Development of Self Conscious UAV

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***Abstract*—The application of UAVs (Unmanned Aerial Vehicles) has been increased day to day in various fields. This paper presents the development of an autonomous UAV which has its application in various fields such as military, agriculture, advances in communication and control systems and civil sectors such as emergency situation, search and rescue, inspection and survey. The self-conscious UAV is an unmanned aerial vehicle, a type of aircraft that can operated without the human intervention depending on the need. The developed prototype model is a fixed wing unmanned aerial vehicle, having the wing span of 1.2m and chord of 0.18m. The calculations are done based on the dimensions of wing span and chord and the model is then designed using CATIA software, after which the UAV is built using balsa wood. The balsa model is incorporated with all electronics such as motor, servos, ESC, battery etc. and this model is checked for stability. The model is fitted with the programmed Pixhawk autonomous board to make the UAV self-conscious. Also the model has a payload compartment where the payload can be placed and deployed accordingly with the help of Servo mechanism. A 2300 mAh 3 cell Li-Po Battery supplies the power to our model. The main aim of this model is to develop the UAV which can be used in military and civil sectors to deliver first aid kit, food and other necessary things needed in emergency situations and used for aerial surveillance and in agricultural field such as can he used as seed bomber and to carry out crop health assessment. Hence by performing such tasks using this model reduces the chances of risking the life of human while carrying the necessary things for people got stuck in the places under flood and drought.**

Keywords— Unmanned Aerial Vehicle, Electronic speed control

I. INTRODUCTION

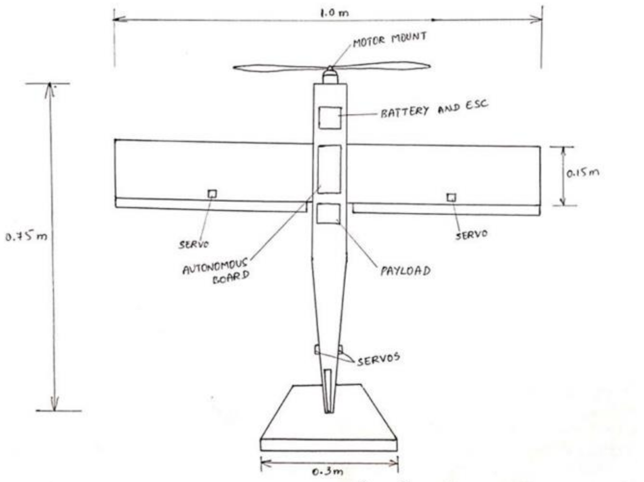
One could say that the first UAV was a stone thrown by a caveman in prehistoric times or perhaps a Chinese rocket launched in the thirteenth century. These “vehicles” had little or no control and essentially followed a ballistic trajectory. If we restrict ourselves to vehicles that generate aerodynamic lift and/or have a modicum of control, the kite would probably fit the definition of the first UAV.

The ability of a UAV to take off, execute a mission and return to its base without the significant human intervention (this is the human-on-the-loop concept rather than the human-in-the-loop concept) is known as the autonomous flight of any aerial vehicle. This autonomy of the unmanned aerial vehicle helps to enhance its application in many domains and results in the less usage of man power as well.

This paper presents the development of a Self-conscious Unmanned Aerial Vehicle which can be used to carry out the task payload deployment at the required area. This mission performed by the UAV is expected to carry out autonomously that is without the intervention of human action in the system during the process. Hence, this UAV is called to be self-conscious (also autonomous) UAV. The UAV developed here can be used in civil, defense and agricultural sectors to carry and deploy the necessary things at any particular place as payload such as first aid kit, food and other necessary things to the places where people got struck in the emergency situations in civil and military sectors, and can also be used for seed bombing in agricultural sector. Performing such tasks using this UAV reduces the chances of risking the life of humans to carry the necessary things for people got stuck in the places under flood and drought. Also, the use of these kinds of UAVs results in conservation of man power.

II. AERODYNAMIC DESIGN

A. Conceptual Designof the fixed wing UAV



SCHEMATIC REPRESENTATION OF FIXED-WING UAV

The conceptual design includes the overall geometry of wing and tail, fuselage shaping, and internal locations of payload, electronic components, autonomous board and other design features.

Design of the UAV using software

The aerial vehicle is designed using the CATIA V5 software. The designing process begins with the wing, primarily and then the fuselage is designed.

Wing

The airfoil of the wing considered here is NACA 2412.

The wing model is designed by extracting the coordinated of the airfoil from the excel sheet.

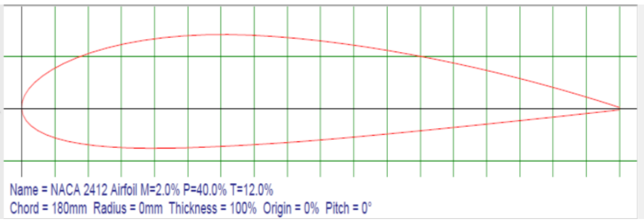
Description of the airfoil

The airfoil, selected here is a four digit NACA series airfoil. The first digit indicating the maximum camber as the percentage of chord, second digit indicating the position of maximum camber in tens' as the percentage of the chord, and last two digits indicating the maximum thickness of the airfoil.

NACA 2412

- 2 – The maximum camber is 2% of the chord.
- 4 – The maximum camber is positioned at (4*10) 40% of the chord.
- 12 – The airfoil has the thickness as 12% of the chord.

The NACA 2412 airfoil selected is shown in the Fig. below



The coordinates of the airfoil NACA 2412 are as follows

Name: NACA 2412 Airfoil [M=2.0% P=40.0% T=12.0%]

Chord(mm) - 180

Radius(mm) - 0

Thickness(%)- 100

Origin(%) - 0

Pitch(deg) - 0

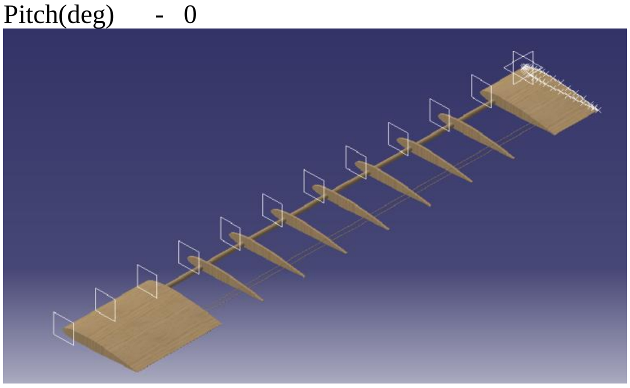


Fig 1 CATIA model of wing

Fuselage

Fuselage being the body of the aircraft, most of the weight of the aircraft lies within the fuselage. All the components of an aerial vehicle such as, motor, payload and necessary electronic components are placed inside the fuselage. Hence, the fuselage must be designed to be strong enough to bear the weight of all these components.

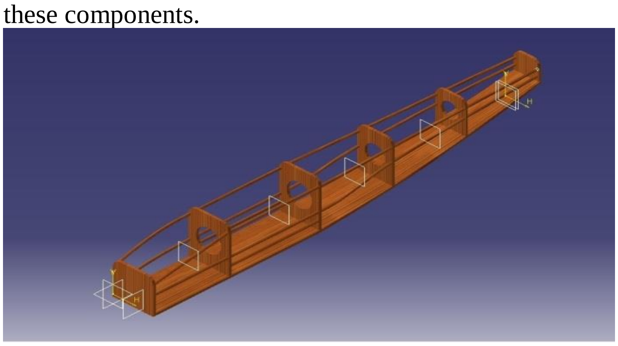
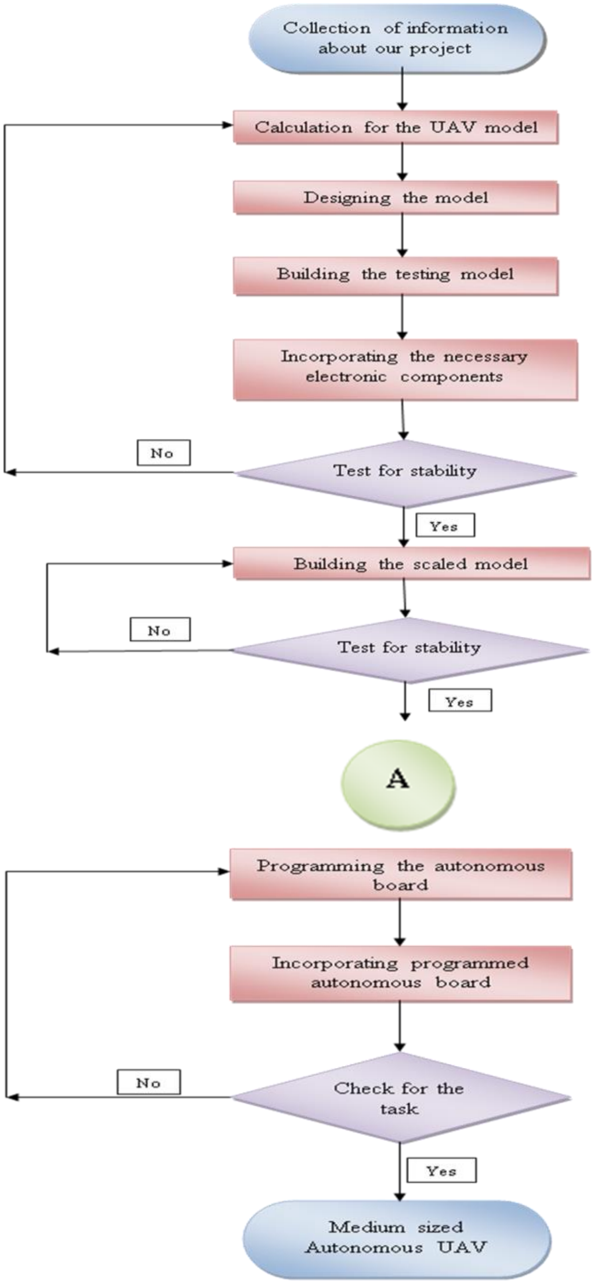


Fig 2 CATIA model of the fuselage

III. MATERIALS AND METHODS

The methodology followed in the development of the Self-conscious Unmanned Aerial Vehicle is as represented in the flowchart below.



The very first step in developing the model is to refer the literature works published on the similar project idea and implementing the required ideas extracted from the referred literatures. Then we proceed to design the model conceptually and decide the dimensions necessary to build the scaled model of the aerial vehicle. The calculations for dimensions of various parts of the aerial vehicle such as fuselage, horizontal and vertical tails and stabilizers are done by considering basically the wing span and chord. And the theoretical aerodynamic behavior of the aerial vehicle is also predicted through calculations. Once the calculations are completed, we then move on to design the aerial vehicle using the software CATIA V5 version. The test model is then built according to the dimensions of the designed model. The built test model is then set to test flight with the incorporation of necessary electronics for the desired task, it is at this step the stability of the model is being tested manually and experimentally. Once, the test model is found to be stable we then proceed with the construction of actual model according to the designed dimensions. The scaled model is the set to fly and the desired task is performed and tested manually. After the task is successfully performed the whole process is done autonomous by programming and incorporating the autonomous board for the desired task.

The key considerations while considering the materials for developing the self-conscious UAV are

- High strength to weight ratio
- Availability and the cost
- Ease of fabrication
- Good structural properties

BALSA WOOD

Balsa wood is used for the construction of model planes, gliders, small sized UAVs. It is considered to be a “miracle material” because of its best strength to weight ratio compared to any other readily available material.

Along with the property of having high strength to weight ratio it is considered to be having low density, easy fabrication, and biodegradable, non-toxic and absorbs shocks and vibrations. The properties of the balsa are considered to be varying along its grain direction and the moisture content in the wood.

PLY WOOD

Plywood is a material manufactured from thin layers or piles of wood veneer that are glued together with adjacent layers having their wood grains rotated up to around 90 degrees to each other. There is usually an odd number of plies, so that the sheet balanced – this reduces warping. Because, ply wood is bonded with grains running against each other and with an odd number of composite parts, it has high stiffness in the direction perpendicular to the grain of the surface ply.

In the UAV developed here, the plywood is used at the places where the load on an aircraft tends to act more such as, the places where landing gears are fixed and the places where the wing is attached with the fuselage.

WING

The wing of the aerial vehicle is developed using Balsa wood according to the desired dimension and according to the designed software model. The ‘Ribs’ are made by cutting the balsa sheet using ‘LASER cutting method’. They are placed at equidistant and are connected together with the spars

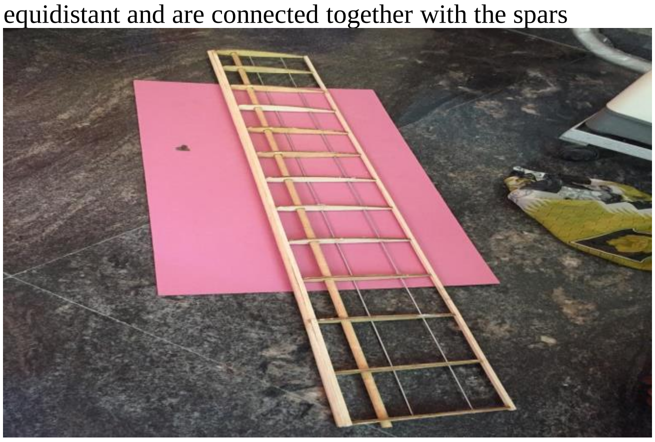


Fig 3 Skeletal model of the wing

FUSELAGE

The fuselage being the body of the aircraft, it is designed and developed accordingly to withstand the weight of all the components and payload placed inside it. The basic structures of the fuselage, ‘Bulk head’ and ‘Formers’ are developed and placed at certain distances as per the designed model.

Fig 4 Skeletal model of the fuselage

TAIL SECTION

The tail section consists of Horizontal tail with horizontal stabilizer that is, ‘Elevator’ and vertical tail with vertical stabilizer that is, ‘Rudder’. The tail section is also developed according to the calculated dimensions using the Balsa wood.

FABRICATION

Fabrication is the process of providing a neat finishing to any model by covering it with the suitable fabricating material. It is the final step in the development of any model or component. The main purpose of fabrication is to provide smooth finishing to the model to ensure that there are no any irregularities on the surface of any model.

Here, the fabrication process is done by using the Monokte covering film. Proper covering of this film on the surface of the model facilitates smooth flow over the body and hence results in the decrease of skin friction drag caused on the aerial vehicle.

Fig 5 Developed UAV

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IV.ELECTRONIC COMPONENTS

Motor

The motor used for UAV is Avionic pro c3536 kv1050 brushless motor which works under maximum continues current 36Amps and maximum continuous power 570watts.

Electronic Speed Control(ESC)

ESC is a device used to control the speed of the motor. The ESC used for this UAV is 40Amps.

Servo

An Electronic Servo is a device used for the actuation of control surfaces. In the project 9g servo is used for the movement of control surfaces.

Pixhawk for autonomous flight

Pixhawk is an open source hardware used for autopilot in the UAVs.

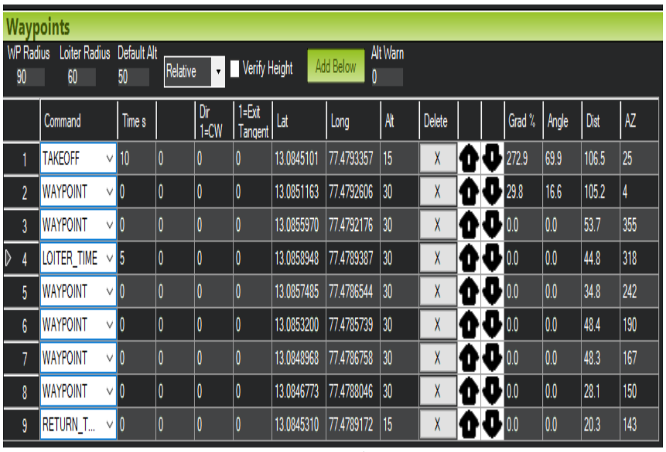
- 32-bit ARM Cortex M4 core with FPU
- 168 Mhz/256 KB RAM/2 MB Flash
- 32-bit failsafe co-processor
- MPU6000 as main accel and gyro
- ST Micro 16-bit gyroscope
- Ideal diode controller with automatic failover
- Servo rail high-power (7 V) and high-current ready
- All peripheral outputs over-current protected, all inputs ESD protected

MISSION PLANNER

- Mission Planner is a full-featured ground station application for the ArduPilot open source autopilot project.
- A few things can do with Mission Planner:
- Load the firmware (the software) into the autopilot board (i.e. Pixhawk series) that controls your vehicle.
- Setup, configure, and tune your vehicle for optimum performance.
- Plan, save and load autonomous missions into you autopilot with simple point-and-click way-point entry on Google or other maps.
- Download and analyse mission logs created by your autopilot.
- Interface with a PC flight simulator to create a full hardware-in-the-loop UAV simulator.
- With appropriate telemetry hardware you can:
- Monitor your vehicle’s status while in operation.
- Record telemetry logs which contain much more information the the on-board autopilot logs.
- View and analyse the telemetry logs.
- Operate your vehicle in FPV (first person view)
- All of these and many more features are covered here.

The flight path of the aerial vehicle to be followed for carrying out the mission of payload deployment is done using the Mission Planner software. The path is planned by mission planner by assigning the number of waypoints in the missioned path and name is assigned for each waypoint if needed. The altitude for each waypoint is entered in the specification table, also the time delay at the waypoint of payload deployment can be done by entering the desired time delay for the purpose of deployment of payload at the point with near accuracy.

Fig 6 Planned Mission Path



Waypoints

WP Radius 90 | Loiter Radius 60 | Default Alt 50 | Relative | Verify Height | Add Below | Alt Warn 0

	Command	Time s		Dir 1=CW	1=Exit Tangent	Lat	Long	Alt	Delete			Grad %	Angle	Dist	AZ
1	TAKEOFF	10	0	0	0	13.0845101	77.4793357	15	X			272.9	69.9	106.5	25
2	WAYPOINT	0	0	0	0	13.0851163	77.4792606	30	X			29.8	16.6	105.2	4
3	WAYPOINT	0	0	0	0	13.0855970	77.4792176	30	X			0.0	0.0	53.7	355
4	LOITER_TIME	5	0	0	0	13.0858948	77.4789387	30	X			0.0	0.0	44.8	318
5	WAYPOINT	0	0	0	0	13.0857485	77.4786544	30	X			0.0	0.0	34.8	242
6	WAYPOINT	0	0	0	0	13.0853200	77.4785739	30	X			0.0	0.0	48.4	190
7	WAYPOINT	0	0	0	0	13.0848968	77.4786758	30	X			0.0	0.0	48.3	167
8	WAYPOINT	0	0	0	0	13.0846773	77.4788046	30	X			0.0	0.0	28.1	150
9	RETURN_T...	0	0	0	0	13.0845310	77.4789172	15	X			0.0	0.0	20.3	143

Fig 7 Waypoints of path planned

V.RESULTS

- In this research project, a fixed wing unmanned aerial vehicle model of total weight 2 kg was designed and developed.
- This UAV is made to fly autonomously from point to point by using programmed Arduino.
- The payload compartment of the model was fitted with the first aid kit of 500 grams and tested for the payload deployment
- Hence the performance of the Self-conscious UAV met the objectives that the team had initially set out.
- Payload can be replaced with any other carriage system so that it can carry medical assistance, food supply during floods etc.

VI.DISCUSSION

The Self-conscious (autonomous) Unmanned Aerial Vehicle developed can be used in future by slightly modifying the programme for specific tasks. It can be used in defense sector by incorporating the bombs to be dropped at a specific location and in agricultural sector can be used as seed bomber. The aerial vehicle can also be used in transporting the goods from one place to another in a short period of time for civil applications.

VII.ACKNOWLEDGMENTS

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REFERENCES

[1] Introduction to UAV Systems(fourth edition)- Paul gerin Falstrom & Thomas James Gleason

[2] Design of a Low-Cost Fixed Wing UAV- Mochammad Ariyanto; Joga D. Setiawan; Teguh Prabowo; Ismoyo Haryanto; Munadi - MATEC Web of Conferences 159, 02045 (2018)

[3] Autonomous UAV System Development for Payload Dropping Mission- Ghozali S. Hadi; Rivaldy Varianto; Bambang Riyanto T; Agus Budiyono - The Journal of Instrumentation, Automation and Systems-2014

[4] Multipurpose UAV for search and rescue operations in mountain avalanche events- Mario Silvagni; Andrea Tonoli; Enrico Zenerino & Marcello Chiaberge- DOI: 10.1080/19475705.2016.1238852-07oct2016

[5] Development of a Small-scale Autonomous UAV for Research and Development- M.S.A. Rushdi; T.M.A. Tennakoon; K.A.A. Perera; A.M.H.Wathsalya; S. R. Munasinghe- DOI: 10.1109/ICIAFS.2016.7946541- Nocember2017

[6] Autonomous Unmanned Aerial Vehicles for Agricultural Applications- Bastiaan A. Vroegindeweij; Sjoerd W. van Wijk ; Eldert J. van Henten- International conference on agricultural engineering-2014

[7] UAS- BIM based Real-time Hazard Identification and Safety Monitoring of Construction projects- Sepehr Alizadehsalehi; Mahsa Asnafi;Ibrahim Yitmen;Tolga Celik- Research gate publication-july2017

[8] Designing and Testing a UAV Mapping System for Agricultural Field Surveying- Martin Peter Christiansen; Morten Stigaard Laursen; Rasmus Nyholm Jørgensen; Soren Skovsen; René Gislum-MDPI-2017

[9] Fundamental Research on Unmanned Aerial Vehicles to Support Precision Agriculture in Oil Palm Plantations- Redmond Ramin Shamshiri; Ibrahim A. Hameed; Siva K. Balasundram; Desa Ahmad; Cornelia Weltzien; Muhammad Yamin http://dx.doi.org/10.5772/intechopen.80936

[10] Development of an Unmanned Aerial Vehicle (UAV) for hyper resolution vineyard mapping based on visible, multispectral, and thermal imagery -D. Turner ; A. Lucieer

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