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IMPLEMENTATION OF COMPUTER VISION IN FPV DRONES

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ABSTRACT

When we hear the word Drones what we think of is some tech or fun flying machines which are controlled remotely or can fly autonomous. A drone has a wide range of applications which can range from creating video content to military applications. In this paper we are working to implement computer vision on simple FPV drones. A few applications we are concentrating to work on are search and rescue operations carried out by the military, surveillance and patrolling of huge estates and border areas, and also some agriculture applications.

Keywords: *Autonomous Drone, Computer Vision, FPV Drone, OpenCV, Surveillance Drone*

I. INTRODUCTION

From the day they were introduced, drones have been redefining what they are capable of doing in a very short time [1]. Drones are nowadays used from recreational purposes to expensive filmmaking. Also with the amount of progress seen in the field of Machine Learning, we have decided to combine both of these technologies for our Major Project

A drone is an unmanned aircraft and formally recognised by the term unmanned aerial vehicle (UAV) . Drones can be either controlled manually or can be autonomous. Our drone falls in the category of VTOL drones[2] 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. Even the components of the drones play a vital role in making a drone for they should be able to sustain all kinds of weather and difficulties in their flight even to sustain a fall. The drone has many components such as the standard prop which is generally made of plastic or sometimes even of carbon fiber for more sturdy build. Better prop design will assist in a smoother flying experience and longer flights. The next is the type of motors that can be used. We have used a brushless DC motors of 2200Kv capacity. The ESC's are electronic speed controllers the 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. It regulates the speed of the motors through ESC's to provide maneuver as well as triggering other payloads such as cameras. It controls the autopilot and other autonomous functions. Flight controller is basically the central to the whole functioning of the drone. The transmitter which we have used is a

six channel transmitter. It has an aux channel which is configured specifically for arming and disarming the drone. Corresponding to the transmitter we have a six channel receiver which is connected to the drone. The battery that is usd for a drone is a Lithium polymer(LiPo) battery for they offer the best power density, energy density and long lifetime. The battery can be charged by using a specific LiPo battery charger. The camera that is used is a Pi camera. For the programming essence of the drone we have used a Raspberry Pi zero and accumulated OpenCV onto the Raspberry Pi zero. The Raspberry Pi zero is a credit-card-sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word processing, browsing the internet, and playing games. OpenCV is known as open source Computer Vision. It is a library of programming functions mainly aimed at real-time computer vision. The library is cross-platform and free for use.

Our autonomous Surveillance Drone is capable of doing a lot more than the name suggests. It will be powered by Raspberry Pi Zero modules for the computing. It can have efficient computer vision algorithms integrated into it, which helps it identify obstacles and differentiate between people [3]. It can be set to a specific path which it will continuously hover over for surveillance. If fixed in a specific location, it'll stay in that position or come back to that position even if it is pushed off by wind. Multiple drones can be clustered together for this purpose [4].

II. RELATED WORK

Through research of a bunch of IEEE papers and a few other articles makes it evident that autonomous drones system has a great potential in robotics research and it is used in industrial applications.

2.1 Dario Floreano [1] says that "We see the new era of robots i.e. drones that can fly either remotely controlled or can fly autonomous in man made or a natural environment . most of these drones limit to defence applications can also have a major impact on non defence areas such as civilian tasks like transportation, communication, agriculture, disaster mitigation and environment preservation. Majority of the flight testing is done in confined spaces showcases great scientific and technical challenges owing to the costs to be more economical in terms of flight time or analytical intelligence that challenges and negotiates in complex environments. It helps to showcase scientific and technological advances that can help to translate into the use of autonomous drones for civilian applications."

2.2 Lian Pin Koh [2] in his paper concludes on how autonomous drones can be useful in forest mapping and conservation. Deforestation is a major issue and causes greenhouse emission. Usually this is dealt with costly remote sensing airborne instruments. They have come up with a prototype which is a lot cheaper and can fly autonomously over a distance of 15 kilometers. This can be very helpful in developing countries to conserve forests.

III. PROPOSED WORK

3.1 Working of drone

The drone mounts a Naze32 Flight Controller, 6 channel receiver (FS-R6B), 4 ESCs and a Power Distribution Board(PDB). The heart of the drone is the flight controller as it communicates with all the other parts of the drone. The 4 Brushless motors are controlled by the ESC which is in turn maneuvered by the flight controller. The 6 channel transmitter(FS-CT6B) works on a 2.4GHz channel and also has frequency hopping techniques to avoid signal interference. The receiver in communicates with the flight controller via SBUS. Based on the commands received, the speed of the motors are varied and hence the motions of the drone is defined.

The block diagram in Fig 1 explains the working of the drone.

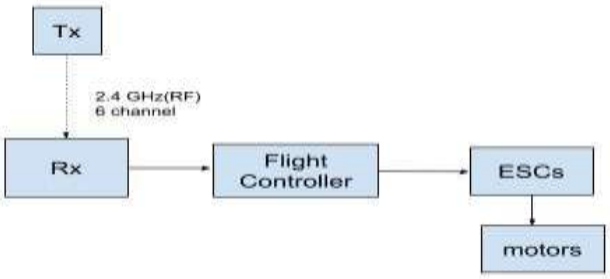

Fig.1 Working of the drone

3.2 Working of computer vision

The setup for the computer vision includes a Raspberry Pi Zero [3] and a camera. OpenCV is an open source python library of functions mainly aimed at real time computer vision. OpenCV is installed on to the Raspberry Pi. The speed of processing is totally dependent on the RAM of the Pi. Prior to using the computer vision setup, it has to be first fed with training data. The Pi can be programmed to alert the user when it recognizes people (in case of surveillance and search missions) or any other objects.

OpenCV works on a wide range of platforms from Windows to Raspbian OS. It also supports many programming languages. The most common language used with OpenCV is Python. The camera is connected to Pi via ribbon cable. The images from the camera is processed on the raspberry pi using the OpenCV and NumPy libraries.

Fig.2 Object recognition

3.3 THE HARDWARE SETUP

3.3.1 Naze32 (Flight Controller)

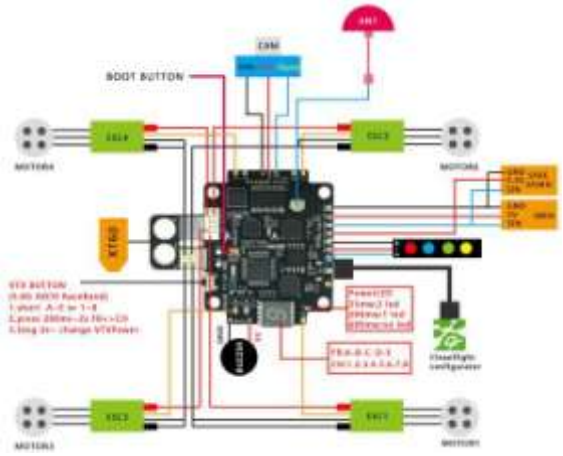

Fig.3 SP Racing F3 pinout

This is the latest version of Flight Controllers from Seriously Pro Racing. The Naze32 is more commonly known as SPF3 (SP Racing F3). The SP Racing F3 mounts an ARM Cortex-M4 72MHz CPU and has a Math Processing Unit (FPU) to handle the flight calculations efficiently. It has an on board accelerometer (MPU6050). There are 8 i/o ports to connect ESCs and motors.

3.3.2 Raspberry Pi Zero

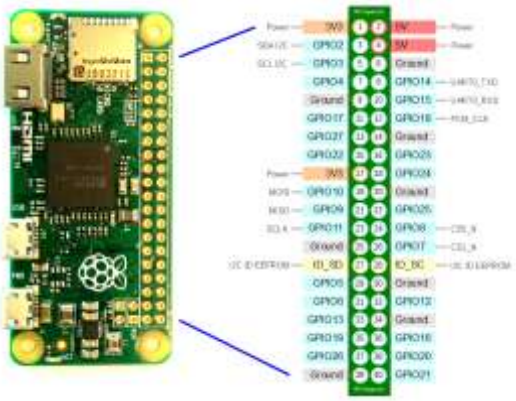

Fig.4 Raspberry Pi Zero

The Raspberry Pi Zero W is a miniature version of the typical credit-card sized Raspberry Pi. It may not be as powerful as the Raspberry Pi 3B (The latest one), but when you consider the form factor vs performance, it is a lot efficient. The Pi Zero comes in handy when you have to fit it on to small spaces. It is a lot cost effective compared to the traditional Raspberry Pi.

IV. CONCLUSION

As mentioned above, one of the main applications is search and rescue operations[5]. The team can just fly the drone over the search area and it can ring an alarm when a person is spotted through the camera. The same applies for surveillance of an estate or a border crossing.

Another application is in agriculture sector, where the drone and it's computer vision can be used to analyze before and after pictures of a drought affected land and conclude on the damage and the incentives that needs to be provided to the government. With proper algorithms and a few modifications to the hardware, this drone can be made completely autonomous. Thus will be used in a more wide range of applications. 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.

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