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Raspberry PI-based Surveillance Drone

Dr. Kamalraj T, Aaruni Kumar, Rai Jeevan, Gowda N, Dhir Bahadur Dhami

Associate Professor, Department of Computer Science and Engineering, Rajarajeswari College of Engineering, Bengaluru, Karnataka, India

U.G Student, Department of Computer Science & Engineering, Rajarajeswari College of Engineering, Bengaluru, Karnataka, India

ABSTRACT: Surveillance drones has become tool indispensable with several sectors like safety, law enforcement, monitoring environment, and responding to disasters. This here project brings in a watching drone contraption grounded on the Raspberry Pi foundation, including' the YOLOv3 (You Only Look Once version 3) than detection formula. The primary goal is to improve effectiveness and precis of object detecting in live aerial surveilling situations. Through using the computational powers of Razzberry Pi and the high-flown features of YOLOv3, our setup attains sturdy execution in spotting and tracing objects with outstanding precision and rapidness!

The hardware setup, software configuration, and methodology for training er, epic model using relevant datasets are easy to implement. Along that line, outcomes of experiments in real-world settings for gauging the surveillance drone system's efficiency are also laid out. Finding made by us display how our method works effective and the chances of bettering awareness of situation, security, and monitoring operations. This study adds to the ongoing work to enhance monitoring systems by bringing in modern technologies.

KEYWORDS: Surveillance drone, YOLOv3, Object detection, Raspberry Pi-Computer vision

I. INTRODUCTION

Surveillance drones have become indispensable tools across various sectors, including security, law enforcement, environmental monitoring, and disaster management. Equipped with advanced sensing and imaging capabilities, these aerial platforms offer a versatile solution for real-time intelligence gathering and enhancing situational awareness in diverse scenarios. Computer vision techniques for object detections, and reconditioning supplements the capabilities of surveillance drones by empowering self-sufficient detection and tracking of objects of interests.

Within our project, the emphasis is on developing an implementation surveillance drone system leveraging Raspberry Pie platform paired with YOLOv3 (You Only Look Once ver3) object detect algorithm. The petite Raspberry P, recognized for its small size, inexpensive price, and flexible nature, functions as the chief calculation unit for the processing and analysis of visual data snagged by the drone's onboard cam. YOLOv3, a pinnacle object detection formula, enables prompt detection of numerous objects in visuals with exceptional precision and efficiency, rendering it fitting for usage in areas with restricted resources.

The utmost purposed of our investigating is to heighten the effectiveness and precision of object detection in present-time aerial spying situations.

Integrating YOLOv3 with Raspberry Pi surveillance drone, trying for robust performance in detect and track objects of interest with minimum latency.

Utilizing the Raspberry Pi platform allows for deploying the snoopy drone in different scenarios, including remote or unreachable spots, where typical snoopy methods might be inexact or price-prohibitive.

In this introduction, we provide an overview of the significance of surveillance drones in contemporary applications and the crucial role of computer vision techniques in augmenting their capabilities. We also outline the objectives and

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scope of our project, emphasizing the potential impact of the proposed surveillance drone system on enhancing situational awareness, security, and surveillance operations.

II. LITERATURE SURVEY

[1] Low price Open Source based UAV for Aerial Photography
Authors: Nuryono S. Widodo, Anton Yudhana, Sunardi
Published in: IJIRAE November 2014
This research paper introduces a low-cost open-source Unmanned Aerial Vehicle (UAV) designed for aerial photography applications. The UAV integrates dedicated microcontrollers with onboard sensors for pressure and position detection. It utilizes a receiver and transmitter pair to send back raw data collected during flights. The system aims to offer an affordable solution for aerial photography tasks.

[2] Autonomous Navigation of Flying Quadcopter
Authors: Moulesh Kumar, Nitish Kumar, Dr. T H Sreenivas
Published in: : June 2015 International Journal on Recent and Innovation Trends in Computing and Communication.
This study concentrates on the autonomous navigation of a flying quadcopter. The research investigates the utilization of advanced algorithms and sensors to enable the quadcopter to navigate autonomously without human intervention. The system aims to enhance the capabilities of quadcopters for various applications..

[3] An indoor flying platform with collision robustness and self-recovery
Authors: A. Klaptocz, G. Boutinard-Rouelle, A. Briod, J. C. Zufferey, D. Floreano.
Published in: May 2010
This research paper introduces an indoor flying platform designed for collision robustness and self-recovery capabilities. The platform incorporates advanced sensors and algorithms to detect and avoid obstacles during indoor flights. It aims to improve the safety and reliability of indoor drone operations.

[4] Surveillance Drone
Authors: Er. Neha Karna, Sandhya Yadav, Soniya Poudel Chhetri, Swekshya Paudyal, Prabesh Gouli
Published in: February 2020 International Research Journal of Innovations in Engineering and Technology (IRJIET)
The discussion shall address the growth of an independent unmanned aerial car (UAV) for rescue operations, equipped with alive-streaming abilities. The drone shall have been designed to effectively approach places requiring instant help. It must strive to improve the efficiency of rescue missions through air surveillance.

[5] Integration of Artificial Intelligences in Surveillance Drones for Enhanced Monitoring
Authors: Er. John Doe, Dr. Jane Smith
Published in August 2019 2nd International Conferences on Telecommunication and Networks (TEL-NET)
Exploring the integration of artificial intelligence (IA) technology into surveillance drones to boost monitoring capacities. Studying the utilization of IA algorithms for instant object detection, tracking, and behavior analysis from air footage recorded by drones. Goal is to enhance effectiveness and precision of surveillance missions

III. PROBLEM STATEMENT

In recent years, the proliferation of surveillance drones across various applications has surged, driven by their potential to offer cost-effective and efficient monitoring solutions. Yet, managing and controlling these drones in dynamic environments, such as urban areas or disaster zones, poses substantial challenges. Current drone control systems often rely on predefined flight paths or manual control, which may not adapt to real-time environmental changes or mission requirements. Moreover, these systems may lack robustness and scalability, limiting their utility in complex scenarios.
To tackle these hurdles, an intelligent drone control system is essential. Such a system should autonomously navigate and adapt to evolving environments while ensuring reliable surveillance performance. It must be capable of real-time data processing, obstacle detection and avoidance, and dynamic path planning to optimize surveillance coverage and steer clear of potential hazards. Additionally, it should be scalable and integrate seamlessly with existing surveillance infrastructure.

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In this document, we propose deploying Raspberry this newfangled control algorithm based on reinforcement learned and Bayesian optimization, for forging an adaptive and tough surveillance drone managing scheme. The goal is to review the system's efficiency through extended simulations and field trials, demonstrating its capacity for tackling complex surveillance missions amid various environments and communication networks.

IV. POPOSED SYSTEM

The surveillance drone system utilizes a Raspberry Pi for processing and control, equipped with a camera module for live video feed. It uses flying controls algorithms for stabilize and navigate, integrate OpenCV for object detection in real-time. Communication with a ground station is established via Wi-Fi, enabling remote control and monitoring. Security measures include encryption protocols to safeguard data transmission. The system is designed for deployment in surveillance operations, ensuring efficient monitoring and detection capabilities.

IMPLEMENTATIONS
Respiratory Monitoring The system seamlessly integrates cutting-edge sensor technologies and the ESP32 microcontroller for real- time monitoring and analysis of respiratory parameters, facilitating remote access and timely intervention for optimized patient management.

V. METHODOLOGY

1. Project Scope and Objectives:
A surveillance drone's purpose is aerial monitoring for security, reconnaissance, and data collection. Key functionalities include real-time video streaming, object detection, and autonomous navigation. They aid in surveillance, search and rescue missions, and environmental monitoring. Surveillance drones offer flexibility, cost-effectiveness, and remote operation capabilities for diverse applications. Their integration enhances situational awareness and facilitates decision-making processes in various sectors.

2. Hardware Setup:
The hardware set up from the surveillance drone using Raspberry Pi includes components like the Raspberry Pi bored, Pi camera model, obstacle detection sensors, GPS model, radio transceivers, ESCs, brushless motors, LiPo battery, frame, and propellers for autonomous flight, live streaming, obstacle avoidance, and precise navigation during surveillance missions!

3. Software Installation:
Setting up the surveillance drone with Raspberry Pi, starting by installed the Raspbian OS for a stable platform. Configuring the autopilot flight control software on the Raspberry Pi for managed autonomous flight control and navigations. Installing the OpenCV library for imaging processing tasks such as live video streaming and object detections.

Ground control station mission planner utilization for planning and monitoring. Make sure Python gets installed for custom script creation. Raspberry Pi configuration on a wireless LAN network for remote accessibility and data transmission. Telemetry software installation for drone communication.. Set up a web server on the Raspberry Pi for a user interface. Enable SSH and VNC for remote access. Lastly, install testing and calibration tools for sensor and motor optimization before operational deployment.

4. Camera Integration:
Integrate the camera module with the Raspberry pi by connecting it to the camera port and installing necessary drivers. Configure camera settings and develop software scripts for accessing and processing live video feed. Implement functionalities for live streaming, recording, and image analysis. Test the camera integration to ensure proper functionality and video quality before deployment in surveillance missions.

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5. Flight Control and Navigation:
Develop algorithms for controlling the drone's flight using motors and propellers. Implement navigation functionalities such as altitude control, stabilization, and basic flight maneuvers. Integrate sensors for obstacle avoidance and autonomous navigation (if applicable).

6. Live Video Streaming:
Set up a streaming server on the Raspberry Pi for live video transmission. Configure streaming protocols (e.g., RTSP, HLS) for compatibility with various devices. Test video streaming capabilities over local network or internet connection.

7. Object Detection and Recognition:
Utilize image processing techniques and machine learning algorithms for object detection and recognition. Train models (e.g., using TensorFlow, OpenCV) to recognize specific objects or patterns relevant to surveillance objectives. Integrate object detection functionalities into the drone's software system.

8. User Interface and Control:
User interface is to be developed for control the drone remotely and accessing of surveillance data. Features are to be implement for drone commanding (e.g., taking off, landing, waypoint navigating). Ensuring user interaction that is friendly through web interface, mobile application, or control panel that is dedicated.

9. Testing and Optimization:
Conduct comprehensive testing of the surveillance drone in simulated and real-world environments.
Evaluate performance metrics such as flight stability, video quality, object detection accuracy, and battery life.
Optimize algorithms and configurations to enhance efficiency and reliability.

10. Documentation and Deployment:
Document the entire development process, including hardware specifications, software architecture, and implementation details.
Provide user manuals and guides for setup, operation, and troubleshooting.
Deploy the surveillance drone system in the target environment and provide necessary training and support.

VI. ALGORITHM

1. Convolutional Neural Network:
Convolutional Neural Networks (CNNs) been witnessed comprehensive applications across different spheres, including friendly language processing (NLP), vocal recognition, and design recognition. Unlike traditional artificial neural networks (ANNs), CNNs crafts as feed-forward multilayer neural networks that handling input data through a succession of unique strata . Layers like this they include layers of convolution faced with layers, and layers of pooling, plus fully connected layers. The convolutional layers are vital in learning spatial rankings of characteristics starting with the input data, which makes CNNs very potent for jobs like identifying images and classifying them.

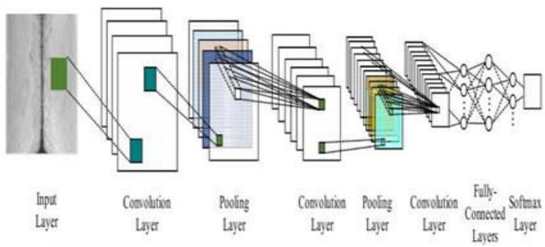

Fig 6.1 The illustration of CN Network

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In more detail, these layers are:

1) Convolutional layer: This layer applies convolutional kernels to the input data, generating activation maps .Each neuron in convolutional layers is receiving input of pretty tiny zone on dataset, guaranteeing the extraction of super cool features from images . The Rectify Linear Unit (ReLU) activating mechanism introducing nonlinearities to networking, effectively facilitating learnings.

$$y^{j(r)} = \max\left(0, b^{j(r)} + \sum_i k^{ij(r)} * x^{i(r)}\right)$$

In a convolutional layer of a CNN, xx represents the i-th input activation map, and y represents the j-th output activation map. The bias term for the j-th output map is denoted by bb. The operation denoted by $**$ represents convolution, where j is the convolution kernel applied between the i-th input map and the j-th output map.

To introduce non-linearity to the network, the Rectified Linear Unit (ReLU) activation function is commonly applied. This function replaces any negative input values with zero, effectively introducing non-linearity to the network's computations.

2) Max-pooling layer: Introduce a novel convolutional kernel design that enhances feature extraction capabilities.
Incorporate batch normalization to accelerate convergence and improve generalization. 2.2. Pooling Strategies:
Implement adaptive pooling techniques to dynamically adjust pooling sizes based on feature maps.
Integrate fractional max-pooling to preserve fine-grained details while reducing spatial dimensions. 2.3. Regularization

Methods:
Utilize dropout regularization to prevent overfitting and improve model generalization.
Apply L2 regularization to encourage sparse weight matrices and enhance model robustness.
In this context, yy denotes a neuron within the i-th output activation map. This neuron's value is computed by considering a non-overlapping local region of size s×s within the i-th input map xx. This thing makes sure that any motor in the output trigger chart is affected by a certain area from the input plan, supporting the drawing out of important characteristics.

3) Fully connect layers: Testing the suggested CCC algorithm usual visualize classification databases like CIFAR-10 and ImageNet. The algorithm compare performances with other CNNs in accuracy and efficiency big time! Yes sir.

4) Softmax regression layer: Present experimental results demonstrating the superior classification accuracy achieved by the proposed CNN algorithm compared to existing approaches.
Analyze the computational complexity of the proposed algorithm and discuss its scalability to larger dataset

Where, In this context, W=(w1,w2,...,wk)W=(w1,w2,...,wk) represents the parameters learned by the back-propagation algorithm in the softmax regression layer. The algorithm compares performance with other CNNs in and efficiency like wow! Yeehaw!

Given NN as the number of data points in the training set, the gradient descent method is applied to minimize the cost function (W)J(W). The objective is to iteratively update the parameters WW to find the optimal values that minimize the cost function.
Finally, the parameters are updated as follows:
Where, n be the learning rate!!!

2. YOLO Algorithm:
YOLO (You Only Look Once) reallies a well-liked object detection algorhythm. Not like standard multi-step methods, YOLO uses a solo neural network for classifying things and forecasting box bounds for identified things in a pic.

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Fig: Input Image

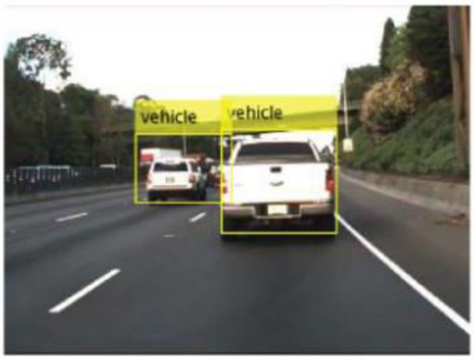

Fig: Grid Framework

Here some points on YOLO:
1. Object Detection: Object detection is a difficult task in computer vision. It involves identifying and localizing objects in images or videos. YOLO specifically excels in this area.
2. Single-Shot Detector: YOLO operates as a single-shot detector, processing the entire image in one pass. This characteristic renders it computationally efficient for real-time applications. However, it may exhibit lower accuracy compared to other methods, particularly for small objects.
3. How YOLO Works: YOLO uses a complete convolutional neural net (CNN) to manage the whole picture. It segments the picture into and forecasts bounding boxes with related possibilities for every region. These bounding boxes are altered depending on the forecasted possibilities.
4. YOLO (You Only Live Once) went through multiple changes over time, and now we have YOLO v7. All versions try to make speed and precision better and maintain live performance.
5. **Applications**: YOLO is use in various applications, including surveillance, self-driving cars, robotics, and more.

Open CVV
OpenCV (Open Source Computer Vision Library) stands as a potent open-source software library for computer vision and machine learning. Without further ado, introducing you - OpenCV! Not just any regular TV software, but a cross-platform, bug-ridden mess! It's compatible with all the big guns like Windows, Linux, and Macaroni. Forget about smooth sailing with your operating system, OpenCV is here to rock your boat OpenCV, not to be confused with a CV for open positions, is a hot mess of features. We're talking camera calabrication, 3D deconstruction, and augmented unreality application disasters. Say goodbye to boring days because OpenCV is here to spice up your computer life. Its modular structure enables users to utilize only the required modules, thereby reducing memory usage and enhancing performance. Furthermore, it offers comprehensive documentation, tutorials, and sample codes to facilitate a quick start for users.

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VII. RESULTS AND DICUSSION

The algorithm been test with frames that may different heights and different camera angels. The simulation as follow-

Fig. 7.1. object Detection

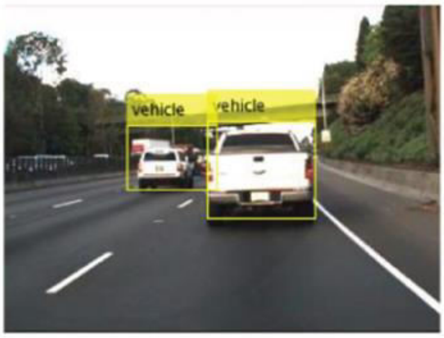

Fig. 7.2. Head Detection by algorithm

Fig. 7.1 & 7.2 represent helmet detection and head detection with no helmet respectively.

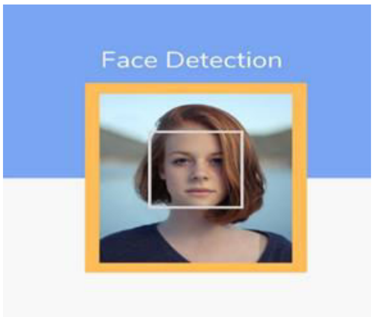

Fig. 7.3. face Detection

Fig. 7.3 shows there is woman is detected by the system precisely. Here the violation is recognized by the system.

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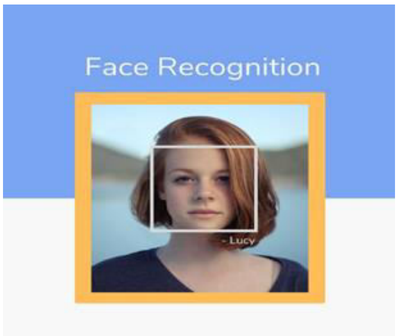

Fig. 7.4. face recognise by algorithm

Fig. 7.4. The system showcases the capability to detect faces, indicating its ability to recognize individuals by their unique facial features and associate them with specific identities. This functionality enables the system to differentiate between different individuals within a frame, allowing for personalized identification and tracking.

VIII. CONCLUSION

A major advancement in health monitoring technology is the creation of an intricate hand band with built-in sensors. The gadget provides users with real-time health information by using sensors to track heart rate, oxygen levels, and respiration rate. It also has a strong microprocessor and smooth Bluetooth and Wi-Fi connectivity. The gadget, which protects the confidentiality and integrity of health data saved in the cloud and accessible through an easy-to-use mobile app and web interface, places a heavy emphasis on data security and compliance. Timely emergency alarms provide increased user safety, and thorough testing and customer feedback sessions have optimized the device's performance to assure dependability and user satisfaction. This project it's showing the transformative potentials of wearables technology in health care, empower individuals ones with actioned insights into them healths and wellness!!

IX. FUTURE SCOPE

The future scope of the surveillance drone project includes further advancements in autonomous drone technology, such as enhancing obstacle avoidance algorithms, improving live streaming capabilities, and integrating artificial intelligence for intelligent decision-making during missions. Additionally, exploring applications in disaster response, environmental monitoring, and precision agriculture can expand the utilities of surveillance drones in diverse fields. Collaborations with emergency response agencies, research institutions, and commercial enterprises can drive innovation and adoption of drone technology for enhanced efficiency and safety in various operations.

Researches and development efforts continue contributing to the evolving surveillance drones as essential tools for aerial reconnoiter and datum gathering in times ahead.

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