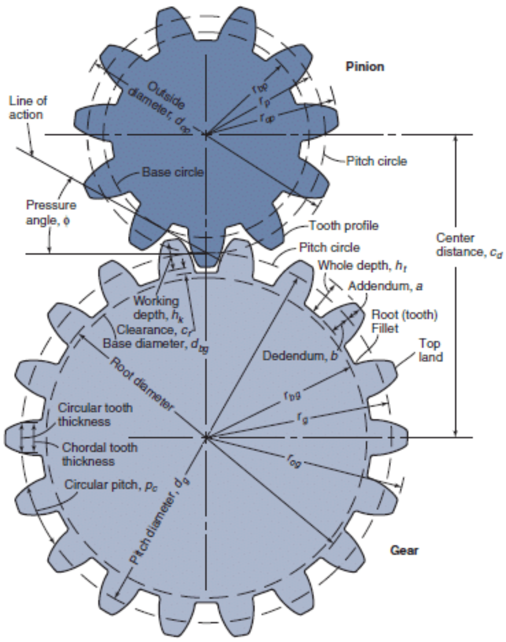

Fig. 2.3 Gear Train

This study proposes solutions for energy management. Regardless of changes in load power, the cell consistently provides a rated power that is equivalent to the maximum required power (800 W). The battery will either provide the additional power required, particularly peaks), or when the fuel cell's rated power surpasses the power of the load, be charged. This easy procedure does have a lot of drawbacks. Owing to a variety of variables, including the mission type, cargo, and even the weather, the hovering power is not always constant. The

hovering power and fuel cell rated power are not always equal. [7]
As a result, it will function outside of its zone of high performance. To provide the additional power required, even the battery can be asked to give a high current. As a result, both sources' lifespan will shorten and they will deteriorate quickly. Furthermore, the drone is intended to do a variety of tasks in addition to hovering-based tasks.
The fuel tank in a hybrid drone is designed to store a liquid fuel suitable for the internal combustion engine. Common fuel types include gasoline or another suitable aviation fuel. The size and capacity of the fuel tank depend on factors such as the drone's design, intended use, and the desired range of the hybrid system. Hybrid drones are often designed to be compact and lightweight, so the fuel tank may not be as large as those found in traditional aircraft. The internal combustion engine in a hybrid drone serves to extend the drone's range beyond what would be possible with batteries alone. The electric propulsion system is used for take-off, hovering, and low-speed flight, while the internal combustion engine can kick in for higher-speed and longer-range operations.

Table. 2.4

MATERIAL	22 Awg Plastic
CAPACITY	150 ml
TUBE LINE	Neoprene Fuel Hose
TUBE LENGTH	40 cm
TUBE DIAMETER	5 mm

The drone's frame acts as its sturdy and lightweight framework, giving the propulsion system's vital parts structural support. This structure, which houses the engine, dynamo, and gears to guarantee peak performance, is expertly engineered with longevity and precision in mind. An essential part of the propulsion system, the engine is placed snugly and securely into the frame. This deliberate placement enhances the engine's efficiency and allows for efficient heat dissipation, both of which improve the drone's overall dependability. Furthermore, the dynamo is precisely attached on the frame and is responsible for producing electrical power by electromagnetic induction. Because of the way the frame is designed, gears may be connected seamlessly, guaranteeing that motion is transferred in unison between components. The dimensions of 600 x 200 mm provide a versatile platform that may be utilized for many purposes, including engine mounts and dynamo supports. By distributing loads evenly across the structure, four supports provide the building stability. The location of these supports is crucial, taking into consideration the anticipated stresses and load-bearing requirements. In the process of production, precision is essential. Using techniques like machining, welding, or extrusion, the aluminium alloy is formed into the necessary frame while maintaining the necessary 2 mm thickness. Quality control measures are implemented to meet strict requirements and guarantee the durability and reliability of the frame. The 600 x 200 mm dimensions offer a flexible platform suitable for many uses, such as engine mounts and dynamo supports. Four supports provide stability by spreading loads uniformly across the structure. Taking into account the expected forces and load-bearing needs, the positioning of these supports is essential.
In the production process, accuracy is critical. The aluminium alloy is shaped into the required frame using processes like machining, welding, or extrusion while keeping the required 2 mm thickness. Strict criteria are met through the implementation of quality control procedures, which ensure the dependability and longevity of the frame.

Fig. 2.4 Structural Frame

Table. 2.5

MATERIAL	ALUMINIUM ALLOY
THICKNESS	2mm
LENGTH	600 mm
WIDTH	200 mm
NUMBER OF SUPPORT	4

The lightweight nature of aluminium 1060 H12 is the reason it was chosen for the structure's design and analysis [12]. The aluminium material is selected for it chemical and physical properties which can provide the strength to the designed structure.

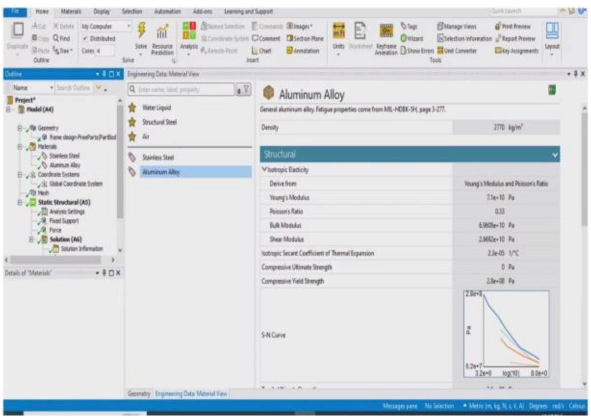

Fig. 2.5 Analysis of Aluminium

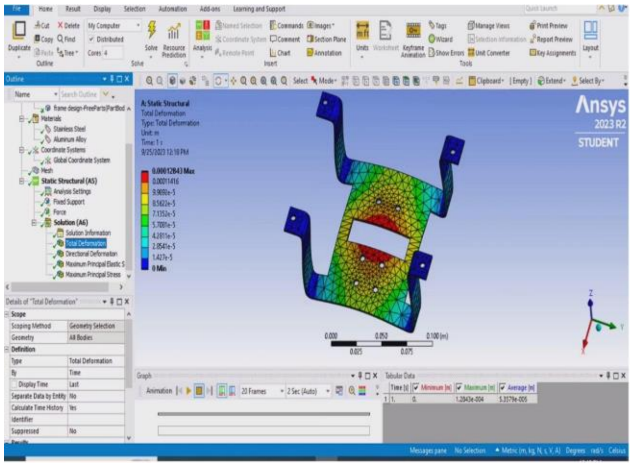

Fig 2.5 Structural Deformation

Operational Convenience

- Pre-flight Inspection
- Fuelling
- Calibration
- Flight Planning
- Communication
- Monitoring
- Data Logging
- Data Retrieval

Results and Discussions

The dimensions of 600 x 200 mm provide a versatile platform that may be utilized for many purposes, including engine mounts and dynamo supports. By distributing loads evenly across the structure, four supports provide the building stability. [13] The location of these supports is crucial, taking into consideration the anticipated stresses and load-bearing requirements. In the process of production, precision is essential. Using techniques like machining, welding, or extrusion, the aluminium alloy is formed into the necessary frame while maintaining the necessary 2 mm thickness. Quality control measures are implemented to meet strict requirements and guarantee the durability and reliability of the frame [14].

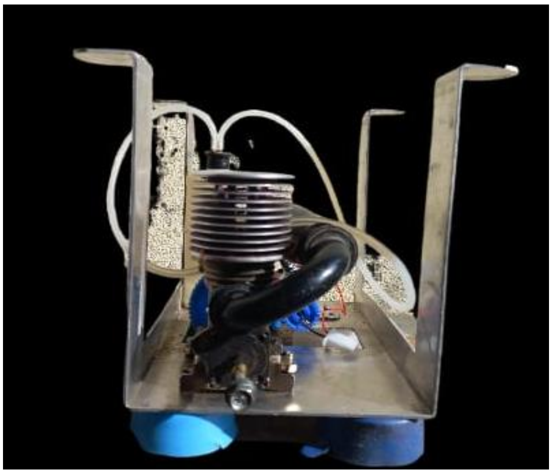

Fig 2.6 Assembled Engine

The project's output will improve a conventional drone's durability, allow for conventional refuelling, and decrease downtime for conventional drones caused by drone battery charging. It will be very useful in the drone and aviation industries. Agricultural drones may utilize it to extend their flight length and reduce their downtime. Greater ability to carry payloads than an electrical drone used for agricultural, military, and civic purposes.

The plate that was created after careful deliberation must be able to support the entire load without becoming fatigued. The proper performing output from the RPM set must be obtained. To keep an eye on and control the set's total maximum vibration, a vibration test must be performed. [13]It is necessary to test the engine's emissions in order to reduce the amount of dangerous pollutants discharged. Testing the dynamo to see whether it can generate the required current flow.

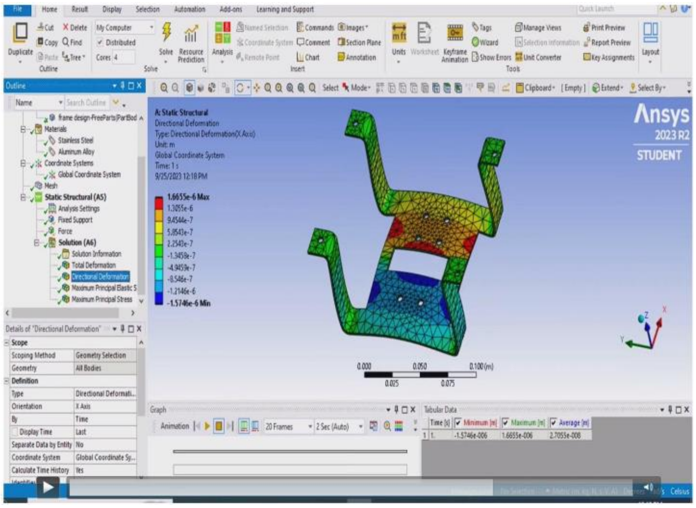

Fig 2.7 Structural Analysis

Conclusion

In conclusion, the sturdy aluminium alloy frame with four strategically placed supports, measuring 200 mm in width, 600 mm in length, and 2 mm in thickness, is created. Its endurance and dependability are guaranteed by its precise construction and coatings that resist corrosion. The frame is finished now, but attaching the engine and dynamo is the next phase, which is where the excitement lies. The next final tests represent the final, significant milestone at which the integrated system is rigorously tested. These crucial tests make sure the assembly not only satisfies but surpasses performance requirements. The results of these tests will confirm the structural soundness, smooth operation of the parts, and suitability of the frame for practical use.

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