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A NOVEL HYBRID DESIGN OF AGRICULTURE DRONE WITH INTEGRATED CONTROL SYSTEM FED BY LITHIUM-ION BATTERY.

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Abstract: - Agriculture is the major source of livelihood in India; however, still, we are lagging behind the developed countries when it comes to adapting the latest technologies for agriculture. Drone Sprayer is the latest advanced technology that can be used to apply pesticides in India. The sprayer will help in reducing chemical contamination to humans and can be used in areas that are inaccessible to humans. Drones are key to accessing intelligent agriculture as information about every inch of farms and agricultural land can be gathered by a drone flying overhead. The main aim of this research is the development of low-cost drone Sprayers for multi-tasking purposes. The drone sprayer helps the farming community in reducing the cost of pesticide application. Moreover, spraying pesticides is very hazardous, so the employment of drone sprayers will be a handful in reducing the environmental pollution. The paper presents the proposed drone sprayer with an intelligent control system powered by a Lithium-Ion battery for longer durability and efficient performance. The intelligent control system facilitates intelligent behaviour in the components of the drone sprayer and ensures the judicious use of energy for the longer durability of the battery. The paper also proposes techniques for enhancing the performance of the drone sprayer.
Keywords: Agricultural Drones, intelligent controller system, Lithium Ion battery, GPS.

I. Introduction

In this era of modern technologies, the structure of the rural labour force throughout the whole world has changed drastically. It has increased the contradiction regarding the demand and lack of rural labour force available therefore agricultural equipment with higher efficiency is sought after to serve for the agricultural production. Besides that, crop diseases and pests are major factors affecting the quality and yield of crops. Chemical pesticides will be the main solution to control and prevent this from happening. The selection of the equipment to be used is a critical factor for chemical pest control. In China, there are more than 88% of manually operated sprayers that includes manual air-pressure or electric knapsack sprayer and knapsack mist-blower sprayer [1]. The quality of the spraying process mainly depends on the skill of the sprayers.

The agricultural industry has embraced drone technology where these advanced tools are being used to modernize traditional farming. Agricultural drones are transforming the way farming is being carried out. Nowadays, while the demand is set to grow, farmers must consider a variety of complex factors which will impact the success of their agriculture businesses or farms ranging from the water access to soil quality, rainfall patterns, temperature, changing climate, wind, the presence of weeds and insects. Farmers must continue to innovate to improve and maintain productivity to meet the demands. Digital technologies have huge potential to provide farmers with all the required data to seize the opportunities for growth and meet these challenges. Consequently, farmers are reaching out to agricultural drone technology to help mitigate these problems.

Flying items have constantly applied an incredible interest on man empowering a wide range of innovative work. The technical challenges in UAV modelling and control in various tangled situations and the absence of good arrangements were extremely persuading. Then again, the wide application in both regular consumer markets and military were empowering the financing of UAV related development. In the meantime, the Autonomous Systems Laboratory (ASL) had effectively aggregated a huge ordeal on UGV with incredible results (such as efficient control system, object avoidance system, night vision system). These systems have made a tremendous difference when operating robots in difficult situations. It gave them more flexibility, controllability and options to use where large human or large equipment cannot go.

II. Literature Review

As a UAV quadrotors are very useful when the environment is inaccessible or hard to reach. When the flight is dangerous, monotonous or flight time is extended and flight is not possible even by a skilled pilot an unmanned quadrotor can provide great advantages. As a helicopter, quadrotors have evident advantages over other aircrafts since they can take-off and land in limited area and can easily hover above stable or moving targets. The studies in quadrotor modeling and control increased rapidly in recent years. Some examples of these studies can be summarized as following; T. Hamel et. al. modeled a quadrotor by incorporating the airframe and motor dynamics as well as aerodynamics and gyroscopic effects and controlled it separating the rigid body dynamics from the motor dynamics [2]. N. Guernad et. al. and D. Suter et. al. also studied on image based visual servo control for quadrotors [3.4]. The entire operating cost of an agricultural UAV is relatively less compared to a knapsack sprayer. The only operation cost will be the operator and to replace the faulty components [5]. Most of the components are fairly low cost and easy to obtain therefore it is very easy to conduct any repair works. It also does not need to pay any airport taxes as it is able to land almost anywhere. S. Salazar-Cruz and J. Escareno et. al., used a Lagrangian model and a controller based on Lyapunov analysis using nested saturation control algorithm and designed an embedded control architecture for a quadrotor to perform autonomous hover flight [6,7,8,9]

III. Proposed Methodology

Quadcopter Anatomy

Quadcopter which is also known as the quadrotor, is a type of helicopter having four propellers. The propellers are in a square formation having equal distance between them and the centre of the quadcopter. They are fixed in upwards direction. To control the quadcopter, the angular velocities of the propellers are in tune to the desired results needed. An electric motor is attached to every propeller which maintains and helps them rotate. Since quadcopter has a very simple design, it has become the most typical design for a small unmanned aerial vehicle (UAV). Quadcopters are used from anything from search and rescue, surveillance, real estate inspections and many other applications.Due to the complex modelling and control of quadcopter, it has generated a vast interest from researchers.

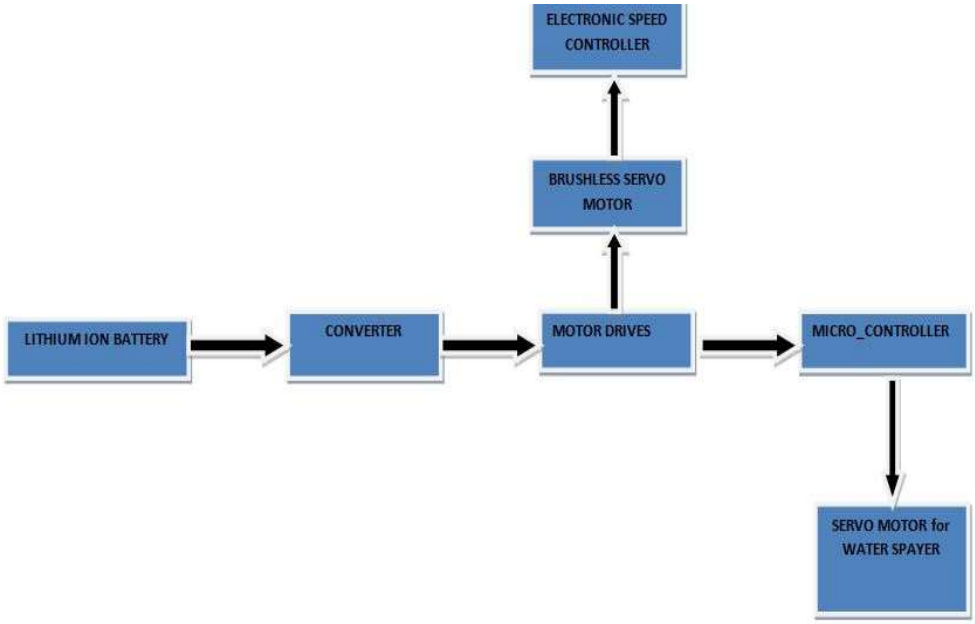

Figure 1: Block Diagram of Proposed agricultural Drone

Figure 1 shows the block diagram of the proposed muti-tasking agricultural drone in which Lithium Ion battery has been used in the design due to their increasing demand in current scenario, they provide the required energy for the longer flying distances. Converters aid in the power supply of agricultural drone and also help in adapting the maximum voltage rating. The motor drives have main role in the proposed design. The battery powers the motors and in the meantime motor drives act as conjunction between motors and the respective control circuits. The motor driver provides a distinction in power supply as motors work on high current and the control circuits work on low currents. Here motors drives provides low currents to the control circuits and high currents to the motors for the proper functioning. The electronic speed control facilitates regulated speeds and also aids in speed control of agricultural drone for the proper control. Microcontroller plays a vital part in the navigation of the proposed agricultural drone. Here we have used servo motors for the sprayer as they have high efficiency, high output power compared to their size and are highly reliable as compared to conventional motors[10,11,12].

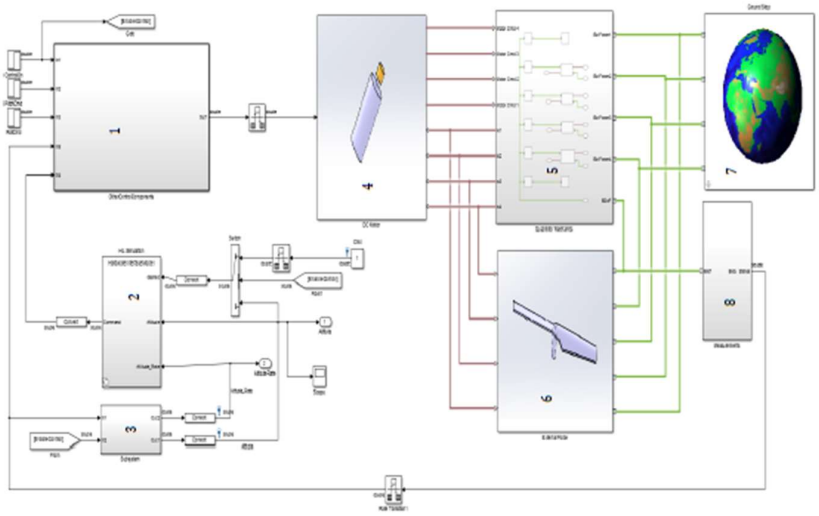

Figure 2: Proposed Methodology for agricultural Drone

With the advancements in the technology, mainly in communication systems, control systems and monitoring systems, there could be a revolution in the field of agriculture if the convectional practices are replaced by the latest technologies. Agricultural drones being one of the kind to speed up various activities in the agricultural field[13,14,15]. The main aim for any drone is the precision and control. PID control is considered as the best technique for it. The control system is composed of Proportional integral derivative controller inbuilt with continuously modulated control. PID controller employs closed loop control system to keep the accuracy, precision and actual output during the meantime. Mathematically PID can be calculated by the following equation.

$ut=Kp\ et + Ki0tet'dt' + Kdde(t)/dt.$

Kp is the coefficient of Proportional term.

Ki is the coefficient of integral term.

Kd is the coefficient of derivative term

During the process controller uses output and the current error along with the previous error to get the exact prerequisite adjustments for the smooth functioning. The algorithm of the working of proposed design is plotted below verifying the simple working of the proposed design of the agricultural drone[16,17,18,19].

Step 1: Start
Step 2: Inflow Current
Step 3: Check Current at Convertor
Step 4: If (Current==1)
Controlling speed of Motor;
Spraying Chemical;
Step 5: Else

Go to Step 2;

Design and verification of mechanism in Flow chart

IV. Result and Analysis

The results are based on the analysis and simulation in Matlab. The design of various components were drafted in Matlab. All the components are analyzed and carried in Matlab tool. Figure3 depicts the results based on the velocity parameter. Figure4and 5 shows the position versus time parameter of the proposed system. All the parameters are successfully tested and verified.

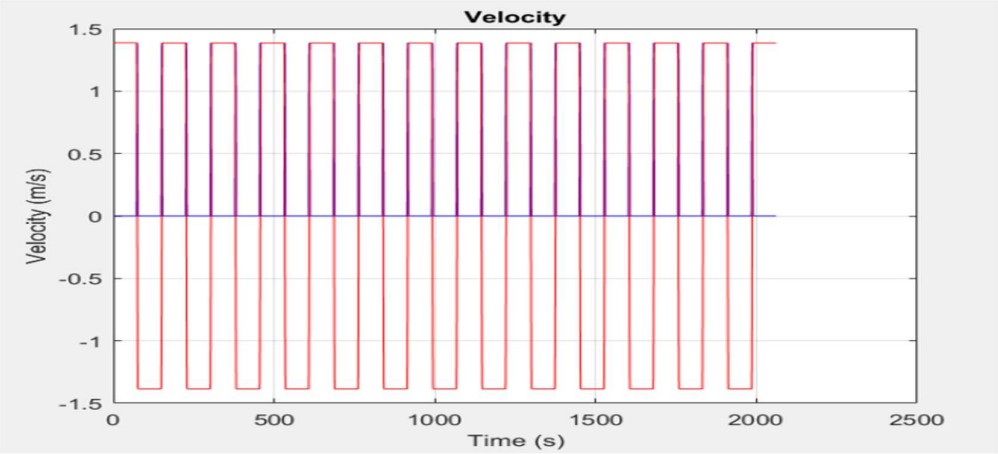

Figure3: Velocity and time domain of low cost agricultural drone

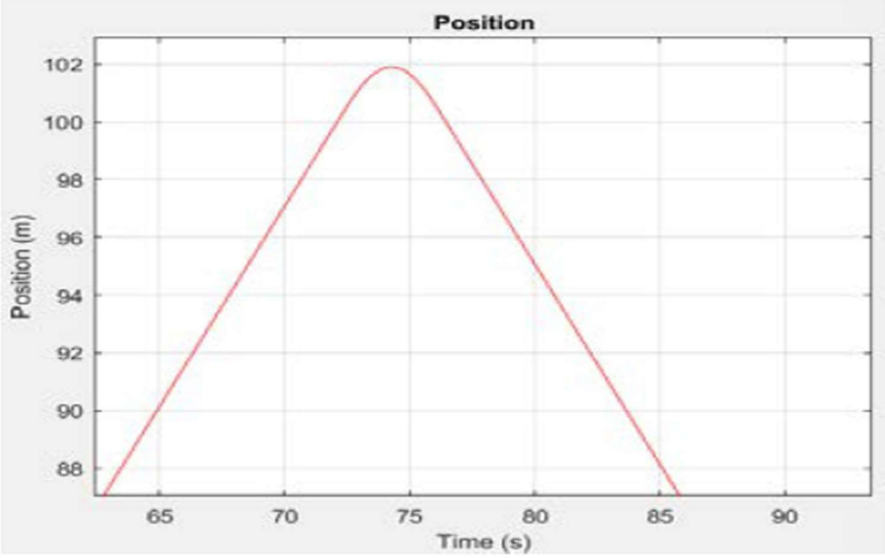

Figure4: Position and time plot of agricultural drone

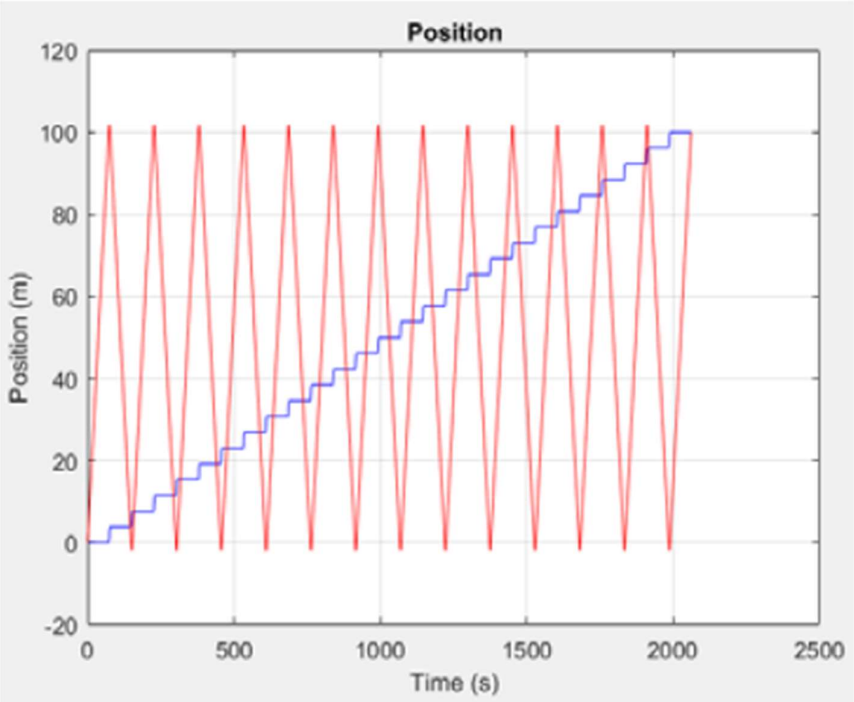

Figure 5: Position and time plot in respective axis

V. Conclusion

In this paper, our proposed design shows efficient results after doing simulation on different parameters. The design of a low-cost multi-tasking agricultural drone was drafted and tested in Matlab. Moreover, the intelligent control system used in the design proves to be various benefits for the functioning of the agricultural drone. As our model is inbuilt with lithium-ion battery which helps to implement the proposed drone at higher reach agricultural areas where power supply is limited. All the results, mathematical modelling and design algorithm prove that the proposed design of agricultural drones will be handy for increasing productivity and save time in agriculture by reaching and covering more agricultural area at one time.

REFERENCES

1. S.L. Yang, X.B. Yang, J.Y. Mo, Prec. Agric. 19, 278 (2017).
2. T. Hamel, R. Mahony, R. Lozano and J. Ostrowski, Dynamic Modeling and Configuration Stabilization for an X4-Flayer, 15th Triennial World Congress, Barcelona, Spain.
3. N. Guard, T. Hamel, R. Mahony, A Practical Visual Servo Control for an Unmanned Aerial Vehicle.
4. D. Suter, T. Hamel, R. Mahony, Visual Servo Control Using Homography Estimation for the stabilization of an X4-flayer. Proceedings of the 41st IEEE conference on Decision and Control. 2002.
5. IATA, “Best Practice for Component Maintenance Cost Management”, International Air Transport Association, 2, 3 (2015).

6. S. Slazar-Cruz, A. Palomino, R. Lozano, Trajectory tracking for a four rotor mini-aircraft, Proceedings of the 44th IEEE conference on Decision and Control and the European Control Conference 2005.
7. Escareno, S. Salazar-Cruz, R. Lozano, Embedded control of a four rotor UAV, Proceedings of the 2006 American Control Conference.
8. S. Bouabdallah, P. Murrieri and R. Siegwart, "Design and Control of an Indoor Micro Quadrotor," IEEE International Conference on Robotics and Automation, 2004, vol. 5, pp 4393–4398.
9. S. K. Phang, K. Li, B. M. Chen, T. H. Lee, Systematic design methodology and construction of micro aerial quadrotor vehicles, in Handbook of Unmanned Aerial Vehicle, Eds. Springer, 181 (2014).
10. L. Zhang, J. Chen, F. Deng, Y. Bi, S. K. Phang, X. Chen, IEEE Trans. Aero. Electro. Sys. 55, 2382 (2018).
11. T. M. Lam, M. Mulder, and M. M. Van Paassen, "Haptic Interface for UAV collision avoidance," International Journal of Aviation Psychology, Vol. 17, No. 2, 2007, pp. 167-195.
12. T. M. Lam, M. Mulder, and M. M. Van Paassen, "Collision Avoidance in UAV Tele-operation with Time Delay," in IEEE International Conference on Systems, Man and Cybernetics, 7-10 October 2007, pp. 997-1002.
13. Wani, A. A., & Faisal, L. (2022). Design & Development of Novel Hybrid Set of Rules for Detection and type of Malignant or Non-Malignant Tumor in Human Brain based on SVM Using Artificial Intelligence Classifier. *Mathematical Statistician and Engineering Applications*, *71*(4), 10253-10276.
14. Mohd, R., Azad, A., Ganai, N. A., & Wani, A. A. (2021). Development of NARX Neural Network based Optimized Deep Learning Algorithm for Adaptive Rainfall Prediction in North-Western Himalayas. *Mathematical Statistician and Engineering Applications*, *70*(2), 764-774.
15. Wani, A. A., Iqbal, J., & Makhdoomi, M. (2022). Modelling an Intrusion Detection system using ensemble approach based on voting to improve accuracy of base classifiers. *JOURNAL OF ALGEBRAIC STATISTICS*, *13*(2), 1844-1865.
16. Wani, A. A., Mohammad, R., &Bhat, I. A. (2022, June). An Advanced Security Framework Scheme Based on SCSR for Hierarchical Wireless Sensor Network. In *Proceedings of Second International Conference in Mechanical and Energy Technology: ICMET 2021, India* (pp. 571-578). Singapore: Springer Nature Singapore.
17. Mohd, R. (2020). A Prognostic Approach For Precipitation Forecast Using Naive Bayes Algorithm. *Solid State Technology*, *63*(6), 7435-7444.
18. Wani, A. S.,& Patel M. (2019, March). A Survey of Next Generation Gigabit WLAN Standard: IEEE 802.11a. *RESEARCH REVIEW International Journal of Multidisciplinary, 4(3),* 1785-1791.
19. Mohd, R., & Faisal, L. (2022). Smart Agricultural Practices using Machine Learning techniques For Rainfall Prediction: A case Study of Valkenburg station, Netherlands. *Mathematical Statistician and Engineering Applications*, *71*(4), 8451-8462.