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AQI MONITORING UAV

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***Abstract*— UAV are used in various applications such as military, surveillance, photography, and delivery systems. Our UAV aims to provide a good surveillance system at low cost and a delivery system for accidental prone areas and hassle free observation of the pollution in urban as well as rural and industrial areas. Monitoring air quality is important to make sure that the amount of harmful air pollutants is under safe levels. It is also important for prompting the required precautions to ensure the safety of the population. Urban air pollution has become a salient environmental issue in many Asian countries owing to their rapid industrial development, urbanization, and motorization.**

***Keywords*— UAV, PM Sensor, ArduPilot, LORA,ESP 32**

I. INTRODUCTION

UAV (unmanned aerial vehicle) also known as drone, is an aircraft without a human pilot on board. Its flight is controlled either autonomously by computers in the vehicle or under the remote control of a pilot on the ground or in another vehicle. UAV has many applications besides the military applications with which UAV became most associated. Numerous civil aviation uses have been developed, including aerial surveying of crops, acrobatic aerial footage in filmmaking, search and rescue operations, inspecting power lines and pipelines, and counting wildlife, business advertisements etc.The project is mainly used for mapping and surveillance purposes.It carry the loads like first aid box and other necessary items and for monitoring the air index.Large drones are very large in size which can be easily spotted by radars and are a high risk since they are very costly and incur huge losses if shot down by missiles.

II. LITERATURE SURVEY

"ARIA: Air Pollutants Monitoring Using UAVs by Department of Industrial Engineering, University of Padova, 2018."

In relevance and research towards the topic of Multipurpose UAV, this paper's main focus will be environmental monitoring activities. People are becoming increasingly aware of airpollution-related issues: current monitoring systems are notable to satisfy every need of modern cities and UAVs are valuable assets in this panorama. This paper aims to collect and explain issues of drone deployment for environmental monitoring activities. Drone swarms, gathering data through sensor-equipped UAVs and integrating them into current Wireless Sensor Networks will be addressed. The ultimate goal of this paper is outlining a preliminary proposal for ARIA project. Its purpose is the deployment of a vertical drone swarm to sense air pollution samples at different heights.

"Experimental Testing of Electronic Speed Controllers for UAVs by Andrew Gong and Dries Verstraete,The University of Sydney, Sydney, NSW, 2006, Australia."

Electronic speed controllers are a vital component in the powertrain of electric propul-sion systems in unmanned aerial vehicles (UAVs). However, performance data of speed controllers is scarce. This paper presents the experimental set-up and testing of a range of commercial-off-the-shelf ESCs. Test results are presented and empirical models are derived to predict the performance and efficiency of these ESCs in a variety of operating conditions.

"PIXHAWK: A micro aerial vehicle design for autonomous flight using onboard computer vision by Lorenz Meier ·Petri Tanskanen ·Lionel Heng ·Gim Hee Lee, August 2012."

In this paper, they introduced a novel quadrotor MAV design, the Pixhawk MAV, which is specifically designed to be a research platform for computer vision based flight control and autonomous flight using computer vision. One of their main contributions is the integration of a computing board that is powerful enough to handle all image processing and flight control processes onboard on a small scale quadrotor MAV. With the possibility of performing all computational processes onboard without the requirement for a constant data link to a ground station, the design brings the vision of having a fully autonomous quadrotor MAV significantly closer. Another major contribution is the hardware IMU-camera synchronization of our system. This allows them to be able to measure the USB image transmission delays in their system precisely. As a result, they are able to do visual pose estimation with the synchronized IMU measurements with improved efficiency and robustness. This algorithm is evaluated and compared to a

vision only marker based pose estimation al-gorithm. In addition, they further advance the state-of-the-art by integrating a vision based obstacle detection system onto the MAV system. The stereo computer vision system produces a high detailed depth map, that gives more detailed information about the obstacle compared to basic sensors as infrared or sonar. The capabilities of the system are furthermore demonstrated by vision only autonomous waypoint based flights. The flight accuracy is compared to Vicon groundtruth. Finally, all the hardware and software designs are made open-source and are published on our web page 1with the goal to create an open research platform for the community.

"A Study of LoRa: Long Range & Low Power Networks for the Internet of Things by Aloy Augustin1, Jiazi Yi, Thomas Clausen and William Mark Townsley, May 2016."

LoRa is a long-range, low-power, low-bitrate, wireless telecommunications system, promoted as an infrastructure solution for the Internet of Things: end-devices use LoRa across a single wireless hop to communicate to gateway(s), connected to the Internet and which act as transparent bridges and relay messages between these end-devices and a central network server. This paper provides an overview of LoRa and an in-depth analysis of its functional components. The physical and data link layer performance is evaluated by field tests and simulations. Based on the analysis and evaluations, some possible solutions for performance enhancements are proposed.

"Research on servo motor motion control system based on Beckhoff PLC, Journal of Physics Conference Series, April 2021."

In order to meet the requirements of high precision, reliability and real-time control of biaxial motion.Taking Beckhoff PLC CX9020 and Yaskawa Σ - 7S series AC servo controller as the control core, using Yaskawa SGM7J series motor and servo driver matching, the X-Y double axis servo motion control system is designed, and the overall hardware design of the control system is carried out. This paper focuses on the parameter setting, analog and digital acquisition, programming and HMI interface setting of servo motor control system. The debugging operation shows that the system runs stably and meets the control requirements of accurate positioning.

"A Review Paper on Unmanned Aerial Vehicle (U.A.V.), Department of Electronics & Communication Vivekananda Institute of Technology, Jaipur Jaipur, India, 2017."

Unmanned Aerial Vehicle (UAV) is commonly known as Drone.It is extensively being used these years.Nowdays drones are used in various Military applications, Commercial Cargo Transport, and 3-D Mapping etc. For supporting the weight of the plane, and shock absorption functions, landing gear design is highly needed.Unmanned aerial vehicles (UAV) are the logical successors to modern aircraft and advancements in automated technology. The current generation of UAV's is focused on wartime capabilities and reconnaissance, leaving an existing market untapped by UAV technology: the commercial field. There are thousands of applications for UAV technology in the civilian market, from quick response applications and media outlets to communication technicians and horticulturalists. The vehicle can even act as a path guider in normal case and as a fire extinguisher in emergency.

III. HARDWARE

The main components of this UAV are the following:

A. BLDC Motor

It is used for propulsion or as an engine.A motor converts supplied electrical energy into mechanical energy. Various types of motors are in common use. Among these, brushless DC motors (BLDC) feature high efficiency and excellent controllability, and are widely used in many applications. The BLDC motor has power-saving advantages relative to other motor types. Specifications- Motor KV: 920 RPM/V, Motor Rotation: CW, Thrust: Around 0.5 kg, LiPO Batteries: 3S-4S, ESC: 30 A, Shaft Diameter: 6 mm

B. ESC (Electronics Speed Controller)

It is connected to the motor for controlling the speed. Esc will be connected to the flight controller. An electronic speed control (ESC) is an electronic circuit that controls and regulates the speed of an electric motor. It may also provide reversing of the motor and dynamic braking. Miniature electronic speed controls are used in electrically powered radio controlled models. Full-size electric vehicles also have systems to control the speed of their drive motors.

C. Servo Motor

It is used to drop the payload/essential Items from UAV. A servomotor is a linear actuator or rotary actuator that allows for precise control of linear or angular position, acceleration, and velocity. It consists of a motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

D. Camera

It wirelessly transmits video feed to goggles, a headset, a mobile device or another display. It is a device for recording an image of an object on a light-sensitive surface; it is essentially a light-tight box with an aperture to admit light focused onto a sensitized film or plate.

E. PM sensor

Particulate Matter (PM) Sensors monitor the function of the Diesel Particulate Filter (DPF) to detect excessive PM emissions. This sensor is used to monitor the function of the diesel particle filter (DPF) and helps reduce particulate emissions by up to 99 %. We are using the frequency of 868 Hz.

F. LORA Module

It is a new wireless protocol designed specifically for long-range, low-power communications. LoRa (short for long range) is a spread spectrum modulation technique derived from chirp spread spectrum (CSS) technology. Semtech's LoRa is a long range, low power wireless platform that has become the de facto wireless platform of Internet of Things.

G. ESP 32

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

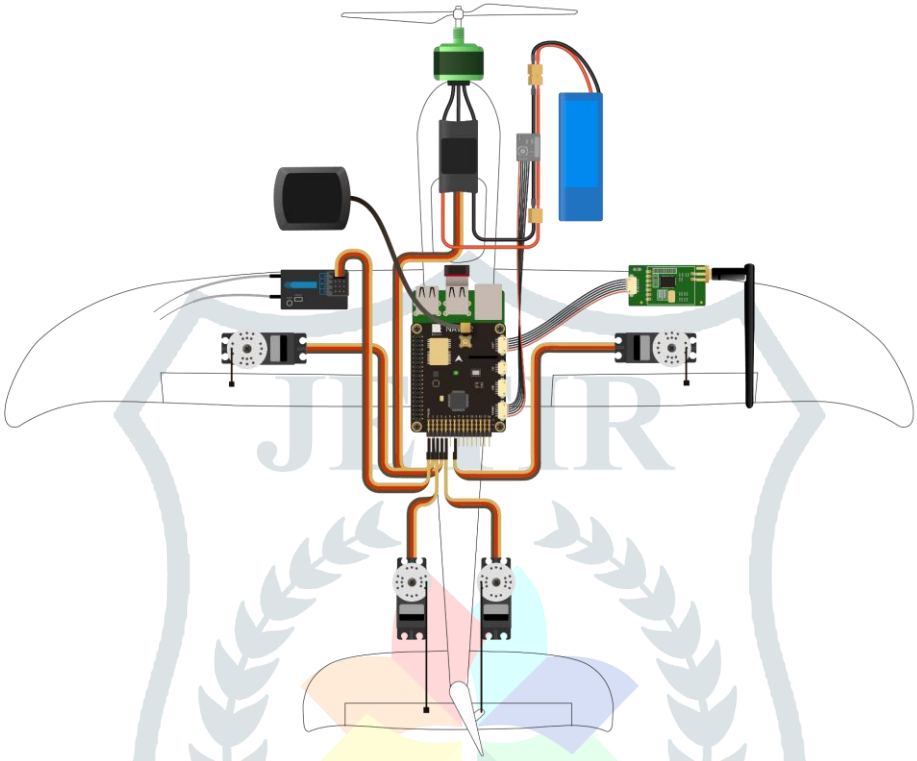

Fig 1.1 Wiring Scheme of UAV

IV. METHODOLOGIES

A. ARCHITECTURE

There are three sections of our project:

UAV:

First we placed a BLDC Motor to which both propeller and motors are connected.ESCs are then connected to all the servo motors. The servo motor is used to control the surface of the plane. The PM Sensor and the camera is installed on the plane for sensing the particulate matter and capturing the view.

PM Sensor:

There are two parts of PM Sensor, first one is receiver and second one is transmitter. PM Sensor is connected to both LORA and ESP 32. Both receiver and transmitter side LORA communicates with each other and helps to deliver the information. And from the help of ESP 32, we can see the result in our web server.

Camera:

In camera also there are two parts, receiver and transmitter. And we can see the footage in our mobiles or PCs on the USB Cam.

B. HARDWARE

First we designed the frame of our UAV. On which we mounted all the components like BLDC Motors, Receiver, PM Sensor, Camera , etc. First we placed a BLDC Motor to which both propeller and motors are connected.ESCs are then connected to all the servo motors. The servo motor is used to control the surface of the plane.**T**he ESCs are connected to balance the whole UAV. After that we placed the PM Sensor and there are two parts of the PM Sensor, first one is receiver and second one is transmitter. PM Sensor is connected to both LORA and ESP 32. Both receiver and transmitter side LORA communicates with each other and helps to deliver the information. And from the help of ESP 32, we can see the result on our web server.

C. SOFTWARE IMPLEMENTATION

In our project, we are using ArduPilot software (Mission Planner). It is a free, open-source, community-supported application and it is a ground control station for Plane, Copter and Rover. Mission Planner can be used as a configuration utility or as a dynamic control supplement for your autonomous vehicle.

Here are few things we have done with Mission Planner:

- Load the software into the autopilot board (i.e. Pixhawk series) that controls the vehicle.
- Setup, configure, and tune the vehicle for optimum performance.
- Plan, save and load autonomous missions into our autopilot with simple point-and-click way-point entry on Google or other maps.
- Download and analyze mission logs created by our autopilot.
- Interface with a PC flight simulator to create a full hardware-in-the-loop UAV simulator.
- With appropriate telemetry hardware we can:
  - Monitor our vehicle's status while in operation.
  - Record telemetry logs which contain much more information the the on-board autopilot logs.
  - View and analyze the telemetry logs.
  - Operate our vehicle in FPV (first person view)

V. RESULTS

The Multipurpose UAV displays the Dust density and the Gas value on a web server with the help of ESP 32. Camera on the UAV can successfully take pictures and videos and are used for surveillance purpose. Multipurpose UAV is a weight carrying drone that is also used to supply essential equipments to the accidental prone areas.

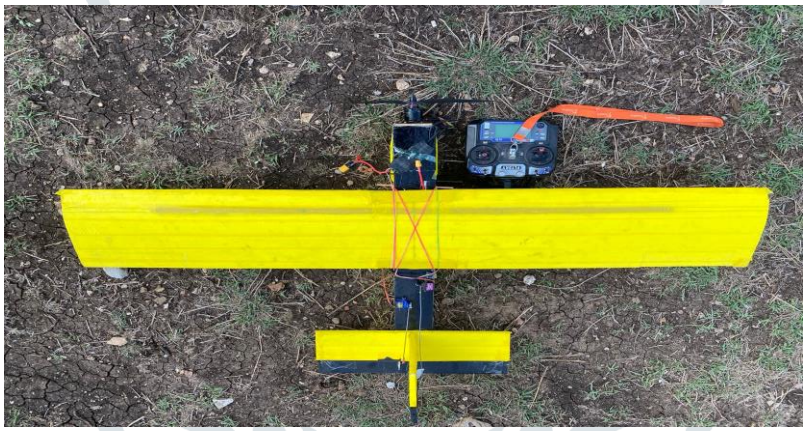

Fig 1.2 UAV with Receiver

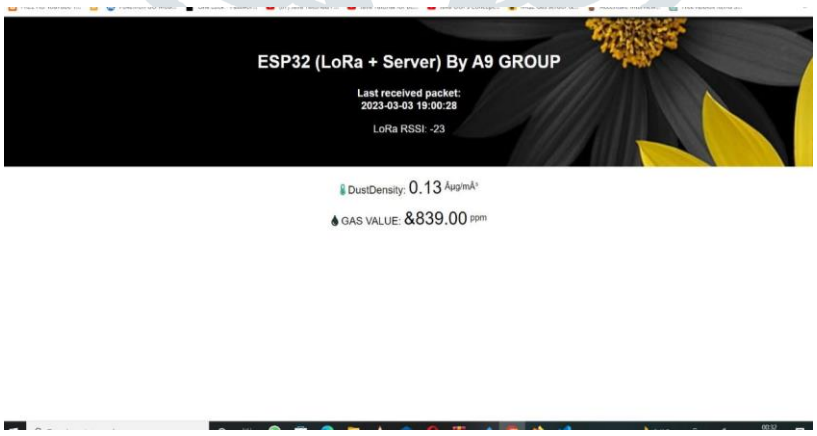

Fig 1.3 Results of Dust density and Gas value

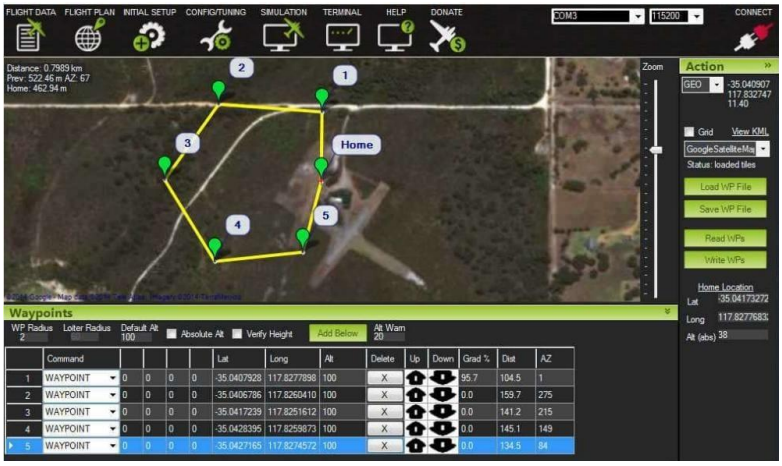

Fig 1.4 Mission Planning of UAV

VI. CONCLUSIONS

The Final conclusion for this project is as it can be used for multiple purpose as a surveillance system for the military and urban areas , and as a delivery system for the accident prone areas for providing essential services and also as a air quality index monitory system for the highly polluted areas this makes this UAV a great multipurpose system in low cost. Unmanned aerial vehicles are now being built with highly versatile technology, continually developing creative ways to provide more outstanding service.

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