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Intelligent Night Surveillance Using Drone

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ABSTRACT

Drones have emerged as reassuring solution for various surveillance utilizations. In this article, we demonstrate a sophisticated nighttime monitoring system that uses drones with infrared cameras. The proposed system leverages advanced image processing techniques for detecting and tracking the moving objects in low light conditions. The drone's flight path is controlled using a path planning algorithm that ensures the optimal coverage of the surveillance area. The system can be remotely controlled by a human operator or operate autonomously using predefined mission parameters. The captured data is analyzed in real-time to detect and classify potential security threats, such as intruders or unauthorized vehicles, and alert the appropriate authorities. The proposed system offers a reliable and efficient way to monitor large areas during the night, providing an added layer of security for critical infrastructure, such as power plants, airports, and military bases. Experimental results demonstrate the effectiveness of the proposed system in detecting and tracking moving objects in low light conditions, with a high level of accuracy and reliability.

Keywords—UAV, Drones, Night surveillance, Infrared cameras

Introduction

Unmanned Aerial Vehicle (UAV):

An unmanned aerial vehicle (UAV), or simply a drone, is an aircraft that does not have a human pilot, flight crew, or passengers. UAVs were developed in the twentieth century for military operations that were judged "dull, unclean, or dangerous" to people. They had grown into critical instruments for the bulk of forces by the twenty-first century [1]. As control systems grew more economical and effective, they were used in a variety of non-military applications. As costs fell and technology increased, the use of control technology expanded to a variety of non-military applications. [2,] wildlife monitoring1, search and rescue operations, and other activities. Drones are flying unmanned robots that can be remotely controlled or made to fly autonomously through software-controlled flight plans in their embedded systems, working in conjunction with onboard sensors and GPS. The drones need to become smart and quick-witted to optimize industrial processes, maximize their utility, and can be widely established in future factories.

Applications of UAV:

UAVs have a wide range of applications, including search and rescue, disaster management, surveillance, package delivery, videography, 3D mapping, stunning 3D model building, large orthographic photos, and elevation models. They are also used in drone racing, population health monitoring, disaster response, personal use and photography, precision agriculture and greenhouses, population health monitoring, being pulled by a UAV in combination with various sporting equipment, such as a snowboard3, and other applications. They are also used in drone racing, population health monitoring, disaster response, personal use and photography, precision agriculture and greenhouses, population health monitoring, being pulled by a UAV in combination with various sporting equipment, such as a snowboard3, and other applications.

Intelligent night surveillance using drones is a method that makes use of unmanned aerial vehicles. Intelligent night surveillance using drones is a technique that use unmanned aerial vehicles (UAVs) outfitted with cameras and other sensors to conduct nighttime monitoring. Thermal imaging cameras on these drones allow them to identify the heat signatures of objects and humans even in full darkness. This has a wide range of uses, including border enforcement, search and rescue, and military activities. Monitoring, characterizing, recording, tracing, and tracking the environment are all part of the process of converting it into usable data.

Intelligent night surveillance drones are unmanned aerial vehicles (UAVs) that are equipped with sensors and cameras that allow them to capture images and video in low light conditions. These drones can be used for a variety of tasks, including mapping, surveillance, and search and rescue. Using a drone for nighttime surveillance has several advantages, including the ability to cover a larger area than a human crew

Lately, the research in UAV systems has received rising attention in various civilian and military applications or their ability to work without human assistance in a complex, difficult and uncertain environment sent, which allow for longer durability. A UAV or an unmanned aerial vehicle as the name suggests is air-barnburner system without the need of onboard human pilot. Drones have proven to be of greator significance ever since interception back in 1907, a decade before the invention of the first airplane. Drones or UAVs can fly autonomously or be piloted remotely and are capable of carrying appropriate payloads according to the requirement and application. Drones that depend on multiple propellers are called multi rotor drones. Multi-rotor drones are also very easy to manufacture and are comparatively cheaper when compared to other drone options. Numerous rotors can be placed on the body of the drone according to the requirement and functionality of it. The versatility of drones provides us with an opportunity to mould them according to our requirement. However, there is, a solid contention that this drone technology is underutilized and can offer extraordinary advantages to specialists oncall.

LITERATURE REVIEW

The present study expands upon a significant part of research which helped in investigating the effects of topic for relevant study to get variable outcomes. In this literature review, it summarizes and analyzes the key findings from previous studies in this area, highlighting the most important and relevant findings to inform the present study.

In study [3], The ever-increasing complexity of asymmetric threats to people or infrastructure necessitates the ongoing improvement of monitoring systems. Such tactics should be founded on previous experience, present technical capabilities, and anticipated technological advances and breakthroughs. Because neither the location nor the timing of an assault can be predicted, effective real-time surveillance of a possible target is critical. Such monitoring is often carried out by specialist instruments mounted on manned or unmanned land, sea, or air platforms. The employment of manned platforms for such operations may pose significant hazards to the crew, whereas unmanned platforms may operate with far less constraints and in harsher settings. These latter platforms are, in reality, "robots" that may be remotely commanded or operate independently.

In study [4], demonstrated the use of Drone assisted wildfire fighting using fire extinguishing balls as a supplement to traditional firefighting methods. The proposed system was a hexacopter with a payload weighing 15 kg and balls of weight 0.5kg each. It consists of scouting unmanned aircraft systems (UAS) to detect spot fires and evaluating the risk of wildfire approach to the building. It also sends the relative data of the firefighting UAS to help them to control the situation. However, these balls were not effective for class A & B fires.

In study [5], In recent years, there have been countless incidents of terrorist assaults and threats in crowded public spaces. The need for greater surveillance in these areas prompted the development of new automated methods to detect and alert potential threats as soon as feasible. In this paper, we suggest a unique technique for developing a decentralised architecture to control patrolling drones and cameras by utilising lightweight protocols from the internet of things (IoT) domain. By using the mist computing paradigm, it is feasible to provide cognitive intelligence to all objects in the smart ecosystem, hence speeding up recognition and analysis processes. Distributing intelligence across all monitoring ecosystem components enables for faster detection and response to potential warnings

In study [6], Small unmanned aircraft systems (UASs) are predicted to play important roles in future smart cities, such as carrying products and commerce, functioning as mobile hot spots for broadband wireless access, and providing surveillance and security. Although they can be utilized to benefit society, bad actors can also use them to execute physical and cyber assaults on infrastructure, private/public property, and people. Even for valid small UAS use-cases, air traffic management (ATM) for UASs becomes crucial for ensuring safe and collusion-free operation. As a result, different methods for detecting, tracking, and interdicting possibly unauthorized drones are crucial for surveillance and ATM applications. In this work, we will look at strategies that rely on ambient radio frequency signals (emitted by mobile devices).

In study [7], Social networking allows us to contact with the proper people; x-ray luggage scanners provide safe travel; and computer programs save a lot of books and digital space. We might proceed to the obvious conclusion: intelligence has insured vital technical advancements that have made today's digital society fully functioning and crystalline. However, we might also ponder how intelligence gauges human progress, or how technology makes us better people. According to Han (2015), the digital world is a panoptic system that has made us all identical in order to better control us. Prior to him, Foucault (1977) maintained that surveillance systems, which had been in place since the 18th century, had evolved into disciplinary forms of social control. A civilization founded on panoptic monitoring has made us willingly subservient.

Developing Drone for Surveillance applications can involve wide range of technical and logistical challenges, depending upon specific requirements. Some of the Key considerations that need to be addressed are:

- Sensor and data processing capabilities.
- Navigation and localization.
- Communication with other devices such as ground control.

PROPOSED METHODOLOGY

The need for an effective and efficient solution for gathering and analyzing data in low light conditions, with the goal of enhancing safety and security. It suggests that there may be a need for a technology or method that can effectively collect and interpret data in these conditions, and that can provide valuable insights and support decision-making. An intelligent night vision surveillance drone can be used to gather real-time data about a specific location or area, providing valuable insights and enabling rapid decision-making.

CAMERA SET-UP

Raspberry Pi: In drones, the Raspberry Pi 4 is used to capture and analyze photos or video. The advanced processing capabilities and camera module of the Raspberry Pi may be utilized to capture high-resolution photos or video from the drone's point of view. This data can be locally kept on the Pi or transferred in real time to a ground station for additional analysis.

IR Sensor: IR sensors are electronic devices that detect the infrared radiation emitted by both inanimate and living organisms. They include temperature, proximity, and movement detecting capabilities and are widely used in a variety of applications. Because they can work in low-light conditions, infrared sensors are helpful in areas where visible light is insufficient.

Camera: Night vision cameras employ infrared (IR) technology to record pictures in low-light or full darkness, allowing for increased visibility and identification of things that may not be apparent to the naked eye.

DRONE SET-UP

ESC: An electronic speed control or ESC is an electronic circuit with the purpose to vary an electric motor's speed, its direction and possibly also to act as a dynamic brake. ESCs are often used on electrically powered radio controlled models, with the variety most often used for brushless motors essentially providing an electronically-generated three phase electric power low voltage source of energy for the motor.

BLDC: Brushless dc motors which have neither commutator rings nor carbon brushes used within the rotating shaft of the motors and have permanent magnets attached on the rotor. It has usually 4 magnets around the perimeter. The stator of the motor is composed by the electromagnets, this making them different from brushed dc motors which have coils making up the electromagnets attached onto the rotor and permanent magnets attached onto the stator providing a static magnetic field, of which also use mechanical commutation by implementing carbon brushes and a commutator ring fixed onto the rotor.

Rotor: The rotor of a typical BLDC motor is made out of permanent magnets. Depending upon the application requirements, the number of poles in the rotor may vary. Increasing the number of poles does give better torque but at the cost of reducing the maximum possible speed.

Flysky CT6B Transmitter and receiver: This is FS-CT6B 6ch 2.4GHz transmitter & receiver It has 0.8W transmitter with range up to 1km line ofsight.

Rotation Mechanism of Drone: Designs of Drone are divided into three stages that is part design in first stage and full interface at second stage. Drone can have described as a small vehicle with four or more propellers attached to rotor located at the cross frame. This aim for fixed pitch rotors are used to control the vehicle motion. The speeds of these four rotors are independent. By independent, pitch, roll and yaw attitude of the vehicle can be control easily. Pitch, roll and yaw attitude off Drone are shown in Figures below. The different working principles of the drone are explained there after which will familiarize the logic behind designing and working of a drone.

Before starting to build thee drone it is necessary to understand in deep the orientation and the way the drone flies. Based on this understanding it is necessary to choose a particular configuration of the drone. Pitching simply means that the front part of the Quadcopter’s body will either move up or down with respect to the back part of the body, rolling on the other hand simply means that the Drone body has either of its sides tipping up towards the left of the right. As we have seen the basic fundamental behaviors of both pitching and rolling moments, yaw moments are a bit complex and are the main reason behind Drone UAV's flight stability and control abilities.

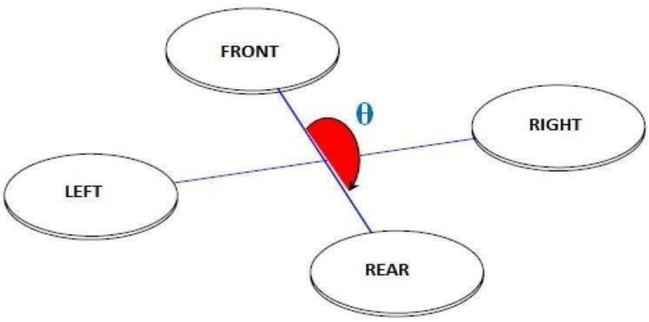

Fig.1: Pitch direction of Drone

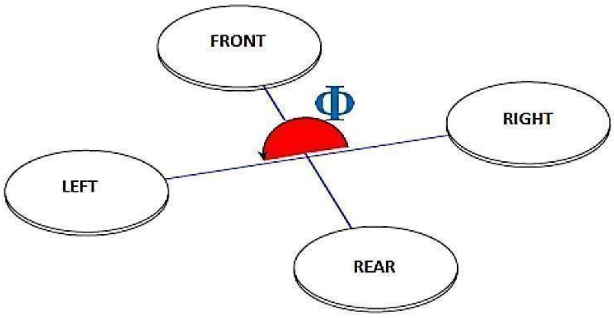

Fig.2: Roll direction of Drone

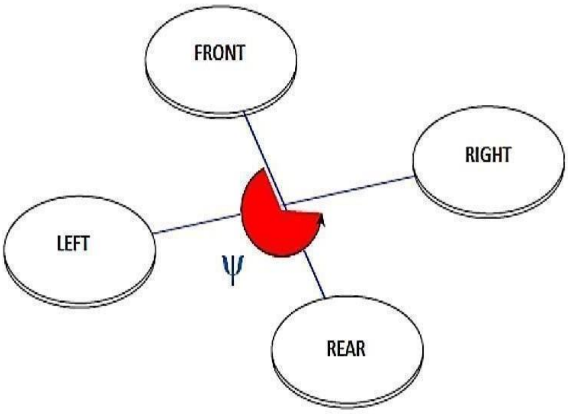

Fig 3: Yaw Direction of Drone

BLOCK DIAGRAM

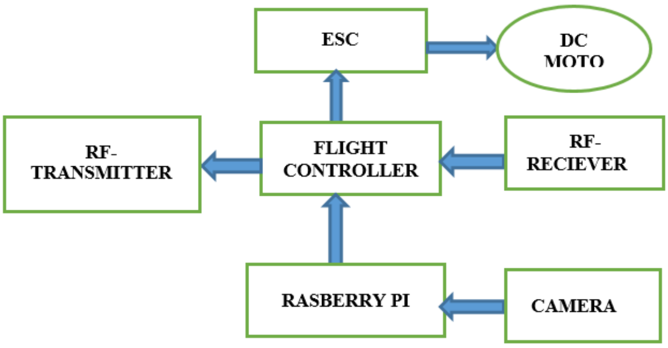

Fig 4: Block Diagram of Proposed Methodology

Developing an intelligent night surveillance drone requires a structured approach to ensure it meets the requirements and operates safely and effectively in different environments. The proposed methodology begins with defining the problem and identifying the key requirements and constraints. This is followed by determining the technical requirements and designing the drone's hardware and software architecture based on those requirements.

Once the drone is designed, it is assembled, and the hardware and software components are integrated. Autonomous features, such as obstacle detection and avoidance and autonomous navigation, are developed to enable the drone to operate safely and effectively in various environments. The drone is then tested and refined to ensure it meets the requirements, with adjustments made to the hardware and software components as needed.After testing, the drone is deployed to the designated location for night surveillance, and operators are trained to use the drone effectively and safely. Regular maintenance and repairs are conducted to ensure the drone operates effectively and meets the requirements.

Overall, following this methodology enables developers to develop an intelligent night surveillance drone that can operate safely and effectively in different environments. By taking a structured approach, developers can ensure that the drone meets the requirements and is reliable, efficient, and effective in its surveillance activities.

RESULT AND DISCUSSION

The Night Surveillance Drone operates at night and provides real-time surveillance and monitoring of selected regions using advanced image technologies. Even in low light, the drone can capture high-quality images and videos, allowing security professionals to spot possible security risks. The Drone with IR Sensor Camera may also operate in daylight settings.

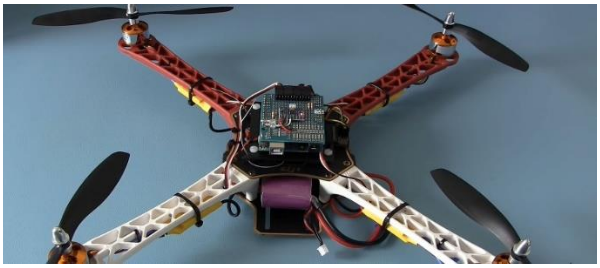

Fig 5: Side view of Drone

IMAGES CAPTURED

IMAGE CAPTURED DURING DAY LIGHT CONDITION :

Fig 6.1: Image captured with Normal Camera

Fig 6.2: Image captured with IR Sensor Camera

IMAGE CAPTURED DURING LOW-LIGHT CONDITION :

Fig 7.1: Image captured with Normal Camera

Fig 7.2: Image captured with IR Sensor Camera

IMAGE CAPTURED DURING NIGHT CONDITON :

Fig 8.1: Image captured with Normal Camera.

Fig 8.2: Image captured with IR Sensor Camera

As demonstrated above, the views acquired by drones during the day and night differ, yet both give critical information to security officers. When compared to IR pictures obtained during the day, the high-resolution visuals captured during the day enable for obvious identification of targets. Images recorded in low-light circumstances might provide difficulties for visual detection and recognition. While infrared images acquired at night provide an additional degree of detection for possible security. When compared to a standard camera, an infrared camera gives more accurate and high-resolution photos at night. Intelligent night surveillance drones may offer 24/7 monitoring of the targeted region by employing both day and night images, increasing the efficacy of security operations.

CONCLUSION

Using drones for night surveillance can provide a number of advantages, including greater coverage, enhanced visibility, increased safety, cost-effectiveness, rapid deployment, and discreetness. However, it also has some disadvantages, such as limited flight time, equipment and training requirements, legal and regulatory issues, privacy concerns, vulnerability to interference, and limited payload capacity. Drones are not a universally effective solution for nighttime monitoring, but they can be helpful in some circumstances. It is significant to assess the specific needs and constraints of the surveillance operation, and to choose a drone and related equipment and software that are suitable for the task. In order to ensure that the use of drones for night surveillance is appropriate and respectful of privacy and other rights, it is also crucial to take into account the legal and regulatory considerations that surround this practice.

FUTURE SCOPE

Drones have a lot of potential for usage in nocturnal monitoring in the future. Potential possibilities for expansion and development include:

- Enhanced technology: It is expected that developments in drone technology will assist the production of more advanced and competent drones for night surveillance, outfitted with enhanced sensors, cameras, and other equipment.

- Improved data analytics: As artificial intelligence and machine learning techniques become more prevalent, drones will be able to handle and analyses data from their sensors and cameras more efficiently, offering more accurate and actionable insights.

- Greater integration with other systems: Drone integration with other systems, such as sensor networks, security systems, and data analytics platforms, is anticipated to allow for more extensive and sophisticated monitoring.

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