OMEGAv1.0- A VTOL Fixed Wing UAV
(AN AUTONOMOUS PLANETARY AERIAL SYSTEM)

Jerrin Bright[1]
[1]School of Mechanical Engineering
Vellore Institute of Technology, Chennai, India

Abstract: In this project, we have designed a completely autonomous aerial system called OMEGA, which is a Vertical-Takeoff and Landing Unmanned Aerial Vehicle capable for undertaking martian logistic and reconnaissance missions. The complete system we have equipped will be explained in brief via this paper. Completely designed and tested from scratch considering the compatibility for flight in a martian environment.

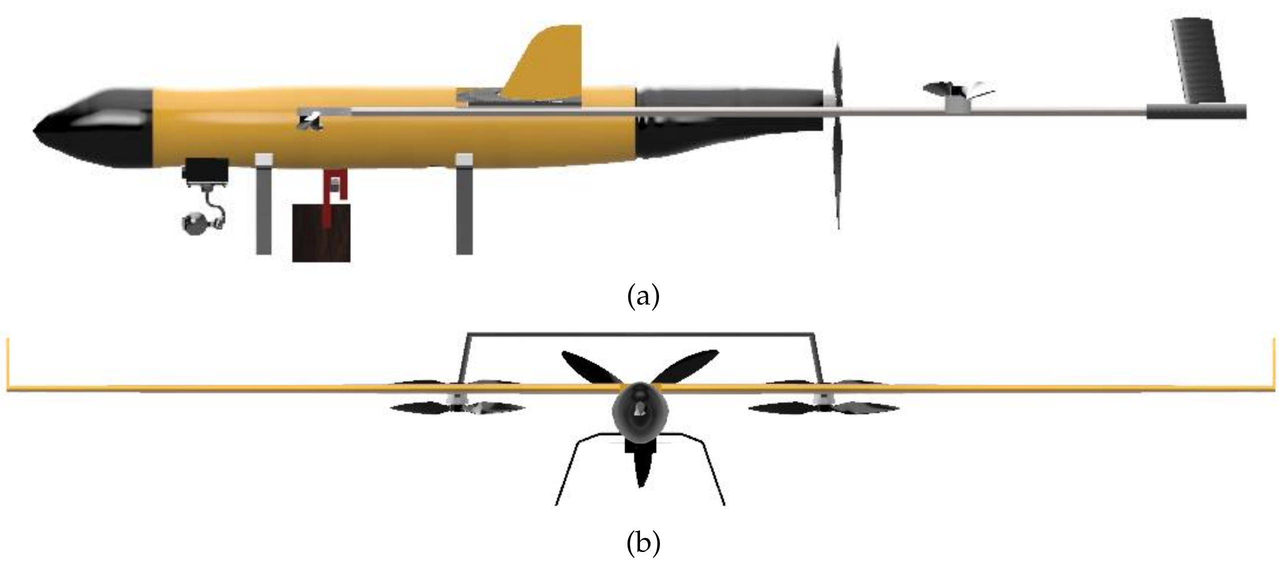
Keywords: Mars exploration; VTOL; UAV; SLAM

1. Introduction

Mars missions are very exciting and stimulating exploration in the current era. Such exploration is believed to be enhanced twofold by using aerial exploration methods. Thus, we have designed a completely autonomous aerial system considering the martian environmental constraints in mind. In the reminder of this work, we will discuss mechanical, electrical, communication, control systems and the software systems equipped for OMEGA.

2. Designing and Simulation

We have used Solidworks for designing; Ansys for Simulation and CFD analysis; Fusion360 for rendering. The design of OMEGA consists of 8 modules: Fuselage, Wing, Rudder, Ailerons, Elevator, Stabilizers and Gripper. The Fuselage is the core of OMEGA streamlined in nature and contains all the components necessary for successful operation of OMEGA. Wings are essential to hold OMEGA in air by upholding the lift. The Ailerons, Elevator and Rudder control the direction of flight of OMEGA. The stabilizers help in direction stability and control. Grippers are used to grasp an object when needed in the martian environment.



(a)

(b)

Figure 1. Structural Framework of OMEGA

Aerofoil parameters were tested using the simulated wind tunnel testing with martian parameters and NACA 0012-48 resulted in the best fit. We then analyzed the Aerofoil, propellers and the overall design using CFD. A rack and pinion setup were used for gripper design considering the steadiness and stability of the built. For weatherproofing in martian environment, silicon conformal coating for water splashes and vibration motors for sand and dust motors were used.

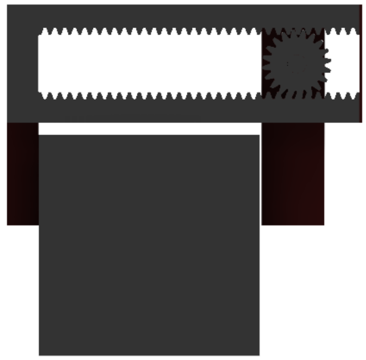


Figure 2. Gripper of OMEGA

3. Electronics

3.1 Propulsion Systems
We are using electronic propulsion system for OMEGA. Moreover, the prime advantage of electronic propulsion systems is that the energy lost will be restocked from the solar panels attached to the wings.

3.2 Power Supply
We are using solar power supply for OMEGA considering its abundance and ease. In particular, OMEGA is equipped with Sun power C-60 photovoltaic solar cells which is highly reliable and efficient with its unique copper foundation.

3.3 Sensor Modules

Table 1. Component Description

Component Name	Quantity	Total Weight	Total Cost
Jetson Nano	1	250	10,000
IMX219-83 + IMU	1	45	4600
IMX586Cam + Gimbal	1	300	15,000
IMU MPU9250	1	30	1200
COBRA CM-2217/20 950 KV	4	304	9000
Spider Pro 30A F390 ESC	4	44	8000
COBRA C-2820/14 840 KV	1	100	3000
FMS 40A ESC with Brake	1	50	2500
Mg995 Servo Motor	4	240	1400
32 Ch Servo Controller	1	20	3500
10 x 18 APC Propeller	1	30	250
10 x 22 APC Propeller	4	100	1000
UBEC	1	7	2500
PCBs	3	15	1000
Gas Sensors	5	45	2300
4S 10,000 mAh LiPo 25C	1	600	5800
Highly insulative Aerogel	1	100	700
Total	**31**	**2280**	**60,750**

4. Communication

We are using 900 MHz Zigbee-Pro Digi Long-range RF module which is designed by us to relay information over a distance of up to 15 miles or 24 kilometers. An ADF7023 transceiver is built in for analog signal transmissions, low power consumption and draws power less than 2.5uA. Thus, with a superior 15 miles of line of sight, ZigBee we are using takes 20% less current than the traditional modules.

5. Software Systems

The complete Software system of OMEGA is visualized in Fig. 3. Our UAV System is developed on ROS melodic running on Ubuntu 18.04 version. ROS is chosen to make the subsystems more efficient and faster. All these subsystems are interdependent in nature; ROS empowers in doing so. Since deploying is done on Nvidia jetson nano our architecture is efficient, fast and light.

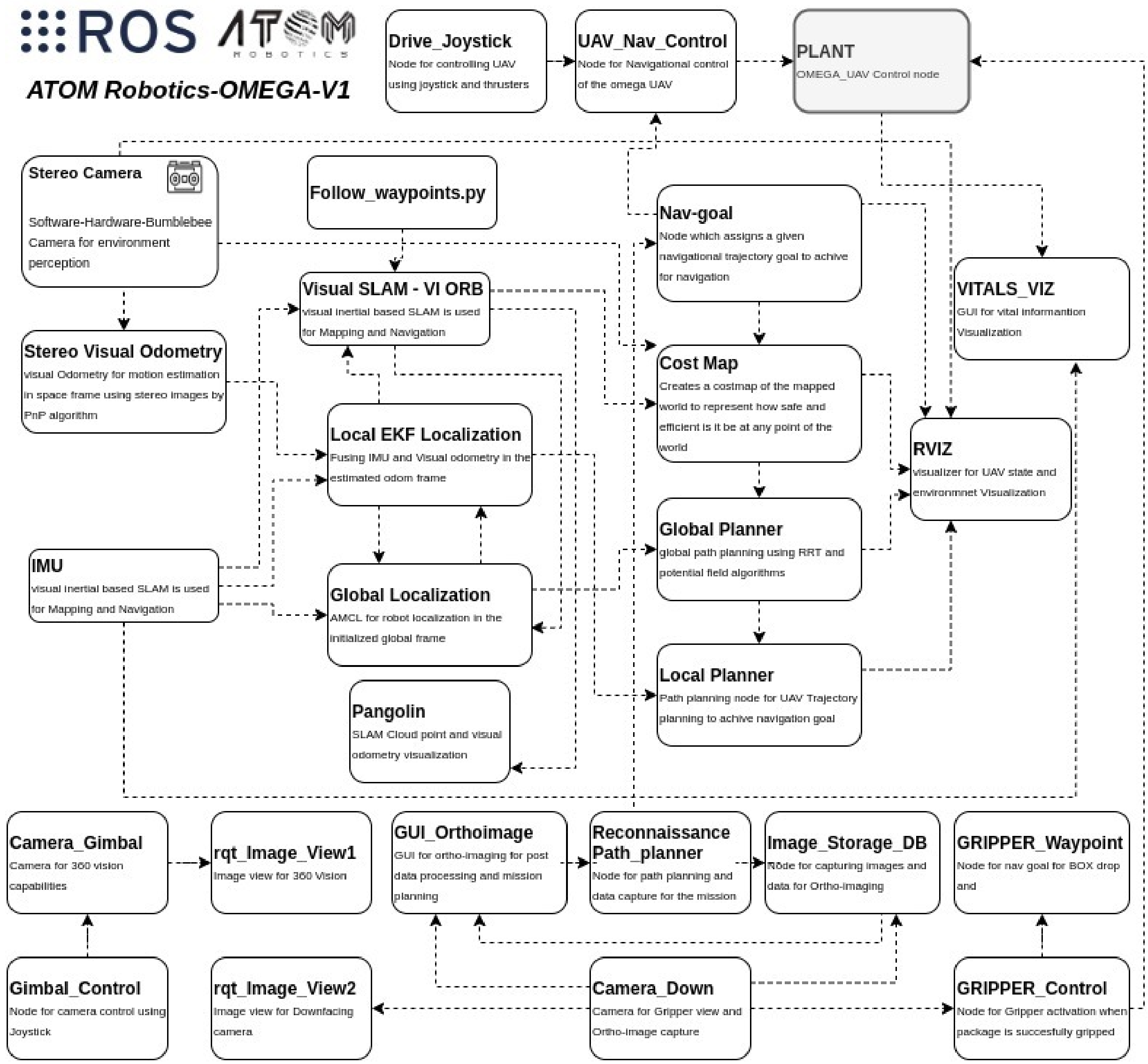


Figure 3. Pipeline of the Software Stack

Path planning approach using RRT algorithm is visualized in Fig. 4. The algorithm is designed such a way that it will stop when a node is generated within the goal region.

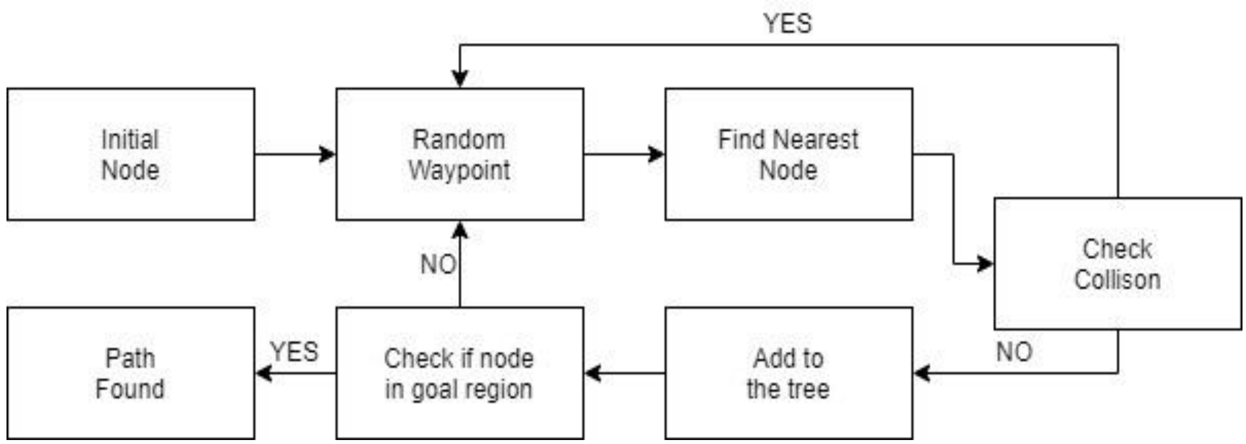


Figure 4: RRT Algorithm

Orthomosaic imaging for understanding the martian atmosphere better is visualized in Fig. 5.

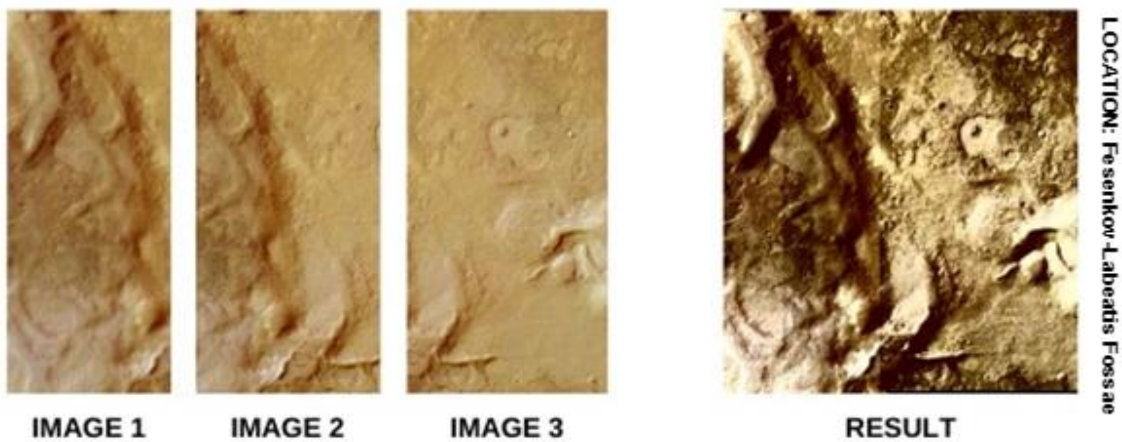


Figure 5. Orthomosaic imagery

Landscape recognition using HiRISE dataset and visualized two of those in Fig. 6. Used a variant of Attention based Residual Network for recognition. This network was applied over the orthomosaic image we obtain from OMEGA to find the landscape of the orthomosaic imageries obtained.

(a) (b)

Figure 6. Landscape obtained from HiRISE

6. Control Systems

Fig. 7 represents the PID control system adapted during the horizontal movement of OMEGA where the direction and speed are regulated by the PWM of the elevator, rudder and alerions.

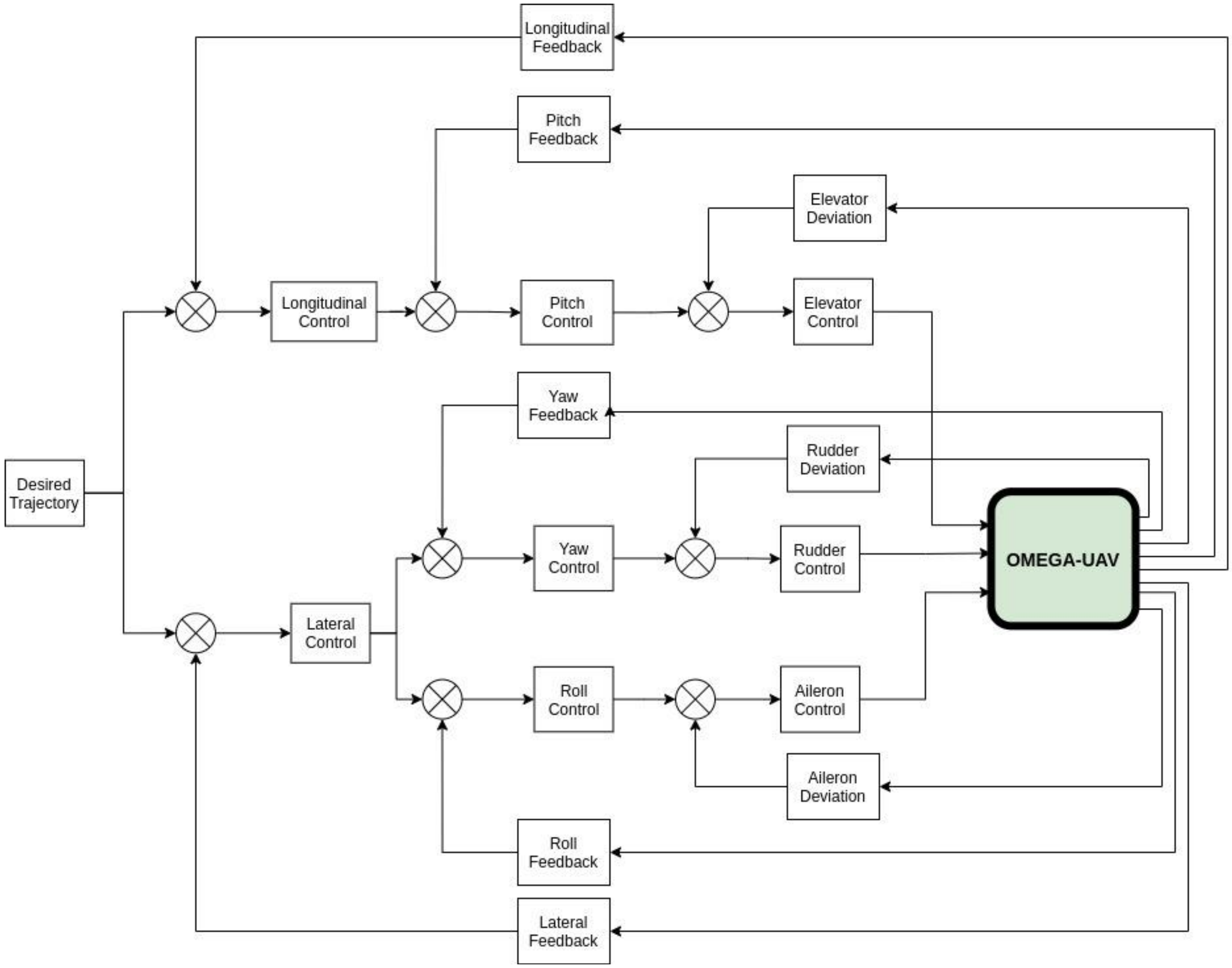


Figure 7. Control System for the forward thrusters

Fig. 8 represents the PID based control system adapted by OMEGA for the vertical takeoff that's vertical movement of the UAV using the drones four motors.

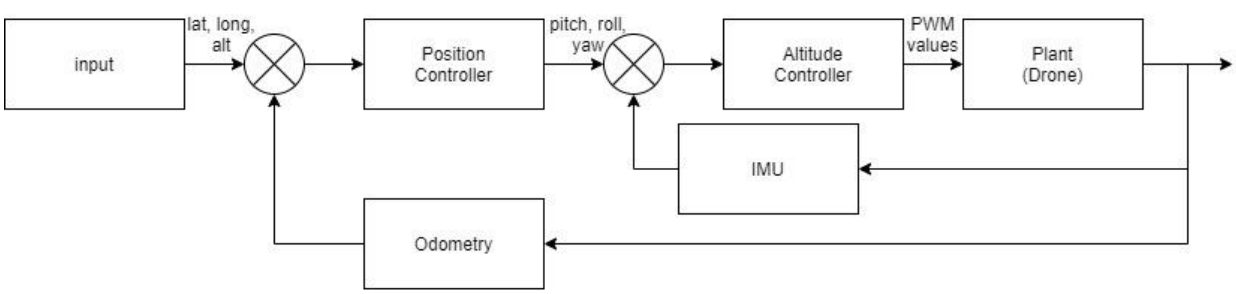


Figure 8. Control System for VTOL

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