The Wingman: A Wi-Fi Enabled Drone

Murtaza Fatakdawala , Siddhi Bhanushali, Rohit Aryal , Dr. Kishor T. Patil

Computer engineering department
Smt. Indira Gandhi college of engineering
Mumbai, India

***Abstract*—Drones are conventionally controlled using joysticks, remote controllers, mobile applications, and embedded computers. A few significant issues with these approaches are that drone control is limited by the range of electromagnetic radiation and susceptible to interference noise. In this study we propose the use of mobile handset and a drone based on the ESP module. ESP module refers to the ESP8266 and ESP32 series of Wi-Fi enabled microcontrollers produced by Espressif Systems. These modules are widely used in Internet of Things (IoT) applications due to their low cost, low power consumption, and rich set of features. The ESP8266 module was first released in 2014 and quickly gained popularity among hobbyists and developers due to its low cost and ease of use. It has a built-in Wi-Fi module and can be programmed using the Arduino IDE or other programming languages such as Lua or MicroPython. The ESP8266 has a range of GPIO pins that can be used to interface with sensors, actuators, and other electronic components. The ESP32 module was released in 2016 and is an improved version of the ESP8266. It has dual-core processors, more GPIO pins, and additional features such as Bluetooth and BLE connectivity, support for touch sensors, and an ultra-low-power coprocessor. Like the ESP8266, it can be programmed using the Arduino IDE, Lua, or MicroPython. Both the ESP8266 and ESP32 modules are widely used in IoT applications such as home automation, industrial automation, smart agriculture, and wearable devices. They have a large community of developers and users, and there are many open-source libraries and projects available for them.**

Keywords—Drone, Machine Learning, ESP, quadcopter

I. INTRODUCTION

Drones, also known as unmanned aerial vehicles, are on the rise in recreational and in a wide range of industrial applications, such as security, defence, agriculture, energy, insurance and hydrology. Drones are essentially special flying robots that perform functionalities like capturing images, recording videos and sensing multimodal data from its environment. There are two types of drones based on their shape and size, fixed-wing and multirotor. Because of their versatility and small size, multirotor drones can operate where humans cannot, collect multimodal data, and intervene on occasions. Moreover, with the use of a guard hull, multirotor drones are very sturdy in collisions, which make them even more valuable for exploring uncharted areas. At present, flying robots are used in different businesses like parcel delivery systems. For example, companies like Amazon Prime and UPS are using multirotor drones to deliver their parcels. New York Police Department uses quadcopters in crime prevention. For the purposes of agriculture monitoring, for instance, the use of multiple sensors such as video and thermal infrared cameras are of benefit. Drones are especially useful in risky missions. For the sake of clarity in the rest of this work, we define a drone as a multirotor flying robot, excluding fixed-wings. A visual camera is an indispensable sensor for current drones. The low cost, low power, small size of image capturing, and streaming devices make them a de facto feature for numerous drones in the market. ESP-based drones are unmanned aerial vehicles (UAVs) that use Espressif Systems' ESP8266 or ESP32 microcontrollers as their main control system. These drones are becoming increasingly popular due to the low cost and high level of flexibility that these microcontrollers offer. ESP-based drones can be built from scratch. These drones can be controlled using a remote control, a mobile app, or a computer program. The ESP microcontrollers used in these drones provide WiFi and Bluetooth connectivity, enabling wireless control and real-time data transmission. They can be programmed using a variety of programming languages such as Arduino, MicroPython, and Lua, allowing developers to easily customise the behaviour of the drone. ESP-based drones can be used for a variety of applications, such as aerial photography, surveillance, search and rescue, and environmental monitoring. They are also popular among hobbyists and enthusiasts who enjoy building and flying their own drones. Overall, ESP-based drones are a cost-effective and flexible option for those looking to build or purchase a drone for a wide range of applications.

II. PROBLEM STATEMENT

Drones have proved to be very useful time and again in emergency situations. Gesture operated drones can be used in the defence sector for spying, tracking, delivery of important consignments in inaccessible areas. Another very important sector where drones can be useful is rescue operations. But sometimes it becomes quite challenging to carry drone equipment. If we could control the drone without any extra equipment this could reduce the price as well make the drone more accessible. The defence sector must travel light, mobile phone controlled drones would help them achieve this to a certain extent. It is very difficult to control a drone with a remote control. Only highly trained individuals are able to do so. When an untrained person tries to control the drone it often ends in a crash or any damage to the drone or others. The second problem is the estimation of the crowd in a specific area. Usually we see many estimations of a gathering and all of them vary with high degree. And no one knows the close to real estimation of the crowd. Often in accidents, we cannot see the people entrapped or gathered in the accidental site.

III. BACKGROUND

(a) Drone Control

Most commercial drones available on the market come with specially designed controllers, either as a dedicated signal transmitter or software applications running on users' hand-held devices (such as mobile phones or tablets). In both cases, the controller sends commands with detailed movement information such as move the drone x units towards a certain direction through wireless channels (e.g.,
Wi-Fi or Bluetooth). Notable products include the DJI drones (models Phantom, Inspire, Matrice, etc.) and Parrot's drones (models AR. Drone, Bebop, DISCO, Swing, Mambo, etc.). Recently there have been commercial products that introduce hand gestures as a viable control mechanism. To capture the gestures, there are two approaches.

• Using specially designed gloves: The controller is mounted on a glove worn by users and detects in real time the yaw, pitch, and roll of the hand to translate into respective movements for the drone. Products include the Kd Interactive Aura Drone, and the MenKind Motion Control Drone.

• Using computer vision via the on-board camera. These devices use the on-board camera to detect in real time where the user's hand is and respond to it in intuitive ways. Products include the DJI Spark Drone.

The first approach above presents an attempt to add new control dimensions, thus allowing more degrees of freedom to the drone controller. Instead of pressing some predefined buttons, users can move their fingers or wave their hand(s) in specific ways that are recognized by sensors installed in the glove, which are then converted into digital commands. The transmission of commands is done over radio channels, so it is the same as the traditional control paradigm. The second approach on the other hand takes a more radical leap by employing real-time image analysis, which is done on the drone itself, to recognize commands instead of sending them over radio channels. In academia, there have been similar attempts to investigate alternative methods to control drones using body parts, such as hand gestures or full body motions. Notably, Cauchard et al. found that when interacting with drones using body language, drone operators feel natural using gestures like those used with a pet or other people, such as beckoning or waving. As such, natural user interfaces (NUIs) present an appealing way to enhance the user experience when interacting with drones, as compared to the traditional way of a remote-control device. In building an NUI for drone control, there are two main directions fellow researchers are working towards: with and without the help of aiding devices. The first involves the use of some third party device that can recognize non-verbal gestures reliably, before mapping the detected gestures into suitable digital commands. Some such devices include the Leap Motion Controller1 and the Microsoft Kinect. While Leap Motion Controller is designed specifically to capture hand motions, the Kinect can capture full body motion faithfully. While this approach yields high accuracy in gesture or body motion detection, they need to be connected to a computer to work, so portability is a limiting factor. In the second direction, body movement is detected in real-time, using machine vision, to control the drone without any additional instrument. Researchers have examined the use of eye gazes, face poses, hand gestures, and the combination of them.

(b) ESP Module based drones

Aerial Photography: Researchers at the University of Tartu in Estonia have used ESP module based drones for aerial photography applications. They added a camera module to the quadcopter and used it to capture high-resolution images of the surrounding area. They also used the quadcopter to create 3D models of the area using photogrammetry techniques.

Environmental Monitoring: Researchers at the University of Belgrade in Serbia have used ESP module based drones for environmental monitoring applications. They added various sensors to the quadcopter, such as air quality sensors and temperature sensors, and used it to collect data on air quality and temperature in different areas. They were able to use this data to identify areas with high levels of pollution and temperature variations.

Search and Rescue: Researchers at the University of Padova in Italy have used ESP module based drones for search and rescue applications. They added a thermal camera module to the quadcopter and used it to search for missing persons in the wilderness. The quadcopter was able to detect body heat signatures and help locate missing persons in a timely manner.

Agricultural Monitoring: Researchers at the University of Michigan in the United States have used ESP module based drones for agricultural monitoring applications. They added various sensors to the quadcopter, such as soil moisture sensors and temperature sensors, and used it to collect data on soil moisture and temperature in different areas of the farm. They were able to use this data to optimise crop yields and reduce water usage.

These are just a few examples of the research that has been conducted on ESP module based drones. As an open-source platform, ESP module based drones provide a flexible and customizable solution for a wide range of applications, and its use in research is likely to continue to grow in the future.

IV. WORKING

Flight Controller Firmware: This is the core software that runs on the microcontroller of the quadcopter. It is responsible for controlling the motors, stabilising the quadcopter, and processing the sensor data. The firmware is written in C++ and is based on the Arduino framework. The firmware is open-source and can be modified to add new features or customise the behaviour of the quadcopter.

Ground Control Software: This is the software that runs on the user's computer or mobile device. It is used to control the quadcopter, set waypoints, and monitor telemetry data. The software communicates with the flight controller over WiFi or Bluetooth and sends commands to control the quadcopter. The software is typically written in Python or Java and is compatible with a wide range of operating systems.

Mobile App: This is a specialised version of the ground control software that is designed to run on mobile devices. It provides a simplified interface for controlling the quadcopter and is optimised for touchscreen input. The mobile app typically includes features such as waypoint navigation, live video streaming, and real-time telemetry data.

The software of ESPcopter is designed to be modular and customizable, allowing users to add new features or modify the behaviour of the quadcopter. The open-source nature of the software also encourages collaboration and the sharing of knowledge, enabling the community to build on each other's work and create new applications for the ESPcopter platform.

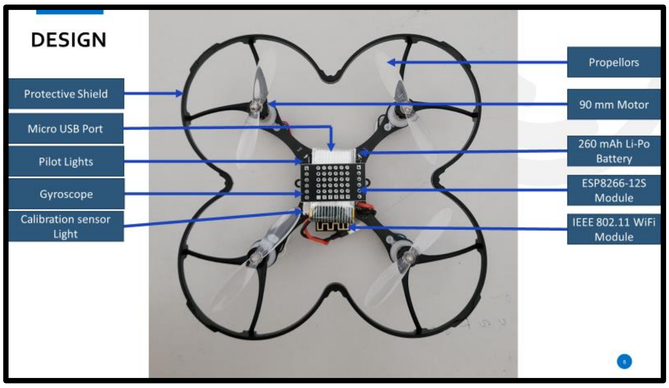

FIGURE IV.I - Picture of drone assembled with all the components.

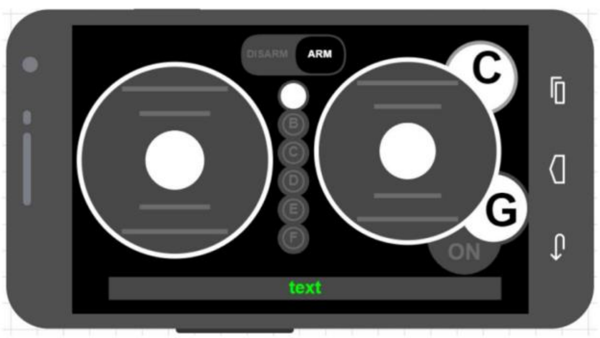

FIGURE IV.II - Picture of the GUI of mobile device.

Drone using ESP chipset is a fascinating and innovative device that combines the power of the ESP8266-12S microcontroller and the versatility of a quadcopter. It is an open-source platform that allows developers and hobbyists to experiment and create their own projects using this technology. Drones using ESP chipset is perfect for beginners and advanced users alike, with its easy-to-use interface and advanced capabilities. The device is also highly customizable, with a wide range of sensors and components that can be added to enhance its functionality. Whether you are interested in robotics, IoT, or just enjoy tinkering with electronics, ESP is an exciting tool that offers endless possibilities. In this introduction, we will explore the features and potential applications of this unique device. Its powerful ESP8266-12S microcontroller provides WiFi and Bluetooth connectivity. Drones are highly customizable, allowing users to add sensors and components to suit their specific needs. For example, you can add a camera module to capture aerial photos and videos, or a GPS module to enable location tracking. ESP module based drones also comes with a range of pre-installed sensors, including an accelerometer, gyroscope, and magnetometer, which are useful for measuring orientation, motion, and magnetic fields. The potential applications for ESP module based drones are vast and varied. It can be used for aerial photography, surveillance, and search and rescue operations. It can also be used as a tool for agriculture, environmental monitoring, and wildlife conservation.

(b) Hardware

- Frame
- Propellers
- Motors
- Batteries
- Laptop
- Flight controller
- ESP8266-12S Module
- Gyroscope
- *RC Receiver*

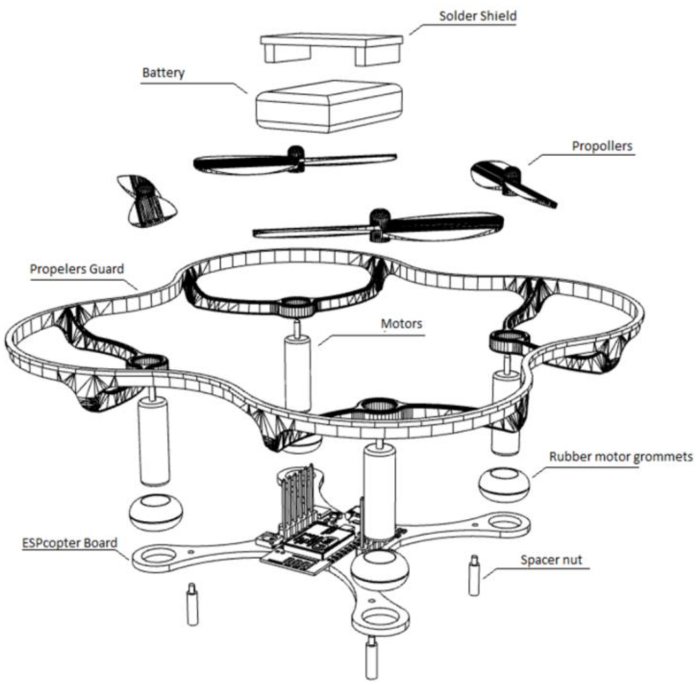

FIGURE IV.III – Frame Design (Hardware components).

(d) Safety

After the signal is received and converted to a command, such as move to the left, the action planner on the drone kicks in to compute the most appropriate course of action that satisfies the recent command. In this process, it is imperative for the drone to carry out the action while ensuring safety to itself, surrounding objects, and the environment. Collision to any of these entities potentially causes serious damage to the parties involved, which is highly undesirable. In our framework, an action planning module requires the drone to utilise its sensors (e.g., camera and proximity) to estimate the area where it can safely fly or hover. Collision avoidance is a topic addressed in robotics. Drones are much more susceptible to external factors that cause their movements to be unstable, such as wind or air flows. Collision avoidance in drones requires additional considerations for such factors. While some approaches rely on the on-board camera for this task others propose the use of more advanced sensors, such as ultrasonic or laser range finders.

One limitation of camera based solutions is that they may perform poorly when there are optical noises, such as in low lighting or foggy environments. Using more non-vision based sensors helps alleviate this problem, but adds more load to the overall weight of the drone, which may not always be feasible.

V. RESULTS

Below are the results of the project. After all the research and surveys we were able to build a drone which is shown in Figure V.I & V.II

FIGURE V.I – Working of the hardware in indoor conditions.

FIGURE V.II – Working of the hardware in outdoor conditions.

VI. CONCLUSION

Our goal is to enable the handset based control mechanism with maximum possible accuracy even in mediocre drones which can be easily outperformed by the state-of-art drones due to their inbuilt high camera resolutions like 4K, 8K, 16K and 64K etc.

1. Flight Control: Our drone has a built-in flight controller that handles the flight operations of the quadcopter. The flight controller receives commands from the user, such as pitch, roll, yaw, and throttle, and uses this information to control the speed and direction of the quadcopter's four motors.
2. Sensors: Our drone is equipped with a range of sensors, including an accelerometer, gyroscope, and magnetometer. These sensors are used to measure the orientation, motion, and magnetic fields of the quadcopter. This data is then used by the flight controller to make adjustments to the quadcopter's flight path and ensure stable flight.
3. Connectivity: The ESP8266-12S microcontroller provides WiFi and Bluetooth connectivity, allowing users to connect to the quadcopter wirelessly. This enables users to control the quadcopter using a mobile app or a remote controller.
4. Customization: One of the key features of our drone is its customization options. Users can add various sensors, modules, and components to enhance the functionality of the quadcopter. For example, a camera module can be added to capture aerial photos

and videos, or a GPS module can be added to enable location tracking.

References

[1] P. Viola and M. Jones, “Rapid object detection using a boosted cas cade of simple features,” in Computer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on, vol. 1. IEEE, 2001, pp. I–I.

[2] V. Gatteschi, F. Lamberti, G. Paravati, A. Sanna, C. Demartini, A. Lisanti, and G. Venezia, “New frontiers of delivery services using drones: A prototype system exploiting a quadcopter for autonomous drug shipments,” in Computer Software and Applications Conference (COMPSAC), 2015 IEEE 39th Annual, vol. 2. IEEE, 2015, pp. 920–927.

[3] `T. Moore, “Nypd considering using drones to fight crime - ny daily news,” May 2014. [Online]. Available: http://www.nydailynews.com/ new-york/nyc-crime/nypddrones-fight-crime-article-1.1799980

[4] D. Turner, A. Lucieer, Z. Malenovsky, D. H. King, and S.A.`Robinson, “Spatial co-registration of ultra-high resolution visible, multispectral and thermal images acquired with a micro-uav over antarctic moss beds,” Remote Sensing, vol. 6, no. 5, pp. 4003–4024, 2014.

[5] Parrot, “Parrot ar.drone 2.0 power edition,” Nov 2017. [Online].Available:https://www.parrot.com/us/drones/parrotardrone20power-edition

[6] K. Natarajan, “Drone project web page,” Dec 2017. [Online]. Available:https://github.com/KathiravanNatarajan/HandGestureControlledDrones

[7] Parrot, “Parrot drones,” Dec 2017. [Online]. Available: https: //www.parrot.com

[8] Z. Stone, “Review: The Hand-Controlled Aura Drone Will Make You Jealous Of Your Kids,” 2017. [Online]. Available: https://www.forbes.com/sites/zarastone/2017/11/20/reviewthehand-controlled-aura-drone-will-make-you-jealous-ofyour-kids/

[9] S. Mughal, “Review: Motion Control Drone fly your drone the easy way,” 2017. [Online]. Available: https://www.oxgadgets.com/2017/ 09/motion-controldrone.html

[10] J. Goldman, “DJI Spark review: Ups the ante on selfie drones,” 2017. [Online]. Available: https://www.cnet.com/products/dji-spark/review/

[11] J. R. Cauchard, J. L. E, K. Y. Zhai, and J. A. Landay, “Drone & me: an exploration into natural human-drone interaction,” in Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing - UbiComp ’15. New York, New York, USA: ACM Press, 2015, pp. 361–365. [Online]. Available: http://dl.acm.org/citation.cfm?doid=2750858.2805823

[12] B. Sanders, D. Vincenzi, and Y. Shen, “Investigation of Gesture Based UAV Control,” in Advances in Human Factors in Robots and Unmanned Systems, Chen J., Ed. Springer, Cham, jul 2017, pp. 205–215. [Online]. Available: http://link.springer.com/10.1007/978- 3-319-60384-1 20

[13] A. Sarkar, K. A. Patel, R. K. G. Ram, and G. K. Capoor, “Gesture control of drone using a motion controller,” in 2016 International Conference on Industrial Informatics and Computer Systems (CIICS). IEEE, mar 2016, pp. 1–5. [Online]. Available: http://ieeexplore.ieee.org/document/7462401/

[14] A. Sanna, F. Lamberti, G. Paravati, and F. Manuri, “A Kinect-based natural interface for quadrotor control,” Entertainment Computing, vl. 4, no. 3, pp. 179–186, aug 2013. [Online]. Available: https: //www.sciencedirect.com/science/article/pii/S1875952113000025

[15] K. Pfeil, S. L. Koh, and J. LaViola, “Exploring 3D gesture metaphors for interaction with unmanned aerial vehicles,” in Proceedings of the 2013 international conference on Intelligent user interfaces - IUI ’13. New York, New York, USA: ACM Press, 2013, p. 257. [Online]. Available: http://dl.acm.org/citation.cfm?doid=2449396.2449429

[16] J. P. Hansen, A. Alapetite, I. S. MacKenzie, and E. Møllenbach, “The use of gaze to control drones,” in Proceedings of the Symposium on Eye Tracking Research and Applications - ETRA ’14. New York, New York, USA: ACM Press, 2014, pp. 27–34. [Online]. Available: http://dl.acm.org/citation.cfm?doid=2578153.2578156