Smart Drone Implementing Detection And Tracking Of Humans

[1]Gaurav Jaiswal, [2]Aditya Tiwari, [3]Siddharth Bhadauria, [4]Justine Kizhakkinedath, [5]Anil Bhadgale
Department of Computer Engineering
PVG's College of Engineering and Technology, Pune, India

Abstract: Real time human detection and tracking on a drone under a dynamic environment is the key technique in the field of intelligent transport. A new lightweight real-time onboard human tracking approach with multi-inertial sensing data is proposed.

The first thing built is the drone and its hardware consists of an embedded system used as the flight controller Ardupilot. The peripherals include brushless direct current motors, electronic speed controller, frame and radio receiver-transmitter, and ultrasonic sensors and GPS module. The flight controller calculates the yaw, pitch and roll of the drone at equal intervals and by using PID values it calculates the corrections to be made to the drone to keep it stable.

Another more powerful embedded system Raspberry Pi is also used to carry out the smart features of the drone such as image processing and taking decisions to track the human in frame. Drone would be able to do feature of human detection and tracking using image processing. ssd_mobilenet model is used for image processing. The user interface consists of a Radio Transmitter and a web interface, for live streaming of video being captured by drone and target selection.

Keywords: Unmanned Aerial Vehicle (UAV), Machine Learning, Object tracking, Object detection, Computer vision.

INTRODUCTION

Unmanned Aerial Vehicle (UAV), also known as drone is an airborne system operated remotely by a human operator or autonomously by an onboard computer. UAVs have many uses in commercial, scientific, recreational, agricultural, and other applications. The use of UAVs has increased manifold times. This is mainly due to increased computing power of micro controllers and computers. UAVs are used both in military as well as civilian areas. They are used for surveillance and intelligence purposes. UAVs are used for collecting information from remote areas. They are used in subject detection and tracking. Thus, they must be portable and reliable for recurrent use.

Object detection and tracking is the key technique for intelligent transport [1]. The objects mainly are cars or traffic signs. Such targets are accompanied by rich prior knowledge, which can be utilized to improve accuracy of object tracking. But same is not the case when the object is human. Very less distinguishable features are available for improving accuracy of human tracking. The paper provides the hardware and software architecture of the drone to implement detection and tracking of human.

DESIGN

Every drone requires, at minimum, the following components: a frame, motors with propellers, motor speed controllers, a battery, a radio receiver, a flight controller, and an attitude sensor.

1. Drone Frame

The frame of the drone provides the physical structure for the entire aircraft. It joins the motors to the rest of the aircraft and houses all of the other components. The frame must be large enough to allow all four propellers to spin without collision, but must not be too large and therefore too heavy for the motors.

2. Motors and Propellers

The motors spin the propellers to provide the drone with lifting thrust. Drone use brushless direct current motors. They provide thrust-to-weight ratios superior to brushed direct current motors. However, they require more complex speed controllers.

3. Speed Controllers

Every motor needs an individual electronic speed controller (ESC). ESCs require commands in the form of PWM signals and output the appropriate motor speed accordingly. Every ESC has a current rating, which indicated the maximum current that it may provide the motor without overheating. Appropriate ESCs must be chosen to ensure that they can provide enough current for the motors.

4. Battery

The battery provides electrical power to the motors and all electronic components of the aircraft. Lithium Polymer batteries have high specific energy.

5. Flight Controller

The flight controller performs the necessary operations to keep the drone stable and controllable. User control commands from the Rx are combined with readings from the attitude sensors to calculate the necessary motor output by flight controller.

6. Radio Receiver

The radio receiver (Rx) receives radio signals from an RC transmitter and converts them into control signals for each control channel (throttle, yaw, roll and pitch). Modern RC receivers operate on a 2.4 GHz radio frequency, while older Rx units often used 72 MHz frequencies. Rx units may have as few as 4 channels, but many have more channels for additional control options.

7. Attitude Sensor

The attitude sensor provides the flight controller with readings of the drone's orientation in space. At minimum this requires a gyroscope, but most drones also incorporate an accelerometer. For a drone application, a 6-axis inertial measurement unit (IMU) is desired, consisting of a gyroscope and accelerometer on the same board.

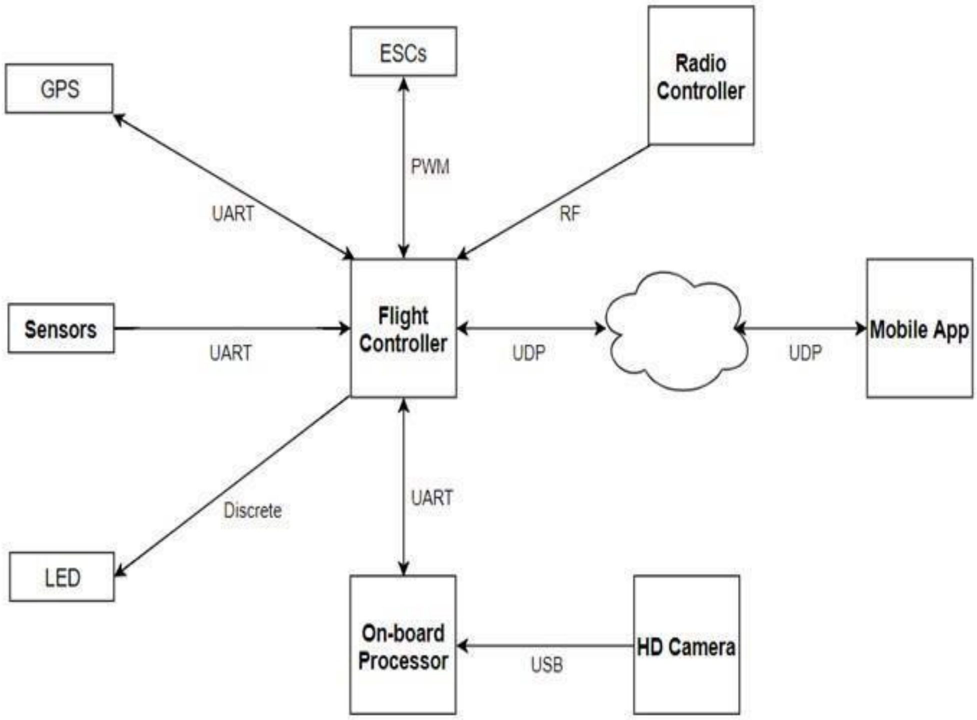

Fig. 1 Drone Essentials

The above figure represents the overall structure along with the type of data being transmitted among different components.

System Architecture:

The Drone consists of three processing board:

1) Flight controller (Ardupilot)
2) Hub (Arduino)
3) Micro-processor (RaspberryPi)

The Flight Controller is the main driver which operates the Drone.

The Arduino acts as the Hub which takes input from RaspberryPi as well as RC receiver, and switches its operation mode based on a designated channel from the RC controller.

The RaspberryPi is used to implement the Image processing [2] and ML.

Software Architecture:

The server-side architecture consists of two main Python applications running in parallel:

1. The Flask server
2. The Machine Learning (ML) application

Flask is a Python-based micro framework for creating web applications.

The Flask server runs in the background, accepts incoming requests and responds with a simple HTML webpage (The Dashboard).
On starting up the Flask server, it starts our ML application as an asynchronous sub process.
There are many off-the-shelf ML models available for object detection from the TensorFlow zoo.
Some of them include:

1) SSD MobileNet
2) SSD RCNN
3) SSD Faster RCNN
4) SSD Inception

Among all of these, SSD MobileNet happens to provide us with highest performance on mobile devices. SSD MobileNet is specially designed and trained for Mini-Computers and Mobile devices. It trades off accuracy for less computational power.
The ML app begins with loading our TensorFlow(TF) model into the main memory and extracting the latest image from the RPiCam using OpenCV. It then runs the image through the model and returns us back a list of output values including the Labels of objects, their confidence values, frame rate etc.
All this information along with the actual webcam input frame is saved onto the disk as an image file. Then the information required for the navigation of the Drone is fed into the Serial port of the RaspberryPi towards the Arduino controller.
The Flask server works continuously and feeds the latest image file to The Dashboard and replaces the existing image on their webpage.
Both the applications need to run in parallel because the initial loading time for the ML application is long.
The Dashboard can be accessed by any modern browsers as long as both the RaspberryPi and your device are connected to the same network.
The Flask server was chosen as the main process and not the other way around because this way we can implement an endpoint in our Flask app and have more granular control over the entire system.

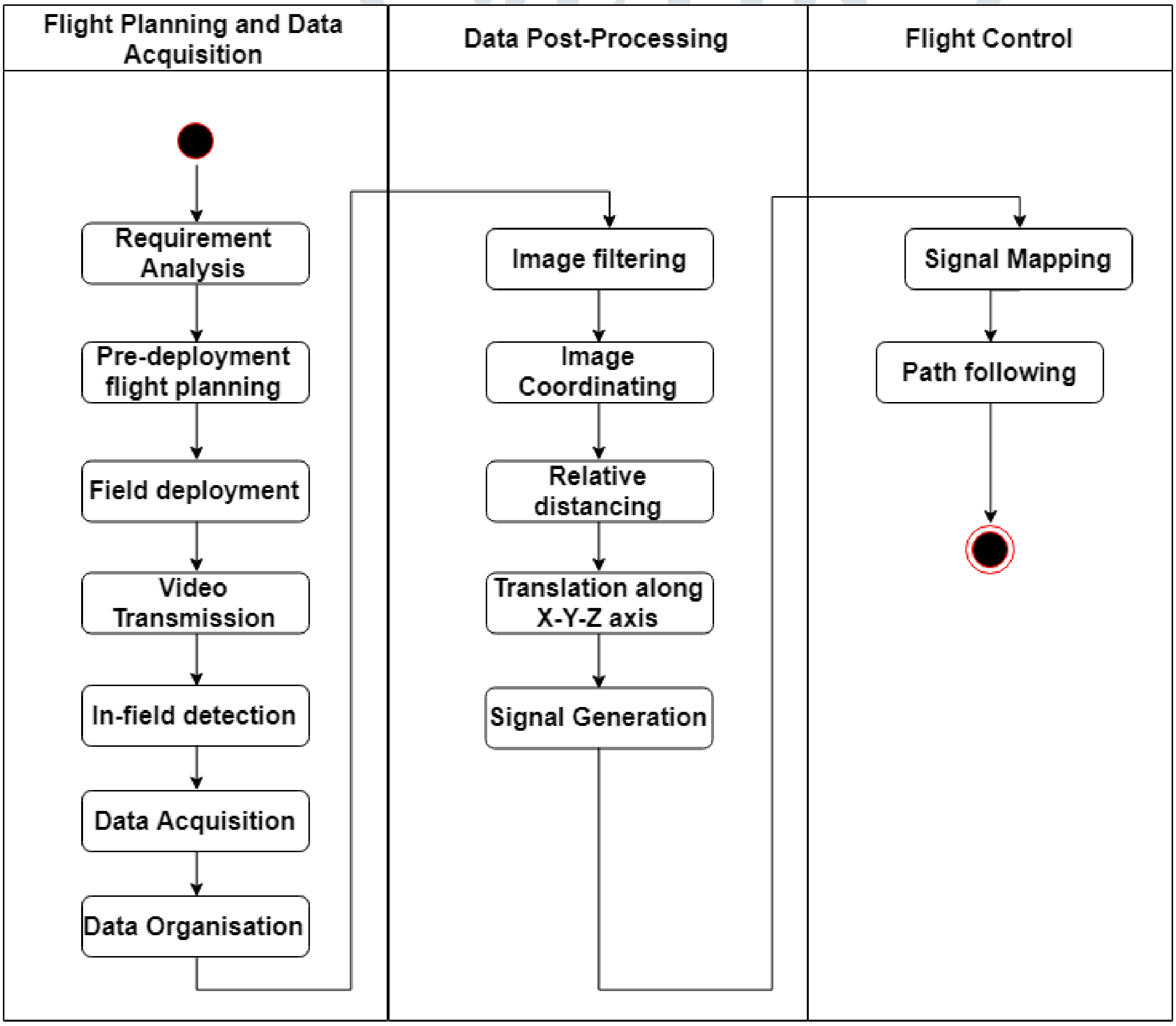

Fig. 2 Activity Diagram

The activity diagram represents the flow from one activity to another activity in the system. It describes dynamic aspect of the system.

CONCLUSION

Using the onboard microprocessor and sensors the drone is able to detect and track the human. Overall structure of the system is represented in the paper. The real time tracking of specified subject is done through the system. The detection of human is done using the ssd_mobilenet MODEL. The system can be used in both civilian and military areas, for surveillance and intelligence. With the use of UAV so developed, the positioning and navigation can also be done. The project provides an economical alternative to high end surveillance systems. It has wide range of applications ranging from military, scientific research to entertainment purpose.

REFERENCES

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