

Design and Fabrication of Fixed-Wing Unmanned Aerial Vehicle (UAV) With Dropping Mechanism

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Abstract- Unmanned Aerial Vehicles (UAVs) which are also known as Drones are aircrafts without a human pilot on board, - usually controlled by a ground-based controller and a communication system or by the ability of being programmed with various degrees of autonomy. The reason of the rapid advancement on drone technology is the need for more precision, accessibility, safety and cost effectivity in many fields. They currently lack the flexibility and adaptability of manned aircrafts. By some measures, 80% of the global drone industry revenues are related to agriculture, in some way. (R1) Unmanned aerial vehicles (UAVs) are one of the most promising innovative technologies invented in recent years to promote precision agriculture and smart farming. UAVs can not only reduce labour requirements but also increase production output, reduce the use of pesticides, and protect the environment. The main objective of our project is to design an aircraft that is capable of lifting as much weight as possible while taking into account the available power and aircraft's length, width, and height requirements. A special attention has been devoted to Dropping Mechanism of the payload which can help us in gaining more ways to deliver the goods we need. The following report is a synopsis of the design process, Fabrications, component selection and Fly with maximum payload.

Index Terms- Cyclone Separator, velocity, pressure drop, turbulence intensity, Vorticity, flow of rotation.

I. INTRODUCTION

A UAV is defined as an aerial vehicle that does not carry a human operator, uses aerodynamic forces to provide the vehicle lift, can be flown autonomously or be piloted remotely, can be expendable or recoverable, and can carry a lethal or a non-lethal payload.

A UAV is controlled either autonomously by onboard computers or by the remote control of a pilot on the ground. According to the Cambridge English Dictionary, an Unmanned Aerial Vehicle is an aircraft that is operated from a distance, without a person being present on it. An unmanned aerial vehicle (UAV for short; also known as a drone) is any aircraft that does not have a human pilot onboard. UAVs have their origins as early as 1915 when Nikolai Tesla wrote a dissertation in which he described "an armed, pilotless-aircraft designed to defend the United States." UAVs come in a variety of sizes, designs and purposes. Initially, UAVs were merely remotely piloted; however, autonomous control is becoming more widely utilized. The Association for Unmanned Vehicle Systems International holds an annual Student Unmanned Aerial Systems competition. The competition involves many teams of university students from all across the United States and abroad. Several different types of UAV are often used such as airplanes, helicopters, and

quadrotors. The competition consists of a pre-determined course that the drone must follow autonomously. Targets are set up along the path for the UAV to identify, photograph, and relay coordinates to the ground. At the end of the course, the UAV will enter a search area where it must autonomously search for additional targets. The competition details design and operation parameters that need to be taken into consideration during the design process. Maximum take-off gross weight needs to be less than 55 lbs



Figure 1. Fixed-wing UAV

The vehicle must be capable of manual override by a safety pilot. Additionally, the maximum airspeed of the UAV cannot

exceed 100 knots indicated air speed. The UAV design needs to accommodate competition guidelines while performing well enough to complete the course as quickly as possible in order to achieve victory over the other competitors.

There are many moral, legal, and ethical issues regarding the usage of drones. In terms of legality, in many countries, a UAV is not permitted to fly openly. However, with the advent of time and special permissions and restrictions, a few countries are now allowing the usage of drones for special purposes. There isn't a clear and codified law regarding the use of drones and their usage. Moreover, there is an absence of government clearness concerning drones in every country. The morality and ethicality of using drones have come under the scanner in recent years after their extensive usage in conducting airstrikes. Around 60-90% of all airstrikes are now being conducted remotely by using drones. Statistically, the world has seen numerous civilian casualties from drone strikes which depicts that drones dehumanize war.

II. LITERATURE REVIEW

UAVs have been in production since before the Wright Brothers first took their historic flight. The earliest account can be traced back to the American Civil War, when an inventor patented an unmanned balloon that carried explosives that could be dropped after a time-delay fuse mechanism triggered a basket to overturn its contents. While this is a relatively primitive idea of what the world has come to know today as "drones" it goes to show how early man began thinking about unmanned aerial systems. This technology began taking small leaps in the years following the American Civil War - the first military aerial reconnaissance photos were taken in 1898 during the Spanish-American War via a camera attached to a kite. As the trend shows, many of the advancements in this technology arose during times of war, whether it was used to help with an offensive strike or just to acquire intelligence on enemy locations and activities. This is seen throughout the history and progress of unmanned aerial technologies. Advancements took place in Britain during the 1930s, where a radio-controlled UAV (dubbed the Queen Bee) served as aerial target practice for British pilots, and also during World War II, during which 10 times the Nazi's developed an unmanned flying bomber known as the V-1 [2]. It wasn't until the 1970s that Israel developed the Scout and the Pioneer, which started the development toward the more widely known glider-type UAVs [2].

UAV design and advancement is a global activity. As technology and needs change, UAVs can be improved to serve these needs. There are several design considerations that are constant. The first of these design criteria is the degree of autonomy. Early UAV designs were mostly set to fly a specified path until they ran out of fuel. They carried a camera onboard, which would be recovered after the UAV landed.

Later, the advent of radio control systems allowed UAVs to be piloted from the ground. Modern UAVs often combine these two basic functionalities. These two modes of operation do not strictly signify autonomy. True autonomy suggests the ability of the aircraft to operate without human interaction. In this regard, UAVs are still very immature. UAV autonomy technology is divided into the following categories:

The ultimate goal of UAVs is to replace human pilots altogether. Another major design criterion is UAV endurance (range). Since there is no human pilot onboard, there is no concern for pilot fatigue. UAVs can be designed to maximize flight times to take advantage of this fact. Different systems can afford a wide variety of maximum range. Internal combustion engines require relatively frequent refueling and inflight refueling is a major obstacle for this type of propulsion system. Photovoltaic UAVs offer the potential for unlimited range and there is much research in this field. One more type of fuel system is hydrogen, which is proposed for use with certain models of stratospheric persistent UAVs. The AeroVironment's Global Observer is one such UAV. This aircraft runs on hydrogen and has a range of 7 days. The idea is for two of such UAVs to be used in tandem to provide continuous, uninterrupted operation 365 days a year. With the sophistication that these systems have arrived at, the market for them has grown astronomically. While the United States still has the largest stockpile of unmanned aircraft, the rest of the world is beginning to follow suit. More than 50 countries have purchased surveillance drones, and many have started in-country development programs for armed versions [4]. More than two-dozen different models were shown at a recent aviation show in China. Due to the changing landscape of the theater of war, many nations are leaning toward unmanned aircraft to handle delicate situations in which human lives need not be put at risk. Also, taking into account the fact that drones sell for a fraction of the cost of manned airplanes, the amount of UAVs a nation can purchase at once has enticed many nations into entering the drone zone. In general, UAVs fall into one of six functional categories.

III. MECHANICAL DESIGN

In order to properly design a frame its functional requirements must be defined. In this case it must provide sufficient actuation for control of the degrees of freedom of interest. In the real V-22 Osprey yaw is controlled by differential longitudinal cyclic pitch, this offsets the thrust angle resulting in a yaw moment about the centre of mass while maintaining a net vertical thrust.

The model V-22 simplifies this method by counterrotating the wing-arm (and motors) as shown in Figure.. For conventional flight the motors must also be able to tilt all of the way forward. As a result the motors were designed to be able to rotate slightly more than 90°.

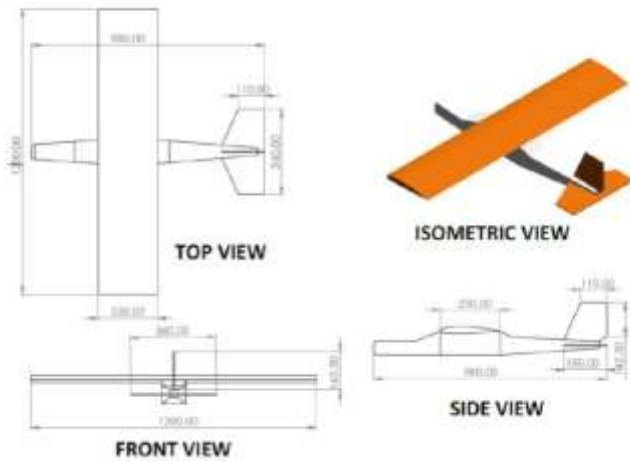


Figure 2. Design

IV. EXPERIMENTAL METHODOLOGY

The process of designing the fixed-wing drone was done as follows,

Making a basic 2D Design

A basic layout and a 2D picture of the required drone according to the required specifications were done on a sheet of paper manually keeping in mind the results obtained from the design phase of the project.

All the parts were drawn at appropriate positions derived from the preliminary analysis of the model. Hence, this laid a foundation for further designs of the model.

Obtaining 2D Drawings with Dimension

As discussed in the Literature review, xflr5 and MATLAB software were used in determining the actual shape and location of the parts on the model as shown in Fig.

Obtaining the final three-Dimensional Model

The final assembly and fabrication of parts were done using OpenVSP software. The software was then exported to CATIAv5 and optimized further.

Most conventional way of designing a cyclone separator is by determining the cut of diameter of particle that needs to be separated. Various designing approach and empirical models passed on them will be discussed in later chapters. The basic principle of separation is that the particles with

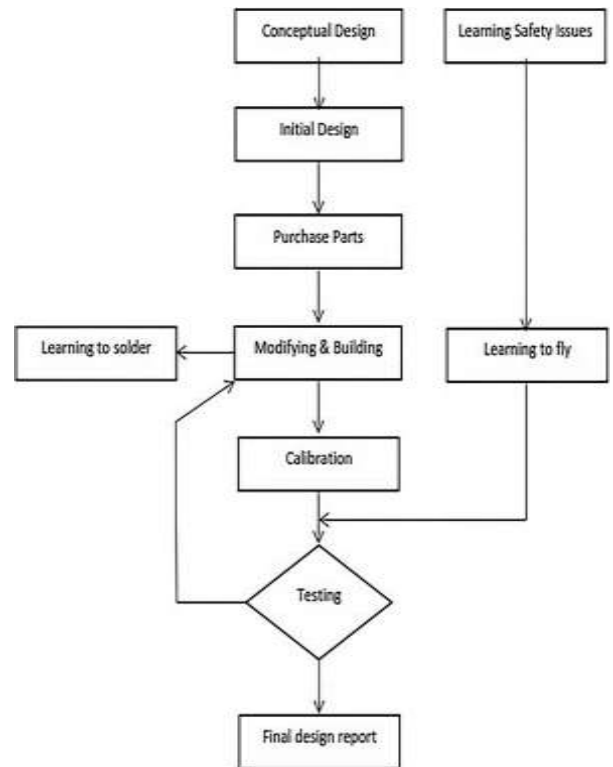


Figure 2: Methodology

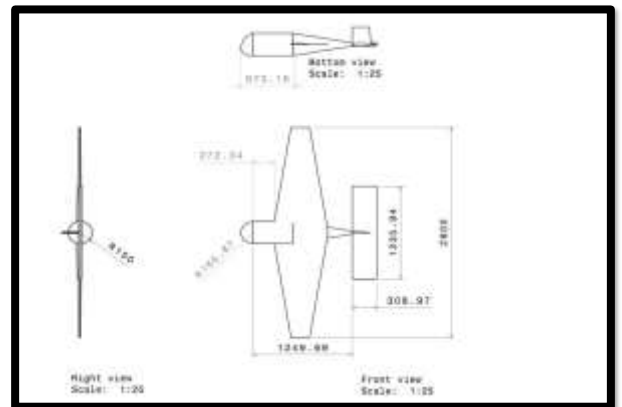


Figure 3. Two-dimensional sketch of the drone

V. AIRCRAFT CONFIGURATION

1. Wing Configuration

Aerodynamic stability of the two designs differs a bit; the centre of lift can be higher in a high-wing design, often offset with dihedral in low-wing aircraft. Ground clearance (and debris protection), specifically in multi-engine aircraft, is going to be greater when engines are mounted on a high wing rather than a low wing. This is true of both propeller and jet engines, although propellers tend to have a larger radius for a given aircraft size

2. Engine Configuration

The Single engine-based aircraft engine will normal fixed at the Nose of the aircraft to make the plane stable and getting maximum thrust of an aircraft. This type of engine configuration is called Tractor.

Table 1. Estimated weight

Components	Weight(grams)	Units	Total weight
Brushless motor	5	5	25
Propeller	15	5	75
Esc	25	5	125
Frame	800	1	800
Battery	300	1	300
Pitch controller	60	1	60
Receiver	25	1	25
Total			1410grams

VI. RESULTS AND DISCUSSION

Once all the elements involved have been described, and the operation of the software that will control the simulation has been explained, the results can be presented. To see if the simulator works well, three tests have been planned for each of the existing Quad Plane models. The first test consists of a ground check: its purpose is to see that the motors rotate properly (through Mission Planner you can test the four motors that are responsible for the vertical movement) and that the control surfaces go to the starting position. The second test consists of the planning of a mission through Mission Planner and the consequent execution by the UAV. The last test consists of the execution of a commanded flight through a radio control.

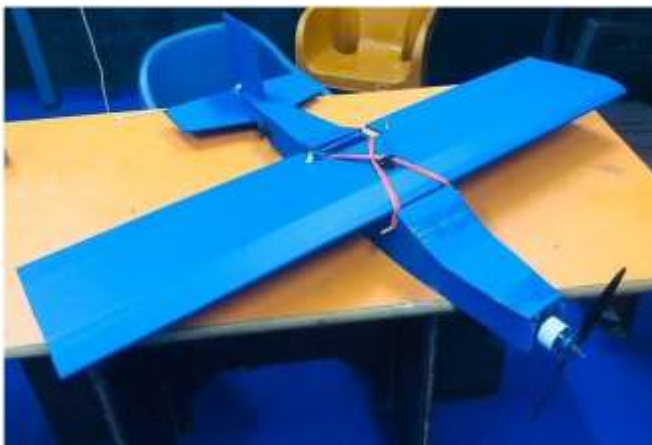


Figure 4. Fixed-Wing Aircraft

With the three proposed tests, it will be possible to see if the operation of the simulator is correct or not. The simulator will

work well if the simulated models are able to follow an operation just like a real Quad Plane would, that is, vertical take-off, transition to horizontal flight, then transition to vertical flight and landing. Since we have two Quad Plane models, we will start testing the Gazebo Standard VTOL model, as it will be error-free, in terms of physical properties such as inertia matrices and mass of the model, due to the fact that it was designed by Gazebo. Then, if the test results are good, we will repeat the tests with the Venturi V1 model. In the case of the planned mission, we will quantify the error between the desired trajectory and the trajectory that the simulated model follows. In the case of the mission controlled with the joystick we will see if the simulated UAV follows the commands that we send it with the joystick in the same way as a real UAV does.

VII. CONCLUSION

The purpose of this work is to create a dropping mechanism based fixed-wing aircraft. The choice to base a final master's thesis on the development of a simulator for a fixed-wing UAV is due to the real needs of Venturi Unmanned Technologies. Venturi is a start-up that is designing drones for the inspection of power lines and pipelines. To develop a reliable drone, it is necessary to perform many configuration tests and do many hours of flight with the actual platform. One of the problems of the company is precisely when it comes to flying the drone: due to the laws, which are very restrictive, they have to fly the UAV in special conditions. The place where these conditions can be recreated is far from the location of the business. This makes it very expensive to perform flight tests in terms of logistics and economics.

The goals that were set at the beginning of the work were two. First of all, make a simulator that follows the flight mechanics of a fixed-wing UAV, because, if you want to test special configurations, the simulator must be able to replicate the flight modes of a UAV. The second goal was to develop a simulator that allows controlling the simulated UAV with a radio control or a joystick. Thanks to this simulator, the company will reduce costs and time in testing new systems and equipment that a UAV can carry, such as cameras and a LIDAR. Also, with the simulator, Venturi will be able to train new pilots without having to leave the office. Novice pilots can learn to configure missions, understand how the basic controls of the UAV work and its flight modes. This will save the time it takes to travel to the location where drones can be flown in accordance with the law, and will save the cost of booking this airspace.

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