JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Autonomous Drone using Open CV

[1]Dr. Lokpriya Gaikwad, [2]Sarvesh Vichare, [3]Siddhesh Patil, [4]Khushal Tayade, [5]Tejas Kamble

[1]Assistant Professor, [2-5]UG Student
Department of Mechanical Engineering,
SIES Graduate School of Technology, Nerul, Navi Mumbai ,Maharashtra, India

Abstract : In today's developing world of technology the impact they have created on human life has been extraordinary. Vehicles have become smart and autonomous which paves way to incorporate the same into aerial and space vehicles too. Drones are relatively small sized flying vehicles that can cater to numerous humans as well as the needs of the ecosystem. Autonomous drones are a boon to the human race. They are capable of navigating on their own without any user input. Machine learning and artificial intelligence play a key role in the structure of an autonomous drone design.Our project's primary goal is to provide necessities to those stranded in disaster-prone locations. Errors will be reduced during times of panic. We will be able to locate the victims easily with the aid of computer vision built into the system, and the Geolocation navigator will assist the system in determining the best route to take to approach the victims. While supplies will be delivered to inaccessible places, grippers are employed to carry the package. Gyroscope and accelerometer sensors will be used to stabilize the drone in inclement weather.

Keywords: **Autonomous; Drone; Open CV**

I. INTRODUCTION

Disasters, especially those caused by humans, pose a constant threat and are happening more frequently around the world. It is expected that ongoing terrorist attacks, wildfires, and floods will keep disaster planning in the spotlight. The nation's plans for disaster management have received more consideration from authorities. One of the crucial stages in the Disaster Response Lifecycle is the response to a disaster. Actions conducted in advance of, during, and shortly following an emergency to ensure that its consequences are minimal and that those impacted receive prompt assistance and support are referred to as disaster response. The delivery drone could allow traditional transportation infrastructure to advance at the same rate that mobile phones did for personal communication in emerging nations. No longer will inaccessible roads obstruct the delivery of medical supplies like blood or medications. This paper examines the state of autonomous drone delivery today with a focus on healthcare packs. Our model-based contribution to the design of a drone health pack would enable more timely, cost-effective, and efficient drone healthcare delivery, perhaps saving lives.

II. LIERTAURE REVIEW

Title of paper: Autonomous Drone for Defense Machinery Maintenance and Surveillance, Date: 2021

This research project's main goal is to develop an autonomous unmanned aerial vehicle (UAV) that is flown by a pix hawk flight controller. The quadcopter can be programmed to follow a predetermined path independently and is capable of autonomous navigation without real-time input from the operator. The program offers an autonomous flight strategy for quad copters, trajectory tracking, fluid motion, and precise altitude hold performance. The main defense-related applications created for Line Of Control and combat zones are surveillance and machinery maintenance. The goal of this project is to create a quadcopter that can be instructed to fly through predetermined route locations. The cloud-based deep learning technology uses data from camera and ultrasonic sensors to identify human motions. Using a Sjcam 5000x elite Camera, deviations from the established protocol are discovered. Additionally, a backup auxiliary small drone is programmed to eject with the information in the memory of the primary drone in the event of an assault or unanticipated disaster that compromises the primary drone's capacity to fly. The drone's architecture has been pre-trained by humans and is stored on the cloud. The reduction of the time and need for human operators is the main goal of research into autonomous drones and navigation. This has the benefit of improving reconnaissance capabilities at a lower risk and cost in terms of time and money. When it comes to keeping an eye on and maintaining them in the case of an error or malfunction, machinery and weapons equipment constitute a major hazard to humans. An autonomous drone can do this with ease since it has the necessary hardware to interact with the gadget installed on the machinery, which wirelessly updates the drone's status while it is in flight within its communication range.

2.2 Title of paper: Image Processing based Drone for Monitoring and Surveillance, Date: 2020

This research paper's objective is to develop a lightweight, reasonably priced quadcopter. A RC (Remote Controller) will wirelessly control the quadcopter from a predetermined distance. This small device will collect data from the quadcopter's camera, such as video and photos, and store it on a memory card. For video surveillance, multiple object detection and tracking are crucial. Due to its effectiveness in collecting distant images that are difficult to see through physical inspection, a drone or Unnamed Aerial Vehicle is particularly valuable for aerial surveillance. This initiative will significantly improve the efficiency with which a greater geographic region can be inspected, particularly in densely populated locations during festivals. To demonstrate how it worked, our drone would record the incoming signals with its camera, save the data to the SD card within the

UAV at the same time, and stream the video feed to the associated smartphone device via an application (available for Android or iOS). Once it has successfully completed its maneuver, we can extract the video into a computer and use OpenCV to identify the faces of any persons in it and retrieve their data from the face database that has already been stored

2.3 Title of paper: Autonomous drone Programming Feature detection, tracking, and obstacle avoidance, Date:2021

The goal of this work is to create a proof-of-concept autonomous drone that can perform basic tasks like tracking a specific feature (such as a face or body part) and taking photos in real-time. Additionally, for operational and safety reasons, the described system must be able to identify and avoid environmental obstacles, map the precise coordinates of the drone in real-time, and switch to keyboard control when necessary. The contribution of this work is to identify a worthwhile trade-off between accuracy and speed (response time), which is imposed by the limitations of the commercial hardware (Tello Drone) used in this paper. This contribution goes beyond the design and implementation of a straightforward, comprehensive, and functional system. Steering control, face detection, and tracking were accomplished using Har-like features, a cascade classifier, a PID controller, and Arco Markers. Future research in this area might examine how each strategy performs in various settings with various contrast levels. On the other hand, applying depth estimation techniques based on a deep learning strategy can increase obstacle avoidance capability and enable reliable navigational skills in a variety of situations

2.4 Implementation of Computer Vision in FPV Drones, Date: 2020

This paper consists of implementation of computer vision on simple FPV drones. The drone falls in the category of VTOL drones which goes by “Vertical Take-Off and Landing”. Now as the drones are small with a limited flight time and no payload can be delivered externally so the drones cannot be built using bulky or heavy materials. The drones are required to be compact with longer flight time so the use of light and more durable materials such as carbon fiber are used to build the drones. They have used brushless DC motors of 2200Kv capacity. The ESC’s are electronic speed controllers that regulate the speed of the motor’s to help maneuver the drone. The flight controller interprets input from receiver, GPS module, battery and other onboard sensors like accelerometer, gyroscope etc. The hardware setup consists of Naze32(Flight controller) and Raspberry Pi Zero. The setup for the computer vision includes a Raspberry Pi Zero and a camera.. The images from the camera are processed on the raspberry pi using the OpenCV and NumPy libraries. The major drawback is that the drone has to be operated by a person. This can be eliminated by upgrading it to an autonomous drone.

2.5 A Research Overview of Deep Learning in Drone Navigation Autonomy, Date: 2021

With the rise of Deep Learning approaches in computer vision applications, significant strides have been made towards vehicular autonomy. Research activity in autonomous drone navigation has increased rapidly in the past five years, and drones are moving fast towards the ultimate goal of near-complete autonomy. A top–down examination of research work in the area is conducted, focusing on drone navigation tasks, in order to understand the extent of research activity in each area. Autonomy levels are cross-checked against the drone navigation tasks addressed in each work to provide a framework for understanding the trajectory of current research. As small form factor UAVs flooded the market, several industries adopted these devices for use in areas including but not limited to cable inspection, product monitoring, civil planning, agriculture and public safety. In research, this technology has been used mostly in areas related to data gathering and analysis to support these applications. However, direct development of navigation systems to provide great automation of drone operation has become a realistic aim, given the increasing capability of Deep Neural Networks (DNN) in computer vision, and its application to the related application area, vehicular autonomy. We apply the Six levels of autonomy standard published by the Society of Automation Engineers (SAE) International. As a first step, we need to define the concept of autonomy for drones, with a view to recognizing different levels of autonomous navigation. Level 2 autonomous features are navigational operations that are specific and use case dependent, where an operator must monitor but not continuously control. Level 3 features allow for autonomous navigation in certain identified environments where the pilot is prompted for engagement when needed. At level 4 the drone must navigate autonomously within most use cases without the need for human interaction. Level 5 autonomy implies Level 4 autonomy but in all possible use cases, environments and conditions and as such is considered a theoretical ideal that is outside the scope of this overview.

III. Ease of Use

This Flight controller will have features like those of NAZA and APM the only difference here is the PID wherein you will need to be patient in getting your drone tuned. To make tuning easier I included a Bluetooth module to ease the tuning step without the use of your computer.

The methodology for an autonomous drone using OpenCV typically involves the following steps.

The first step is to set up the hardware required for the autonomous drone. This includes the drone propellers, Drone Frame, accelerometer, gyroscope, arduino, Battery, BLDC motor, ESC 30amp,Symmetric multiprocessor, Bluetooth module, GPS module, IC, Remote controller, pressure sensor, camera a processing unit (such as a Raspberry Pi).

The flight controller, the drone's central processing unit, is responsible for controlling the motors and ESC. We have created the flight controller for this internally using Arduino. An electronics board is used to mount sensors, processors, communication protocols, and transmitter pins. A flight controller controls every part of the drone. The drone may be maneuvered by varying the RPM of the motors. This is accomplished by receiving signals from sensors, passing them to the CPU, who in turn provides the control signal to the ESCs, instructing the ESCs to accurately adjust the motor rotational speeds to balance the flight. This information is processed before being sent to the ESCs, which adjust each motor's rotational speed to control the flying orientation (yaw, right, left, up, down, backward, forward).

The required software for the autonomous drone system must then be installed. This includes any further software needed for navigation and control, as well as the OpenCV library for object identification and tracking.

The following stage is to use OpenCV to create an object detection and tracking method. This programme needs to be able to monitor moving objects using the camera or other sensors, identify them in real-time, and report their coordinates and other pertinent data.

The development of a navigation and control algorithm comes after the object recognition and tracking algorithm has been created. The movement and navigation of the drone should be managed by this algorithm using the object coordinates and other pertinent information.
The autonomous drone system as a whole must be integrated with the object recognition and tracking algorithm as well as the navigation and control algorithm. To make sure the system isaccurate and effective, many real-world scenarios must be tested

IV. DESIGN

The design of the Quadcopter is based on the following parameters:

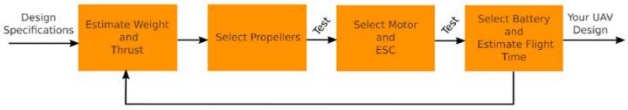

Figure 1:Flow of Design

Thrust = Total weight*9.18 = 1.25*9.18 = 12.26N
Thrust per motor = Total Thrust/4 = 12.26N/4 = 3.065N
Maximum thrust = 2*(Thrust per motor) = 2*3.065 = 6.13N …….(Assumption)
Considering the below standard table and required thrust values :

Frame size	Propeller size	Motor Size	KV Rating
150 mm or smaller	3 inch or smaller	1306 or smaller	3000 KV or higher
180 mm	4 inch	1806	2600 KV
210 mm	5 inch	2204-2206	2300 KV-2600 KV
250 mm	6 inch	2204-2208	2000 KV-2300 KV
350 mm	7 inch	2208	1600 KV
450mm	8/9/10 inch	2212 or larger	1000 KV or lower

TABLE 1: STANDARD VALUES

The Frame Size is finalized to be 250 mm.
The Propeller Size will be 6 inch.
Motor Rating will be 2300 kv.

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NAME	QTY	WEIGHT (in gms)
Motors	4	100
Battery	1	145
Propeller	4	120
ESC	1	244
Flight Controller	1	16
Miscellaneous		160
Raspberry Pie	1	50
Servomotor	1	10
Picam	1	3
Lift capacity		70+300
	TOTAL	1250

TABLE 2: list of components

Motor Mixing Algorithm:
Motor (front right) = Thrust (cmd) + Yaw (cmd) + Pitch (cmd) + Roll (cmd)
Motor (front left) = Thrust (cmd) – Yaw (cmd) + Pitch (cmd) – Roll (cmd)
Motor (back right) = Thrust (cmd) – Yaw (cmd) – Pitch (cmd) + Roll (cmd)
Motor (back left) = Thrust (cmd) + Yaw (cmd) – Pitch (cmd) – Roll (cmd)

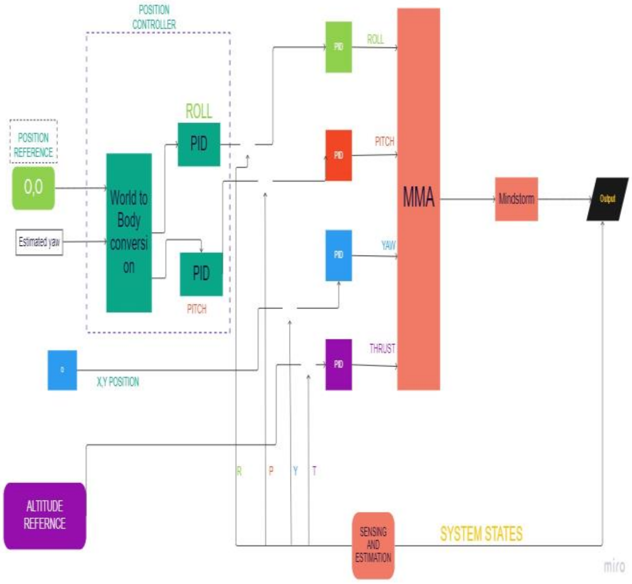

Figure 2: UML Diagram

The sensors give feedback from the real world to the controller which is in the form of altitude, pressure, position reference etc. the above values are then compared with the set reference points provided to the system and their differences are tuned in the controller using PIDs for each control operation (Thrust, roll, pitch, yaw). The obtained signals from the PIDs are later sent to the plant which is our drone itself in the form of motor speed values. Those values are used for the operation of a motors mixing algorithm to maneuver the drone.

Figure 3: Prototype of Drone

V. CONCLUSION

In conclusion, the creation of an autonomous drone system that uses OpenCV for object tracking and detection has demonstrated promising results for a variety of practical uses. The system can recognise and track objects in real-time with high efficiency and precision thanks to OpenCV, enabling autonomous flight and navigation without the need for human input.

The project's overall cost has been significantly lowered because of the development of an inhouse flight control system employing opensource hardware and flight control algorithms (Arduino). As a result, it is now possible to construct open source drones and conduct additional research in the area of autonomous flying.

Overall, the OpenCV-based autonomous drone system offers enormous potential for a variety of uses, such as surveillance, inspection, and search and rescue missions. This technology has the potential to evolve into a crucial tool in a number of different disciplines and industries with further research and improvement.

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