

AUTONOMOUS SECURITY DRONE FOR INTELLIGENT SURVEILLANCE AND THREAT DETECTION

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DOI: [10.5281/Arimaa.19042501](https://doi.org/10.5281/Arimaa.19042501)

ABSTRACT

The creation of human-powered detection drones, which combine smart monitoring, self-piloting control, and communication in real time for improved operational efficiency, represents a significant technological advancement in unmanned aerial vehicle (UAV) innovation. The development and design of an individual recognition quadcopter technology using a Brushless DC (BLDC) motor, GPS module, flight controller, high-quality imaging sensor, a Raspberry Pi Pico microprocessor, and GSM communication unit is shown in this research. The BLDC motor ensures steady and energy-efficient airborne operation by offering effective propulsion and vertical take-off and landing (VTOL) capability. The airborne processor controls dynamic stability and altitude regulation, while the GPS module facilitates precise navigation and localization monitoring. The suggested identification of a human drones can be used in a variety of contexts. It makes it possible to quickly scan an area and identify people in areas that are inaccessible or damaged by disasters during rescue missions. It improves crowd control, intrusion detection, and perimeter monitoring in surveillance and safety with little human participation. Additionally, the framework helps with resource allocation, survivor locating, and post-event assessment in disaster management. All things considered, the combination of sophisticated UAV elements with clever human identification techniques shows a reliable and expandable way to enhance security, situational consciousness, and responding effectiveness in crucial environments.

KEYWORDS: Autonomous Navigation, Human Detection Drone, Image Processing, Search and Rescue, Surveillance and Security, Unmanned Aerial Vehicle.

INTRODUCTION

Drones, which are also referred to as unmanned aerial vehicles (UAVs), have become indispensable instruments in a number of domains, providing previously unheard-of possibilities for surveillance flights, investigation, and response to emergencies. The Human Presence Detection Drone project is an innovative attempt to use UAV technology to monitor and detect human presence in a variety of settings. The research intends to transform rescue activities, boost surveillance of security, and strengthen disaster response efforts by combining cutting-edge sensors, intelligent algorithms, and autonomous flight capabilities [1]. The potential of UAVs for tackling significant social problems pertaining to safeguarding, protection, and disaster mitigation is becoming increasingly apparent as they proliferate throughout industries. Building on this growth, Human Recognition Drone research uses the most recent developments in artificial intelligence, robotics, and sensor technology in order to create a flexible and efficient platform for real-time tracking and detection of human targets. The initiative aims to enhance the present capacity and enable faster and more coordinated emergency response operations by autonomously scanning large areas, recognizing people in trouble, and communicating critical information to ground control centres [2].

The Human Monitoring Drones initiative's primary objective is to create, construct, and implement a UAV that can independently recognize and monitor individuals in continuous motion. The project aims to resolve issues with quick reaction, utilizing autonomous aerial systems' capabilities for emergency coordination and surveillance from a distance [3]. Establishing reliable algorithms for human detection, including sensor technologies for accurate localization, and enhancing UAV performance for dependable operation in a variety of circumstances are important goals. Propeller mechanisms, guidance modules, sensing arrays, internal processing units, and communication interfaces are among the crucial parts of the Human Detection Drone's modular system design. The drone's design prioritizes effectiveness, flexibility, and versatility, making it possible to include more sensors, computations, and features with ease. Each part is essential to the system as a whole and helps the drone identify, follow, and react to human activity [4].

UAV has become a game-changer in a number of industries, especially emergency response, defence, surveillance, and disaster management. Human detection drones are one of these applications that has attracted a lot of scrutiny since they can locate and identify people on their own in real time, even in difficult or unreachable situations. These unmanned aircraft can carry out difficult operations with little assistance from humans thanks to the integration of sophisticated sensors, microcontrollers, and communication modules, which improves efficiency, accuracy, and safety [5]. A BLDC motor, GPS component, flight control system, the Raspberry Pi Pico

microprocessor, powerful camera, and GSM module are among the essential parts of the suggested human detecting drones. While the GPS component enables autonomous navigation and precise positioning, the BLDC motor guarantees reliable propulsion and VTOL functionality. Using embedded algorithms, the onboard camera records live video streams for image-based people recognition [6]. Real-time data transmission to ground stations or mobile devices is made possible by the Pico microprocessor, which controls sensor integration and communication between the flight controller and GSM module.

The combination of computer vision and intelligent sensing methods for human monitoring and detection has been made possible by recent developments in unmanned aerial vehicle (UAV) technology. Improving UAV-based human identification has been the attention of several researchers in order to enable applications in emergency response, rescue operations, and surveillance. [7] claim that UAVs with thermal and optical cameras showed excellent accuracy in recognizing people in a variety of outdoor settings, especially in the dark. Similar to this, we used deep learning algorithms like YOLOv3 and SSD to create a drone-based surveillance . Design and development of autonomous UAVs for surveillance applications. International Journal of Advanced Computer Science and Applications levels. The work suggested self-navigating UAV architecture for search and rescue that uses GPS and onboard sensors to quickly locate individuals who have disappeared in areas devastated by disasters [8]. Their findings demonstrated that integrating immediate image processing with GPS navigation greatly increased identification effectiveness and decreased search duration. Furthermore, GSM and IoT components in UAV technologies in order to guarantee continuous tracking and information relay by enabling remote monitoring and fast connection with control stations [9].

The use of Brushless DC (BLDC) motors for effective propulsion and stability in aerial applications has been extensively documented from an equipment standpoint. BLDC-powered UAVs provide better mobility and energy economy for extended flights. Additionally, embedded systems like the Raspberry Pi and the Pico offer rapid, lightweight processing speeds that are necessary for control and sensor data fusion [10]. The present study is based on the evaluated studies, which together highlight the possibility of combining computer vision, intelligent control, and communication modules in UAV systems for dependable and effective human identification.

SYSTEM ARCHITECTURE

In order to enable effective real-time operation, the system architecture of the suggested person detecting drone is made to guarantee smooth incorporation of hardware elements, control modules, and networking interfaces. The four main parts of the overall architecture are the communication unit, sensing and detecting unit, control and navigation unit, and power supply unit.

To accomplish its operational goals, the human detection drone's system design integrates a number of hardware and software elements. initially, the aerodynamic control unit, GPS component, sensor, GSM system, BLDC motor, and Pico processor are among the essential parts of the hardware design. Through the flight controller controlling flight dynamics and stability, the GPS module supplying accurate positioning data, the camera capturing visual information, the GSM module enabling remote communication, the BLDC motor controlling movement, and the Pico wireless controller coordinating the entire system's operation, each component is essential to the drone's performance. The hardware design has been thoughtfully created to guarantee excellent performance and smooth integration in a variety of operational scenarios.

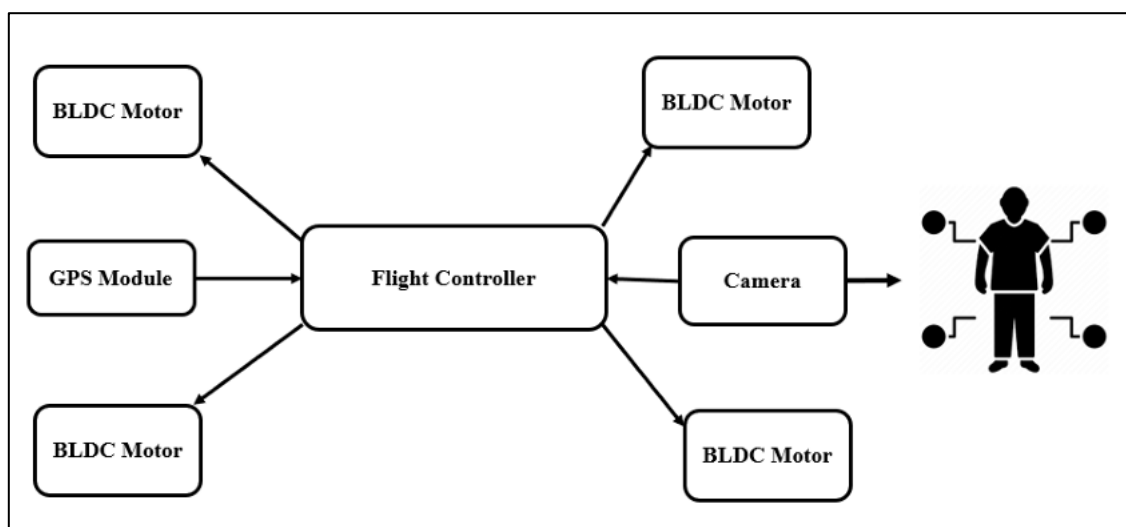


Figure 1. Block Diagram of Proposed system

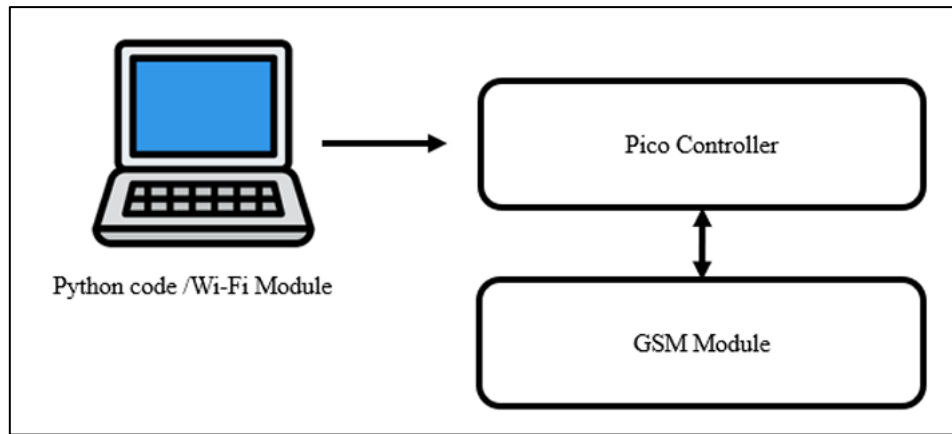


Figure 2. System Interface Module

Figure 1 shows Block Diagram of Proposed system. The drone's propulsion system, which provides thrust for flying, is a BLDC (Brushless Direct Current) motor. In order to produce rotational motion, BLDC motors electrically commutate the motor windings. To precisely regulate the drone's movement in the air, the flight controller communicates with the BLDC motor to modify its speed and direction. Figure 2 depicts System Interface Module

The drone's position and speed are determined by the GPS (Global Positioning System) module, which receives information from satellites orbiting the planet. The component uses the duration delay of information obtained from multiple satellites to determine the drone's latitude, longitude, elevation, and speed. This data is necessary for the drone's exact positioning during flight operations, waypoint tracking, and self-navigating.

As a drone's primary control mechanism, its flight controller is in charge of maintaining stability while in flight, carrying out flight directions, and stabilizing the aircraft. It monitors the drone's position, height, and velocity by receiving inputs from sensors including gyroscopes, accelerometers, and barometers. The flight control unit modifies the BLDC motor settings in response to these inputs in order to maintain the unmanned vehicle and carry perform the intended navigation movements. Pictures and videos of the drone's surroundings are captured by the camera unit. Light is converted into digital signals using optics, sensors, and electronic components. Onboard image processing algorithms then process these signals.

By allowing controllers to observe the surroundings, spot any dangers, and identify human presence within the drone's range of vision, the camera offers crucial insight into the situation.

The drone's brain is the Pico controller, which manages all internal parts and runs complex programs for recognizing people and allocation of resources. In order to maximize the drone's performance and guarantee effective operation in changing conditions, it processes information from sensors, evaluates environmental circumstances, and applies control techniques. During flight operations, the drone can track motions, recognize human presence, and react to changing situations thanks to the Pico microcontroller.

The GSM (Global System for Mobile Communications) module facilitates mobile connection to networks between the drone and operators or ground control stations. It enables data transfer, command exchange, and remote control, enabling operators to keep an eye on the drone's condition, get real-time video feeds, and provide commands from a distance. In critical situations, the GSM module allows for real-time decision-making and improves flexibility in operation. A human detection drone is a useful tool for rescue attempts, monitoring tasks, and emergency response efforts because it can successfully navigate, detect human presence, and communicate vital information by combining these components and their corresponding operating processes.

HARDWARE REQUIREMENTS

The precise hardware parts and settings required to ensure a software system's efficient operation are described in the hardware specifications. The specifications for the central processing unit, storage, hard disk or SSD and the visual processing unit, if appropriate, are usually included in these specifications. Furthermore, necessary and suggested configurations may be specified by hardware requirements depending on variables such system efficiency, capacity, and user demands. Table 1 illustrates Hardware Specifications.

Table 1. Hardware Specifications

Component	Specification
System	Pentium IV 3.5 GHz or Latest Version
Hard Disk	40 GB
Monitor	14" Color Monitor
Mouse	Optical Mouse
RAM	1 GB

BLDC MOTOR

A BLDC motor is a kind of power source that runs on electric current and controls rotation using electronic commutation rather than mechanical brushes. It is made up of a stator with electromagnets and a rotor with permanent magnets. The stator windings are successively energized by electronic controllers to produce a revolving magnetism that combines with the rotor magnets to produce revolution. In order to accurately control speed and direction, the controller uses data from sensors like encoders or Hall effect sensors to adjust current timing and strength. Because BLDC motors do not employ mechanical brushes, which lead to wear and friction, they are extremely effective, long-lasting, and low operation.

Automation in consumer electronics, industrial automation, and electric cars all make extensive use of them. In addition to maximum speed, size, and external variables like range of temperatures and IP rating for moisture and dust protection, typical specifications include rated voltage, which is typically 12V, 24V, or 48V, rated electrical current, torque, and power rating. Depending on design and load conditions, their efficiency can range from 70% to more than 90%. BLDC electric motors can have a variety of rotor and stator layouts and range in size from small electronics designs to massive industrial machines. They may be sensor-based employing Hall sensors or encoders or sensor-less using back EMF for position recognition, according to the purpose of the application. Additionally, producers offer customizable choices for mounting designs, shaft dimensions, and winding arrangements. BLDC motors are perfect for applications in automobiles, aviation, industrial control, and robotic systems because of their high torque density, effectiveness, and accuracy. Figure 3 shows BLDC Motor.



Figure 3. BLDC Motor

GPS MODULE:

A GPS module is an electrical gadget that uses information from GPS satellites that are in orbit to calculate accurate location, time, and speed. In the automobile, aviation, maritime, and unmanned aerial vehicle industries, it is extensively utilized in tracking applications, navigation systems, and location-based services. The receiving device, the antenna, the microprocessor, storage space, and interfaces for communication are the main components of the module. The antenna transforms radio signals sent by several GPS satellites into electrical form for additional processing, while the receiver receives and interprets these signals. The precise position, altitude, and movement speed of the module are then ascertained by the microcontroller after analyzing the received data and carrying out intricate computations. Figure 4 shows GPS Module.



Figure 4.GPS Module

A GPS module is an electrical gadget that uses information from GPS satellites that are in orbit to calculate accurate location, time, and speed. In the automobile, aviation, maritime, and unmanned aerial vehicle industries, it is extensively utilized in tracking applications, navigation systems, and location-based services. The receiving device, the antenna, the microprocessor, storage space, and interfaces for communication are the main components of the module. The antenna transforms radio signals sent by several GPS satellites into electrical form for additional processing, while the receiver receives and interprets these signals. The precise position, altitude, and movement speed of the module are then ascertained by the microcontroller after analyzing the received data and carrying out intricate computations.

PICO CONTROLLER

A Pico controller, which is also sometimes referred to as a Pico-sized microcontroller, is an extremely small and low-power microcontroller unit (MCU) intended for purposes where expenses, resource economy, and space are crucial limitations. It is perfect for embedded systems with low processing requirements because of its compact physical shape, straightforward architecture, and essential feature set. Pico controllers are ideal for battery-powered and energy-saving gadgets since they are optimized for low power consumption and usually come in surface-mount packaging. They have basic interface like GPIO pins, timers, and serial communication protocols like UART, SPI, and I2C that allow connectivity to actuators, sensors, and other electronic components, despite having fewer peripherals than full-scale microcontrollers.

Additionally, these types of controllers are made to be reasonably priced, which enables their broad use in electronics for consumers and Internet of Things products where economy is crucial. Using standard languages like C or assembly-language coding is typically simple, and its growth is aided by simple platforms and integrated development environments. Pico processors are frequently used in lightweight embedded electronics, wearable technology, remote control systems, IoT sensor nodes, and small appliances. Pico controllers offer an ideal combination of ease of use, smallness, and efficacy, rendering them a viable option for contemporary electronic structures that place a premium on size reduction, low energy consumption, and cost effectiveness—even though they might not have the extensive performance capabilities or peripheral diversity of larger MCUs. Figure 5 depicts PICO Controller.

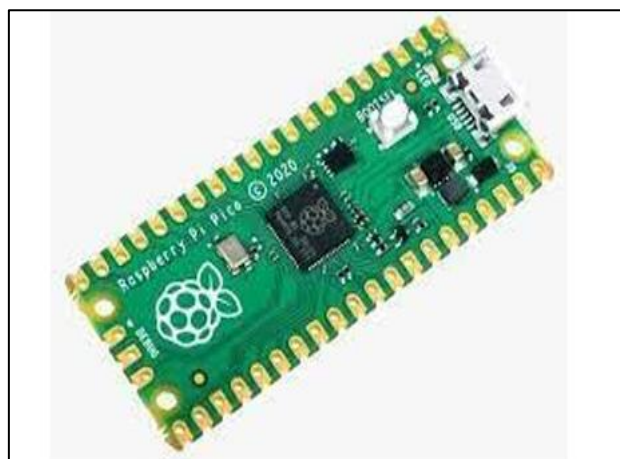


Figure 5. PICO Controller

FLIGHT CONTROLLER

The main part of a UAV is a flight controller, which processes sensor input and runs control algorithms to stabilize and regulate flight. It consists of an inertial Measuring Unit with gyroscopes and accelerometers for orientation and motion sensing, a microcontroller unit that serves as the system's brain, and frequently incorporates a receiver that uses GPS for precise tracking and guidance. Electronic speed controllers control motor speed for balance and movement, while additional parts like a barometer aid in determining height. Communication with transmitting devices, monitoring circuits, and embedded systems is made possible by interfaces for communication such as UART, SPI, and I2C. Stability and responsive flight dynamics are guaranteed by sophisticated control algorithms, which are usually based on PID logic. recording images, aerial visualization, and search and rescue are just a few of the UAV applications that may be tuned for thanks to customizable software. In general, a drone's control facilitates independent, secure, and effective flying activities by acting as the UAV's controlling centre. Figure 6 shows Flight Controller.



Figure 6. Flight Controller

SOFTWARE REQUIREMENTS

The advanced, interpreted programming language Python is renowned for its ease of use, accessibility, and adaptability. It was created by Guido van Rossum in 1991 and is extensively used in a variety of industries, including the development of websites, artificial intelligence, data science, robotics, and embedded technology. Its emphasis on straightforward syntax and effective program layout through outlining makes it beginner friendly. computational, object-focused, and functional programming are just a few of the programming paradigms that Python supports. It also has a large standard library and a sizable collection of third-party modules. It is open-source, compatible with macOS, Windows, and Linux operating systems and is capable of being created with programming languages like as IDLE, VS Code, or PyCharm. While investigating libraries like NumPy, Pandas, Matplotlib, TensorFlow, and Django, beginners usually begin by learning fundamental ideas like parameters, looping, linear operations, and control of movement. Python is one of the more potent and approachable languages for programming for educational and commercial uses because of its robust support from the community, lucid instructions, and constant improvement.

3. RESULT AND DISCUSSION

The use of human surveillance drones has produced encouraging outcomes in a number of applications, demonstrating their efficacy in improving security, safety, and operational efficiency in a range of situations. Human recognition drones have been shown to be capable of quickly locating missing people or survivors in difficult situations during search and rescue missions. These drones have greatly shortened search periods and increased the likelihood of effective recoveries by utilizing cutting-edge sensors and image technologies, saving lives in dire circumstances. Human detection drones have shown great value in border security and surveillance by keeping an eye on border areas and spotting suspicious activity or unauthorized crossings. These drones, which have real-time communication capabilities and high-resolution cameras, give border security authorities rapid intelligence so they can successfully preserve border integrity and react quickly to potential dangers.

Human surveillance drones have improved situational awareness and enabled proactive police initiatives in law enforcement and public safety applications. These unmanned aircraft help law enforcement organizations handle security problems, stop illicit activities, and guarantee safety for the public during big events or disasters by keeping an eye over crowds, spotting people of interest, and supporting search operations. Human detection drones have been essential in disaster response and emergency management, helping to locate those who survived, evaluate destruction, and coordinate rescue operations. Emergency responders have been able to efficiently allocate resources and speed up rescue efforts in disaster-affected areas thanks to their capacity to swiftly visit remote or inaccessible places and provide real-time aerial imagery.

Human detection drones have proved crucial for monitoring wildlife habitats, conserving threatened species, and seeing illegal acts like trafficking and deforestation in the fields of environmental monitoring and wildlife conservation. Due to These unmanned aircraft promote initiatives to preserve and lessen the adverse effects of human activity on ecosystems by carrying out aerial surveys and collecting important data on wildlife populations and



Figure 7. Developed Drone

environmental conditions. Figure 7 shows the proposed developed Drone. In summary, the outcomes of using human detecting drones highlight their adaptability, efficiency, and capacity to tackle a variety of problems in a number of different fields. Drones are predicted to play an increasingly important role in improving security, efficiency, and environmental responsibility as innovation grows and gets improved, becoming essential instruments in the current era.

CONCLUSION

In summary, human-identified uavs are a game-changing technology that has the possibility of completely disrupting a number of industries, like environmental monitoring, wildlife conservation, law enforcement, search and rescue, border surveillance, and disaster response. These unmanned aircraft have proven to be remarkably effective in increasing awareness of the situation, boosting reliability, and protecting individuals from dire circumstances.

Human surveillance drones will get even more advanced as drone technology and sensor capabilities progress, allowing for more accurate and dependable identification of people in a variety of settings. Furthermore, the UAVs' capacity to evaluate complicated data and make defensible conclusions in real time will be further improved by the incorporation of artificial intelligence and machine learning algorithms. Drones for human detection have several advantages, but their use additionally brings significant moral, legal, and confidentiality concerns. To guarantee that they are used sensibly and morally, it is crucial to create precise rules and laws governing their usage. We can use human detection drones to build more secure, resilient, and more environmentally friendly neighborhoods by tackling these issues and appropriately utilizing their potential.

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