International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 1
DOI: https://doi.org/10.17762/ijritcc.v11i1.6056
***Article Received**: 20 November 2022 **Revised**: 16 December 2022 **Accepted**: 04 January 2023*

Hybrid Autonomous Vehicle (Aerial and Grounded)

Subba Reddy V[1], Venu Madhav[2], Bhargav M[3], Anjani Krishna A[4], Kishore A[5], Syed Inthiyaz[6], Sk Hasane Ahammad[7]

[1]Deparrment of ECE, Koneru Lakshmaiah Education Foundation
Guntur, India-522502
[2]Department of ECE, Prasad V Potluri Siddartha Institute of Technology
Vijayawada
[3]Deparrment of ECE, Koneru Lakshmaiah Education Foundation
Guntur, India-522502
[4]Deparrment of ECE, Koneru Lakshmaiah Education Foundation
Guntur, India-522502
[5]Deparrment of ECE, Koneru Lakshmaiah Education Foundation
Guntur, India-522502
[6]Deparrment of ECE, Koneru Lakshmaiah Education Foundation
Guntur, India-522502
[7]Deparrment of ECE, Koneru Lakshmaiah Education Foundation
Guntur, India-522502
ahammadklu@gmail.com

Abstract—This work discusses hybrid autonomous vehicles that are grounded and aerial vehicles that are utilized to select their course based on their environmental characteristics. It includes algorithms for path planning, obstacle avoidance, and trajectory planning. It also has a microcontroller, known as the PIXHAWK Flight Controller, for various transmissions and configurations. Calibration and testing are performed using Mission Planner software. This article shows the different problematic features of an autonomous vehicle with several functionalities.

Keywords-Autonomous Vehicle, AGV, AAeV, Hybrid Vehicle, Semi-Autonomous, Aerial - Grounded, Path Planning, Obstacle Avoidance, Trajectory Planning.

I. Introduction

A vehicle conveys goods or people from one region to another through the land, air, transit, or Marine. The current vehicular system incorporates various qualities such as an Electronic Control Unit, Sensors, and Actuators enabling Level 2 and higher Vehicle Autonomy. When it comes to Hybrid Vehicular Technology, it represents the combination of two or more modes of transportation, such as Aerial - Grounded, Grounded - Marine, Aerial - Marine, and so on. A Hybrid Vehicle with airborne and ground capabilities. It is a modern technology that comprises of a hybrid vehicular type. According to its capabilities and environmental circumstances, the wheel supports interchanges to aerial and grounded mode of transmission. This might be utilized to facilitate quick transportation from one site to another. It can detect and modify its method of transmission by utilizing various sensors or a predefined route.

Figure 1. Pix-Hawk 2.4.8

The complex 32-bit ARM CortexM4 processors, SPI, I2C, CAN, and UART interfaces of the PIXHAWK 2.4.8. It can manage and configure a large number of aerial and ground vehicles, and it includes 14 PWM to control velocity, displacement, and orientation. Several bus interfaces are used to interact with external devices like as sensors, micro-controllers, and radio antennas. Control Area Network (CAN) protocol is supported for remote configuration and calibration. This

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 1
DOI: https://doi.org/10.17762/ijritcc.v11i1.6056
***Article Received**: 20 November 2022 **Revised**: 16 December 2022 **Accepted**: 04 January 2023*

includes many built-in sensors such as the MPU6000 as the main accelerometer and gyroscope, the ST Micro LSM303D Magnetometer, and the MEAS MS5611 Barometer, all of which are programmable and consistent.

Figure 2. Neo 9M GPS

The receiving positioning data by using real-time coordinates and is linked to ground stations, satellites, and a network of receivers of a NEO 9M GPS as shown in Fig 2. It must be interfaced with a supported micro-controller for calibration and firmware updates.

Figure 3. Telemetry 915 MHz

The Telemetry illustrates the Radio Signals produced by the Transmitter and Receiver via Telemetry Data Transmission. It transmits and receives data using 433Mhz Electromagnetic Waves. It is mostly used to calibrate and customize data transmitted via wireless transmission.

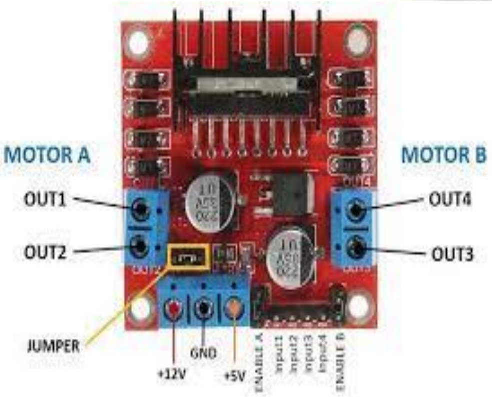

Figure 4. L298N Motor Drivers

Figure (4) depicts a 15-lead Multi-watt and Power packaging with an embedded mono-licit circuit. It has dual full bridge consists of higher voltages and currents driver designed to control conventional Transistor Transistor Logic levels and drive inductance load like as transistor switches (Relays), solenoids, Direct Current and stepper motors known as L298N Motor Driver. The motion of the Motor can be monitored as well as controlled by it.

Figure 5. Li-DAR

Figure (5) depicts the Light Detection and Ranging that uses light pulses to detect ranges of object. It has an ability to generate Dimensional analysis of given Geographical Environment.

Figure 6. UAV (Drone)

UAV's as shown in Fig 6. are composed of a variety of protocols that aid in the combination of several data transmissions. The sensors will provide information from the environment to the micro-controller. Because a hybrid vehicle always has two controller boards, data must be sent between them. We may link the two controllers that used the I2C protocol. The serial data from the pix-hawk will then be sent to the Arduino board. The FTDI protocol can be used to establish a wireless connection.

Figure 7. Grounded Vehicle

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 1
DOI: https://doi.org/10.17762/ijritcc.v11i1.6056
***Article Received**: 20 November 2022 **Revised**: 16 December 2022 **Accepted**: 04 January 2023*

A grounded vehicle or land Vehicle is the functioning of a vehicle that operates on land and on guided roads as shown in Fig 7. This is regulated and monitored via instrumentation measures and monitoring devices such as LED's, LCDs, and so on. It is also controlled by Micro - controller Signal Inputs and gets data from various sensors through digital or analog pulses. Track pads, wheels are responsible for the motion of vehicle.

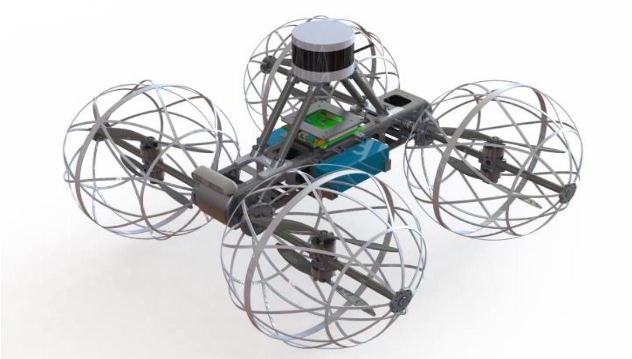

Figure 8. Hybrid Vehicle

A hybrid vehicle as shown in Fig 8. is a combination of two or more vehicles that may switch modes dependent on its specifications and configuration. It has a capability to train itself to maintain stability and control over its functionalities. It uses FTDI and I2C serial protocols to communicate with one micro-controller to another micro-controller as well as sensors data.

II. WORKING PRINCIPLE

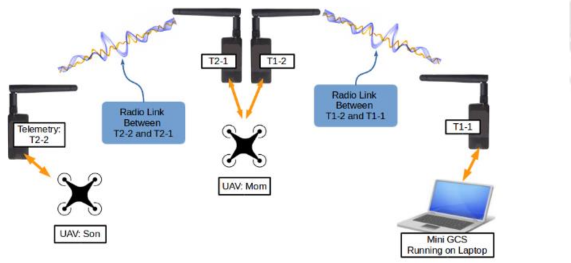

Figure 9. Telemetry Communication (T1<=>T2)

For Wireless communication CAN Protocol is used as well as Telemetry Following this, path planning is introduced as shown in Fig 9. Generally, path planning may be accomplished with mission planner software. For the specified route, we may give fixed locations. A route that is both terrestrial and aerial. When the instruction is provided in such a way that the vehicle travels on the ground from point A to point B and in the air from point B to point C. Because of the channel shifting feature, both kinds of transmission will occur.

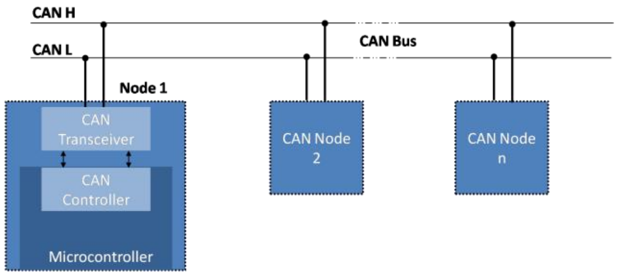

Figure 10. CAN (Controlled Area Network)

CAN protocol gathers data from various sensors and fused together from one ECU (Electronic Control Unit) to another ECU. It is multiple access protocol with arbitration of data priority as shown in Fig 10.

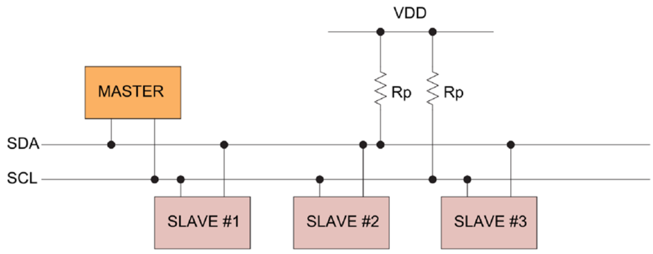

Figure 11. I2C (Serial Communication)

Inter-Integrated Circuit is a serial bus connection protocol used in serial communication devices. It is popular miniature-distance communication protocol. It is a communication protocol in which it uses Serial Communication between end-device and controller.

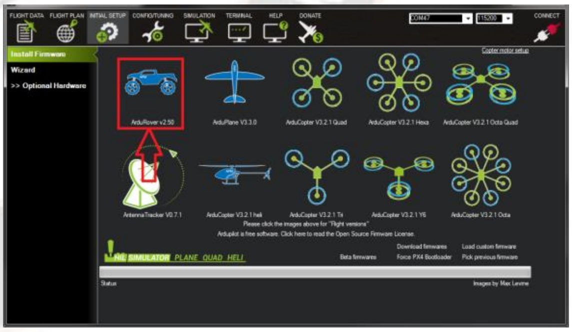

Figure 12. Mission Planner Rover Setup

Figure 12 depicts the setup and calibration model of a grounded vehicle that must be configured according to its specifications and user requirements. This consists of various parameters which include Motor layouts, Driver, GPS, Compass, Accelerometer, Gyroscope, Trajectory and obstacle avoidance (PX4 Flow). This is to be done after installing the Rover Firmware module as shown in Fig 12.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 1
DOI: https://doi.org/10.17762/ijritcc.v11i1.6056
***Article Received**: 20 November 2022 **Revised**: 16 December 2022 **Accepted**: 04 January 2023*

Figure 13. Mission Planner Rover position after calibration

After successful calibration it will display the real time status which includes direction, Coordinates, Altimeter, Position and Orientation values will be displayed as shown in Figure 13.

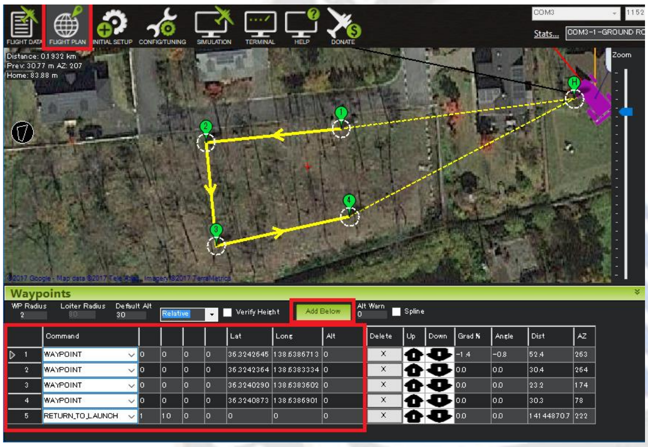

Figure 14. Mission Planner Rover Path Planning

Fig 14 displays the vehicle way points in which it needs to satisfy by reaching the coordinates assigned to it without human interaction. If the vehicle completes one cycle with error rate less than 10% then it is said to be a autonomous Grounded Vehicle.

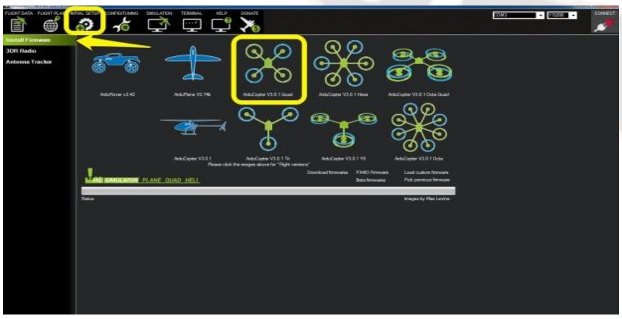

Figure 15. Mission Planner Quad-copter Setup

Figure 15 depicts the setup and calibration model of a Aerial vehicle that must be configured according to its specifications and user requirements. This consists of various parameters which include Motor layouts, ESC, GPS, Compass, Accelerometer, Gyroscope, and obstacle avoidance (PX4 Flow). This is to be done after installing the Rover Firmware module as shown in Fig 15. For the automatic transmission the Transmitter must be calibrated for better outcomes.

Figure 16. Mission Planner Copter position after calibration

After successful calibration it will display the real time status which includes direction, Coordinates, Altimeter, Position and Orientation values will be displayed as shown in Figure 16.

Figure 17. Mission Planner Copter Path Planning

Fig 17 displays the vehicle way points in which it needs to satisfy by reaching the coordinates assigned to it without human InterAction. If the vehicle completes one cycle with error rate less than 10% then it is said to be a autonomous Aerial Vehicle.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 1
DOI: https://doi.org/10.17762/ijritcc.v11i1.6056
***Article Received**: 20 November 2022 **Revised**: 16 December 2022 **Accepted**: 04 January 2023*

III. ALGORITHMS &MATHEMATICAL MODELING

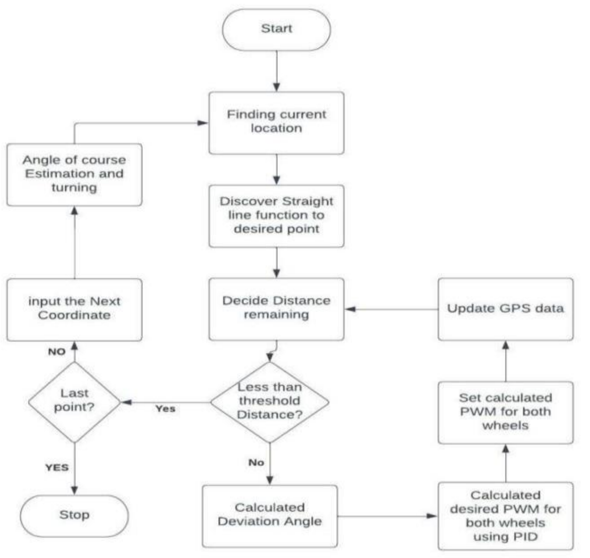

Figure 18. Flow Chart for Path-Planning Algorithm

The proposed classification considers how path planning algorithms work. Many previous reviews made two types of distinctions: whether the environment is dynamic or not, and between online and offline path planners. As well as the scale of environmental conditions, either local or global. Typically, the online is co-related to the local, whereas offline is co-related to the global. The major issue with this is there are various algorithms can be classified as belonging to both categories. Because of its high computational speed, an algorithm with no re-planning potentiality could be used as an online. The inverse could also occur. The Dynamic Window Approach (DWA), for example, is a reactive computing algorithm that is typically used for localization but can be used for globalization. And colleagues make an intriguing distinction within algorithms that requires preliminary map presentation and those that do not (advanced). Traditional methods include Graphical based Search, whereas computational intelligence and random sample algorithms are examples of advanced methods. Considering to the robot model (holonomic, non-holonomic, kinematic), according to the modeling of map requirement; consequently, to the planning ability (offline or online); and according to algorithm for weather always measures the same statement or not, according to configuration parameters for first one, propose various clear and reasonable path planning categories (deterministic or probabilistic).

The classification proposed in this paper serves two functions. For starters, this category aims to cover broader range of algorithms compared to previous reviews. Many previous reviews claim to represent the general overview of path planning.

$$f(n) = K_1 g(n) + K_2 h(n) + K_3 p(n) \quad \text{(Eq.01)}$$

$$rhs(s) = \begin{cases} 0 \\ min_{s' \in pred(s)}(g(s') + c(s,s')) \end{cases} \quad \text{(Eq.02)}$$

$$K(s) = [\min(g(s), rhs(s)) + h(s); \min(g(s), rhs(s))] \quad \text{(Eq.03)}$$

$$\emptyset_{xx}(z_i, y_i) = \frac{u(z_i+2, y_i) - 2u(z_i, y_i) + u(z_i-1, y_i)}{h^2} - \frac{k^2 u_{xxxx}(z_i, y_i)}{12} \quad \text{(Eq.04)}$$

$$\emptyset_{yy}(z_i, y_i) = \frac{u(z_i, y_i+1) - 2u(z_i, y_i) + u(z_i, y_i-1)}{k^2} - \frac{k^2 u_{yyyy}(z_i, y_i)}{12} \quad \text{(Eq.05)}$$

$$h^2 \emptyset(z_i, y_i) = u(z_i+1, y_i) + u(z_i-1, y_i) + u(z_i-1, y_i)\, u(z_i, y_{i+1}) + u(z_i, y_{i-1}) - 4u(z_i, y_i) \quad \text{(Eq.06)}$$

These Equations refer to Path planning in which it represents the orientation and trajectory for every event in the given path or position. It follows the Inverse Kinematics to plan its motion based on the desired plan.

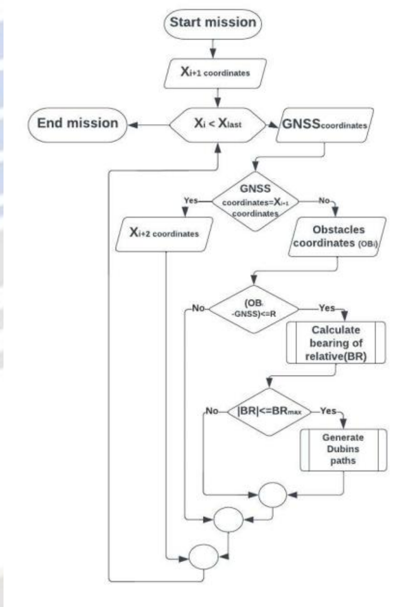

Figure 19. Flow chart for Obstacle Avoidance Algorithm

Unmanned aerial vehicles (UAV's) are becoming increasingly important for enhanced search and rescue, scrutiny, remote sensing, and other enhancements as science and technology advance. Multiple UAV collaborative control is a potential method for carrying out these tasks. A quad-rotor UAV double loop control technique is proposed based on the acceleration matching approach, which successfully reduces the position gap between each UAV and the virtual leader in the presence of external disturbances. It can also allow cooperative control of numerous quad-rotor UAV's and make additional efforts to improve the system reliability of the flying system. A widely distributed leader-follower flocking control mechanism. It will use a parallel-triggering mechanism (PTS). Unlike

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 11 Issue: 1
DOI: https://doi.org/10.17762/ijritcc.v11i1.6056
***Article Received**: 20 November 2022 **Revised**: 16 December 2022 **Accepted**: 04 January 2023*

traditional flocking control algorithms, this technique is assigned to various quad-rotor UAVs to address the issue of flight stability in the face of a variety of obstacles and the UAV's limited thrust, and it employs PTS to preserve and improve communication resources, various simulations and compilers are offered to prove the suggested technique may further lower transmission exchange rate than an event-triggered scheme.

$$\log(r(z,y) = \log(\sqrt{(z-z_0)^2 + (y-y_0)^2} \quad \text{----------(Eq.07)}$$

$$\frac{\partial}{\partial_x}\log\big(r(x,y)\big) = \frac{x-x_0}{r(x,y)} \quad \text{----------(Eq.08)}$$

$$\frac{\partial}{\partial_y}\log\big(r(z,y)\big) = \frac{y-y_0}{r(z,y)} \quad \text{----------(Eq.09)}$$

$$\nabla_{\emptyset_a} = \nabla_{\emptyset_{wallsa}} + \nabla_{\emptyset_{leftclosed}} + \nabla_{\emptyset_{rightopen}} \quad \text{----------(Eq.10)}$$

$$\nabla_{\emptyset_b} = \nabla_{\emptyset_{wallsb}} + \nabla_{\emptyset_{leftopen}} + \nabla_{\emptyset_{rightclosed}} \quad \text{----------(Eq.11)}$$

$$\nabla_{\emptyset_c} = \nabla_{\emptyset_{wallsc}} + \nabla_{\emptyset_{leftclosed}} + \nabla_{\emptyset_{rightopen}} \quad \text{----------(Eq.12)}$$

$$\nabla_{\emptyset_d} = \nabla_{\emptyset_{wallsd}} + \nabla_{\emptyset_{leftopen}} + \nabla_{\emptyset_{rightclosed}} \quad \text{----------(Eq.13)}$$

$$\nabla\emptyset_a - \nabla\emptyset_b = \nabla_{\emptyset_{leftclosed}} - \nabla_{\emptyset_{leftopen}} + \nabla_{\emptyset_{rightopen}} - \nabla_{\emptyset_{rightclosed}} \quad \text{----------(Eq.14)}$$

$$\nabla\emptyset_c - \nabla\emptyset_d = \nabla_{\emptyset_{leftclosed}} - \nabla_{\emptyset_{leftclosed}} + \nabla_{\emptyset_{rightopen}} \quad \text{----------(Eq.15)}$$

IV. CIRCUIT DIAGRAM

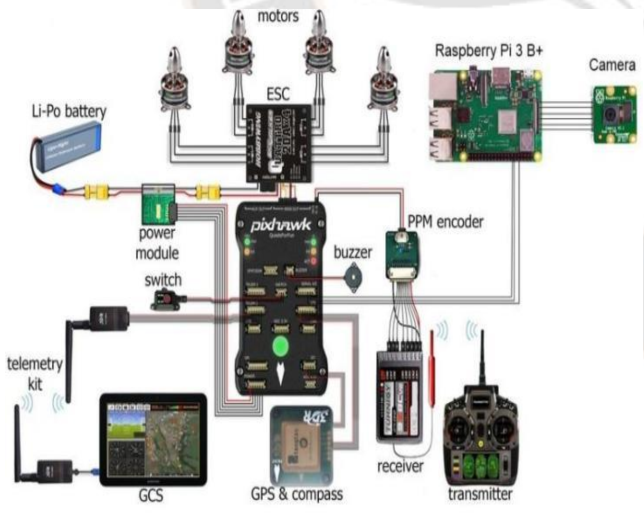

Figure 20. Circuit Diagram for Pix Hawk

The Pix Hawk consists of several I/O ports which sends and receives data from external connected devices. In Fig 20 it displays the connections between Pix Hawk and several external Sensors and Modules which is responsible for proper customization of the vehicle. The GPS, Telemetry, Receiver module, SC followed by BLDC motors, Power Module followed by Battery, FPV Camera, Li-DAR are known as external devices which is displayed in Fig 20. For connecting we use FTDI protocol which enhances the data format to TTL format.

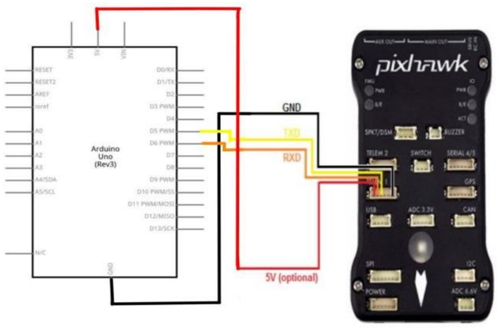

Figure 21. FTDI Serial communication b/w Pix Hawk & Arduino

Fig 21 represents the circuit consists of interfacing between Arduino UNO and Pix Hawk via Serial Communication. The Arduino gets the data from Pix Hawk and its modules and Sensors. It helps to sort the data required from additional data. As the data transfer is mostly Analog the I2C communication is accurate and highly responsive.

V. RESULTS

Figure 22. Output of Hybrid Vehicle (Grounded and Aerial)

Figure 23. Output of Hybrid Vehicle (Path Planning)

The results from fig 22 and fig 23 are the path monitoring and vehicle monitoring display where the path information and coordinates can be viewed. On the other hand, the mission planner can also diagnose vehicles. Transmit back to the user panel.

VI. CONCLUSION

This work concludes the working model of a hybrid vehicle. It can be autonomous, both aerial and ground vehicles. A path planner can do path determination. Different algorithms are used in the design of hybrid vehicles. Each has different applications which turn the hybrid vehicle into an autonomous one. This design concludes the working of a grounded and aerial vehicle fused into a single vehicle.

REFERENCES

[1] S. Sedighi, D. Nguyen and K. Kuhnert, "Guided Hybrid A-star Path Planning Algorithm for Valet Parking Applications," 2019 5th International Conference on Control, Automation and Robotics (ICCAR), Beijing, China, 2019, pp. 570-575.

[2] Shi Y, Yang J, Bu S, Zhu L. Intelligent vehicle path planning algorithm based on improved RRT [J]. Computing Technology and Automation, 2019, 38 (04): 81-86.

[3] Wang X, Liu X, Wang Y. Research on task scheduling and path optimization of warehouse logistics mobile robot based on improved A ~ * algorithm [J]. Industrial Engineering, 2019, 22 (06): 34-39.

[4] Huang Jun, Jing Hong et al. Preliminary Research on Gesture Control Technology Based on Leapmotion. Computer Systems,vol. 14,No.1, pp. 259-263, 2015.

[5] N. Wang, K. La, and X. Zhang, “Design and myoelectric control of an anthropomorphic prosthetic hand,” J. of Bionic Engineering, Vol.31 No.1,pp. 27-34 ,(2019)

[6] K. F. Gretsch et al.,“Development of novel 3D-printed robotic prosthetic for transradial amputees,” Prosthetics and Orthotics Int, vol. 40, No.3,pp. 400-403, 2016.

[7] J. Oblak, I. Cikajlo, and Z. Matjacic, “Universal haptic drive: a robot for arm and wrist rehabilitation,” IEEE Trans. on Neural Systems and Rehabilitation Engineering, vol. 18, No.2,p. 293-302, 2010.

[8] T.Tsuji, T. Shibanoki,G. Nakamura and A. Furui, “Development of Myoelectric Robotic/Prosthetic Hands with Cybernetic Control at the Biological Systems Engineering Laboratory, Hiroshima University,” J.Robot. Mechatron, vol. 33, No.4, pp. 27-34, 2019.

[9] Haruhisa Kawasaki and Tetsuya Mouri, “Humanoid Robot Hand and its Applied Research,” J. Robot. Mechatron., Vol.31, No.1, pp. 16-26, 2019.

[10] Hongli He, Yong pin Dan “ The research and design of smart Mobile robotic arm based on gesture control”, Rail Transit Institute,conference on advanced Mechatronic systems,Hanoi,Vietnam,pp.10-13, 2020.

[11] Huang Jun, Jing Hong et al. Preliminary Research on Gesture Control Technology Based on Leap motion. Computer Systems,vol. 14,No.1, pp. 259-263, 2015.

[12] Ahammad, S.H.,Rajesh, V. Venkatesh, K.N., ... Rao, P.R. Inthiyaz, S., “Liver segmentation using abdominal CT scanning to detect liver disease area”, International Journal of Emerging Trends in Engineering Research, 2019, 7(11), pp. 664–669, 41.

[13] Murali Krishna, B.,Siva Kumar, M., Rajesh, J., ...Bhavani, M., Adidela, C.N., “FPGA implementation by using XBee transceiver”, Indian Journal of Science and Technology, 2016, 9(17) 93032.

[14] Inthiyaz, S., Tulasi, S.K., Jayanthi, R.S.L., Sahitya, C., Jyothi, C., “Design of bi-trigger sram using schmitt trigger for low power 13t cmos application”, International Journal of Scientific and Technology Research, 2019, 8(12), pp. 1466–1471.

[15] Siva Kumar, M., Inthiyaz, S., Dhamini, J., Sanjay, A., Chandu Srinivas, U., “Delay estimation of different approximate adders using mentor graphics”, International Journal of Advanced Trends in Computer Science and Engineering, 2019, 8(6), pp. 3584–

[16] Inthiyaz, S., Madhav, B.T.P., Kishore Kumar, P.V.V., ...Srikanth, K., Arun Teja, B., “Flower image segmentation: A comparison between watershed, marker controlled watershed, and watershed edge wavelet fusion”, ARPN Journal of Engineering and Applied Sciences, 2016, 11(15), pp. 9382–9387

[17] Myla, S., Marella, S.T., Swarnendra Goud, A., Hasane Ahammad, S., Kumar, G.N.S., Inthiyaz, S., “Design decision taking system for student career selection for accurate academic system”, International Journal of Recent Technology and Engineering, 8(9), pp. 2199-2206.

[18] Srinivasa Reddy, K., Suneela, B., Inthiyaz, S., Hasane Ahammad, S., Kumar, G.N.S., Mallikarjuna Reddy, A., “Texture filtration module under stabilization via random forest optimization methodology”, International Journal of Advanced Trends in Computer Science and Engineering, 8(3), pp. 458-469.

[19] Poorna Chander Reddy, A., Siva Kumar, M., Murali Krishna, B., Inthiyaz, S., Ahammad, S.H., “Physical unclonable function based design for customized digital logic circuit”, International Journal of Advanced Science and Technology, 28(8), pp. 206-221.

[20] Nagageetha, M., Mamilla, S.K., Hasane Ahammad, S., “Performance analysis of feedback based error control coding algorithm for video transmission on wireless multimedia networks”, Journal of Advanced Research in Dynamical and Control Systems, 9(Special Issue 14), pp. 626-660.