Under-roof GPS Denied Environmental Crawler Drone for Special Applications

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Abstract- This research paper deals with the construction of a test bench for an unspecified aerial system UAS type with controlled electric motors and tilt rotors (propellers) executed on a quadcopter pattern is the subject of this research work. This experimental test bench offers a transitional stage between the simulation process and the UAS's actual flight, enabling the testing and evaluation of solutions in a controlled and safe environment. As a result, techniques for state estimation and control of UAS can be developed. Additionally, the system that is created can be utilized to instruct students about the fundamentals of autonomous control in multirotor aerial vehicles. There is a quadcopter model on the test bench described in this study.
The goals of this project were to research, design, and assess a drone test bench. Modeling and structural analysis of the frame, which needed to be lightweight but robust enough to endure the stresses of the application, was one area of concentration for this goal.[21]

Key Words: **UAS, Simulation, Testing,**

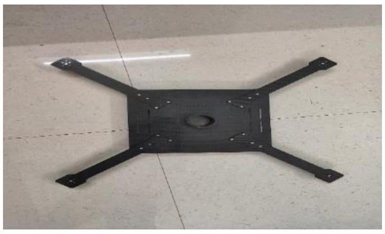
1.INTRODUCTION

The system proposed in this paper is a drone i.e flying robot that can fly and operate remotely. Drones have become important to several businesses and government agencies. This test bench is used to test the various applications of the Drone. The UAS system proposed in this paper is a small category type.
Basically drones have various controls like:
1.Pitch: This control is used to control the system to move forward or backward.
2.Throttle: This control is used to move or change the altitude of the system**.**
3.Roll: This control is used to control the system to move left or right**.**
4.Yaw: This control is used to control the system to rotate around the 360 degrees.
Applications of UAS:This system has more popular in the environment. It will have high demand in the society. Now-a-days it is used in various fields like agriculture, infrastructure, inspection, entertainment, military applications etc,.
Testing and evaluating a UAV's controlled response, such as checking its control loops to see if it met the project's requirements, are essential once the project is complete.
Real-time outdoor testing and testing on a platform are the two ways to ensure a drone is operating properly.
The conduct of outdoor tests generates a considerable risk for the UAV, which can lose control or run into an obstruction at any time, etc., particularly when we discuss the development of fully autonomous aerial systems and non-traditional configurations of drones. Therefore, it is recommended to take into account the usage of secure and dependable experimental platforms, as this enables testing and evaluating solutions in environments that are safe and under your control.
In recent years, the use of unmanned aerial vehicles has grown tremendously. Determining the best propulsion system for each operation is crucial since the missions for which they were created have different needs.[13].The idea of an unmanned flying device may have originated in 1849, when Austria used unmanned balloons loaded with explosives to assault Venice.Although strictly speaking balloons do not fit the modern definition of a drone, it does demonstrate that the use of unmanned aerial devices was conceptually contemplated even then.The Ruston Proctor airborne Target, which first debuted in 1916, was the first airborne unmanned vehicle. Better drones were then made possible by technological advancement, even though the most were just intended for one-way missions or as targets for anti-aircraft crew[14].There are other test bench models that go beyond the most basic ones, in which the UAV revolves around a single fixed axis [5] or is fixed to a joint using wires [4]. The majority of cutting-edge technologies produce greater than 3 DOF [2]. The purpose of this study is to propose a practical, adaptable, and affordable method for calibrating and testing the flight controller prior to the flight test phase.
Small unmanned aerial vehicles (UAVs) are now a viable choice for monitoring, ground mapping, agricultural and environmental preservation techniques, fire detection, transmission power line infrared supervision, etc. in big, risky, or distant locations. Due to the specific mission, UAV systems can be fitted with a wide range of sensors [1-3, 5, 6, 9]. Additionally, the development of micro-electronic components, such as microcontrollers, sensors, receivers, drivers, miniature-type cameras, etc., as well as the use of contemporary manufacturing capabilities and element bases have allowed for the production of aerial vehicles with lightweight and strong hulls.

2.PROBLEM STATEMENT
Some systems has various limitations based on frame configuration and flight controller. It leads to damage or crashes in the system. To avoid these crashes and expensive of the application system.
2.1 Scope of proposed system
The scope of this system is to avoid the crashes or damages in the system. This system will become the basic model for designing of any other model in the future.

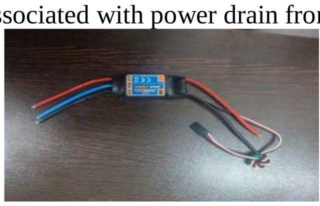
3.LITERATURE REVIEW
A drone is an unmanned aircraft. Which is known as an unmanned aerial system. Drones have become important to several businesses and government agencies. In rapid delivery, from industries to out-of-reach locations to military bases, drone technology plays a crucial role and has proven to be extremely beneficial. A drone can be piloted using a remote or using a mobile application. Drones can work in conditions where dry, dull, or dangerous for human pilots. UAVs have been in production since before the Wright Brothers first took their historic flight. The structural design of UAVs has changed over their developmental history in order to serve a variety of purposes. 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.Obviously, the first-order engine properties of thrust, weight, specific fuel consumption, and cost are crucial factors in UAV applications[16].One of the top manufacturers of unmanned spectral and lidar sensors[17].UAV-based applications have a lot of room for expansion, especially in fields like emergency response, dynamic GIS, and smart city applications that require regular local updates[19]

4. COMPONENTS
This system require the basic components to design a model is
1.Quad Copter Frame
2.Flight controller
3.Electronic Speed Controller
4.Battery and power distribution cable
5.Transmitter
6.Receiver
7.Brushless motors
1.**Quad copter frame**: This is a structure (FRAME) in which all the other parts fit in. It acts as a skeleton in which different components are placed in such a manner that they uniformly distribute the drone's centre of gravity. Different drone designs have different frames structure with a minimum of 4 propeller fitting gaps. They are available shapes and sizes and their prices depending on their quality.



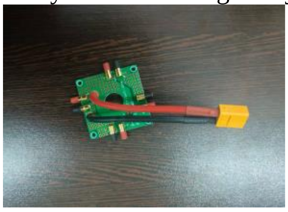
2.Flight Controller: The flight board makes a log of the take-off place just in case the need arises for the drone to go back to its take-off location without being guided. This is known as 'return to home' feature. It also determines and calculates the drone's altitude in respect to the amount of power it consumes.
Specifications:
Input voltag : 7v
Firmware: Mission Planner

Sensors: Gyrometer, Barometer
Accelerometer
High performance Barometer
3.Electronic Speed Controller: This is an electronic control board that varies the motor's speed. It also acts a dynamic brake. The component helps the ground pilot to approximate the height at which the drone is running in. This is attained by gauging the amount of power used by all the motors. Altitude is associated with power drain from the power reservoirs.



Specifications: Operating Voltage: 3v - 9v
Maximum current: 25A
Constant Current: 20A
Battery Input: Li-po 2S
4.Battery and Power Distribution Cable: The battery acts as the power source to the drone. It supplies energy in all the electronics

in the frame work through the power distribution cables. Nickel Metal Hybrid or Nickel cadmium-based batteries were first used; however, their use has diminished while the use of lithium batteries has increased. They can store a greater amount of energy than the Nickle cadmium and Nickle metal hybrid. The rating of atypical battery is 3000 mAh and 11.1v.




5.Transmitter: It is a channelled transmitter and a communicator to the drone. Each channel has specific frequency capable of steering the drone in a certain motion. Drones require at least 4 channels for effective operation.

Specifications:

RF range(GHz) : 2.40 – 2.48

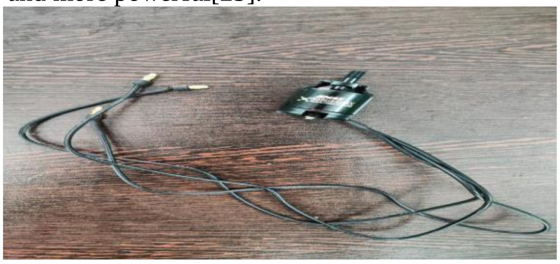
Bandwidth (KHz) : 500

Power : 6V

RF Power (Dbm) : <=20

6. **Brushless DC Motors:** Motors are essential for the propeller's rotation. This enhances a thrust force for propelling the drone. Still, the number of motors should be the same as the number of propellers. The motors are also fitted in a way such that they are easily rotated by the controller. Their rotation enhances the drone control in terms of direction. Choosing the right motor is essential for the efficiency of the drone. You have to check carefully about various parameters such as voltage and current, thrust and thrust to weight ratio, power, efficiency and speed and so on.The output speed depends on the load's torque in Nm and the throttle's percentage (in%). A motor must be tested with various input voltages and loads if its whole character is to be determined. Software can alter the throttle, and the kind and size of the propellers can alter the load.[21]

The smallest propellers that have been previously mapped often have diameters that are close to four feet, run at high RPMs and relatively high forward speeds, and have high operating Reynolds numbers as a result.[24].Unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs), which are mobile robotic platforms, are becoming more and more popular, and there is a desire to make them smaller, lighter, cheaper, and more powerful[25].



5. DESIGNING OF TEST BENCH

Let us take a bench and strong wire .An initial conceptual design was created to evaluate the project's underlying premise.[23]

The table is placed on the floor and wire is hanged to the roof of the top.And this wire is tightened with some weight at below the bench to avoid vibrations in the wire.

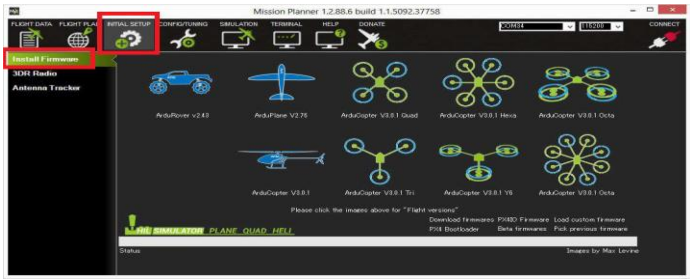
After installing the test bench,we placed the components connected on a frame as per the architecture of the drone system.Now the system is placed on the bench and wire is taken into the hole of the frame to tight at the bench with some supporting sponge placed on a bench to avoid crashes if occurs.The ability to validate the concepts as well as the implementation before a device is created helps development teams save time and effort. Simulation is by far the most common technique used in functional verification today.[20]

Basically to design a system we consider four parameters:
- Thrust to weight ratio
- Motor type to propeller size ratio
- Drone frame configuration/Air frame type
- Maximum take-off weight

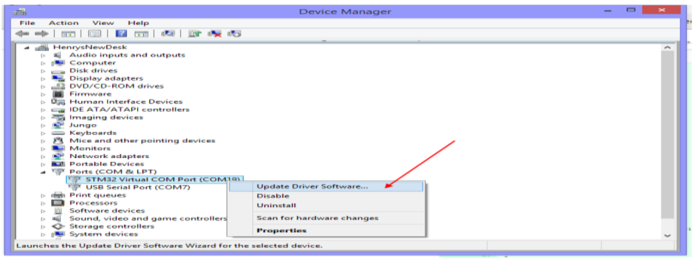
6. INSTALLING FIRMWARE

Step1: open the mission planner view

Step 2:Configure the frame we selected



Step 3: Setting up the firmware and updation of the firmware



7.WORKING METHOD OF THE SYSTEM

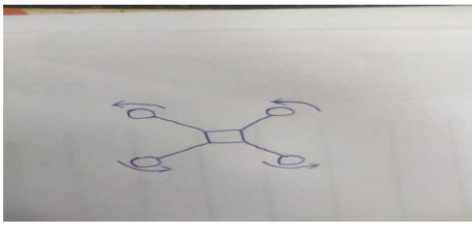
After successful installation of the firmware into FC, we can calibrate the FC without GPS to arm the system. Successful completion of calibration we can control the Radio transmitter to receiver. After calibrating transmitter with receiver, we can control the system within the controlled environmental conditions.

8.RESULTS AND DISCUSSIONS

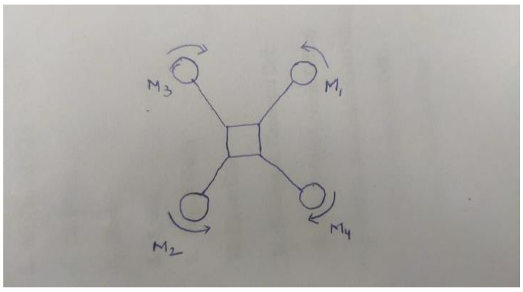
ESC calibration: The ESC's Should be connected in a correct way to control the motor.
Connection of ESC with motors be like**:**

Observations

connection of motors in wrong manner :
If we connect the motors in wrong way, then the motors will rotate around its axis and it leads to crashes in the drone**.**



Connection of motors in correct way:
If we connect the motors in correct way i.e M1 connects in Anti-Clockwise direction, M2 connects in Anti-Clockwise direction, M3 and M4 connected in Clock-wise direction**.** Then the motors will rotor in their correct way and it leads to lift up the drone.



FUTURE SCOPE

At this point in its development, the UAV is in a finished state but it has some limitations. Here we are using Pixhawk flight controller to test the drone. But we can use several flight controllers to test a drone. After successful installation drone, we can use different applications whatever we want. By using the test bench we should test the drone of every type and it controls the damage of the drone. By using this test bench we can develop different drones depending the application. After some years it should be the basic model to design any application drone.

CONCLUSION

Thus, the use of the developed test bench platform has made possible to test the designed UAV in a safe and controllable environment conditions.
Further, there will be improved the physical model the test bench platform with the aim to positioning it as a research tool, as well as a teaching tool for the development of control systems and design in general of UAVs. This test bench is the intermediate step between simulation process and real time flying.

REFERENCES:

[1] Osedo A et al. 2015 Flight control systems of a quad tilt rotor UAV for a large attitude change IEEE Robotics and Automation (ICRA) Conference pp 2326–31
[2] Salazar-Cruz S et al. 2008 IEEE Transactions on Aerospace and Electronic Systems Conference 2 783–94
[3] Emelyanova O V et al. 2017 The synthesis of electric drives characteristics of the UAV of convertiplane-tricopter type. 2016 Workshop on Contemporary materials and technologies in the aviation industry (CMTAI2016) MATEC Web of Conferences 99 pp 249–63
[4] Jatsun S F et al. 2014 Mathematical model of the quadrotor type unmanned aerial vehicle with neurocontroller Proceedings of the 18th International Conference on Circuits (CSCC '14) & Proceedings of the 2014 International Conference on Mechatronics and Robotics, Structural Analysis (MEROSTA 2014) Advances in Robotics, Mechatronics and Circuits pp 46– 50
[5] Jatsun S et al. 2017 Control flight of a UAV type tricopter with fuzzy logic controller IEEE XIII International scientific and technical conference "Dynamics of Systems, Mechanisms and Machines" pp 1–5
[6] Jatsun S et al. 2019 Issledovanie kolebanij konvertoplana v vertikal'noj prodol'noj ploskosti Proceedings of Southwest State University 23 4 pp 42–56
[7] Emelyanova O V et al. 2017 Sintez parametrov ehlektroprivodov BPLA tipa konvertoplan-trikopter IV International School-Conference for Young Scientists "Nonlinear Dynamics of Machines" Mechanical Engineering Research Institute of the Russian Academy of Sciences pp 239– 49
[8] Efremov A V et al. 2011 Dinamika poleta: uchebnik dlya studentov vysshih uchebnyh zavedenij (Moscow: EDP Mashinostroenie)
[9] Martinez Leon A S 2015 Razrabotka konstrukcii konvertoplana 2nd International Scientific and Practical Conference 2, Southwest State University pp 265–8
[10] Jatsun S et al. 2020 Investigation of oscillations of a quadcopter convertiplane in transient mode in the vertical longitudinal

plane Proceedings of 14th International Conference on Electromechanics and Robotics “Zavalishin's Readings” (Singapore: Springer) pp 345–58
[11] Pavlovsky V E et al. 2015 Matematicheskoye modelirovaniye robota s peremennym vektorom tyagi Bespilotnyye transportnyye sredstva s elementami iskusstvennogo intellekta (BTS-II-2015), Russian Association for Artificial Intelligence pp 99–106
[12] Pavlovsky V E et al 2014 Robototekhnika i tekhnicheskaya kibernetika 4 49–57.
[13] R. Naughton, "Monash University Engineering," 2 February 2003. [Online]. Available: http://www.ctie.monash.edu.au/hargrave/rpav_home.html. [Accessed 15 February 2017].
[14] "War History Online," [Online]. Available: https://www.warhistoryonline.com/war-articles/top-10- greatest-aerial-battles.html/. [Accessed 16 February 2017].
[15] P. M. Company, "Popular Mechanics Magazine, June 1956," p. 144, June 1956.
[16] J. R. Nelson, "Development of Engines for Unmanned Air Vehicles: Some Factors To Be Considered," Institute for Defense Analyses, Alexandria, 2003.
[17] "UAV Applications," Ascending Technologies, [Online]. Available: http://www.asctec.de/en/uavuas-drone-applications/. [Accessed 16 February 2017].
[18] "AERO-UAS30," CEiiA, [Online]. Available: https://www.ceiia.com/aero-uas30. [Accessed 16 February 2017].
[19] Aibotix GmbH – Part of Hexagon Systems, [Online]. Available: https://www.aibotix.com/industries/case-studies. [Accessed 17 February 2017].
[20] A. Tiwari, "SlideShare - Testbench Development," 19 March 2011. [Online]. Available: https://www.slideshare.net/Abhishekt11/test-bench-development?qid=b4b3d26c-3add-4afd-b236-583e4e26960d&v=&b=&from_search=7. [Accessed 27 February 2017].
[21] "HobbyKing," Turnigy Thrust Stand and Power Analyser v2, [Online]. Available: https://hobbyking.com/en_us/turnigy-thrust-stand-and-power-analyser-v2.html. [Accessed 28 February 2017].
[22] "RCbenchmark," Tyto Robotics Inc., [Online]. Available: https://www.rcbenchmark.com/. [Accessed 28 February 2017]. [23] H. Brogueira, "Design of a Test Bench for Micro Combustion Engines," Instituto Superior Técnico, Lisboa, 2016.
[24] M. Pankaj, "Propeller Performance Measurement For Low Reynols," Wichita State University, Wichita, 2005.
[25] A. M. Harrington and C. Kroninger, "Characterization of Small DC Brushed and Brushless Motors," Adelphi, Army Research Laboratory, 2013, pp. 1-6.