
Auto Identification of Drones/UAVs Using Concept of RF Interfacing and Compact Surveillance Radar Mechanism through Neural Networks and Computer Vision

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Abstract

According to the defense point of view, it is necessary that every single care must be taken in order to secure the country from enemies, whether the mode of attack is air, water or land. In this modern era of technology, drones are being developed as they are promising high tech security from every aspect. But because this technology is also present at enemy, it is necessary for us to be one step ahead from them by continuously updating our research and technology implementation for a better and secured tomorrow. Auto identification of Drones/UAVs in time efficient way can most suitably be done using CSR (Compact surveillance radar) and obstacle detection using laser scanner and stereovision mechanism implemented on an energy efficient drone. All the accurate object detection will be done with a micro-camera enabled with thermal and night vision facilities covering estimated distance of 0.45 kms and 120-140 degree rotation.

Keywords: Auto-identification, Drones, CSR, Obstacle Detection, Laser, Stereovision.

Introduction

Drones/UAVs being popular and known for commercial, scientific, recreational, farming, sports and security purposes. Drone surveillance is nowadays considered as most effective security tracking ways as compared to other available solutions because of its efficiency, low maintenance cost, effectiveness and accuracy. Since for security purpose every other country/ criminal organizations use drones for location tracking, live feeds capturing, image identification and location capturing via images which eventually is harmful for the country being targeted. There are various conditions affecting the detection of drones such as weather, obstacles, areas, distance where the drones can hide, day time, night and temperature etc. There are two ways through which drones/ UAVs can be detected: 1] Static way in which the system is placed at one location and from that location, process of detection of objects is carried out. 2] Another way is two use a high tech advanced 360 degrees rotating long distance camera and CSR enabled cost and

energy efficient drone which can travel the required and relative distance giving advantage of detecting object at a far location or before coming in boundary so to take the necessary steps required.

Problem in Current Scenario

Current approach of object/drone/UAVs detection which are normally used by drone making agencies and companies includes the use of:

Audio and Video Detection – Not suitable for long range object and the propellers sound [2] and may change, resulting in lag of identification. While for video detection the identification mechanism may not work during weather conditions as like rain/ fog and storm situation. Thus not viable depending the situations.

RF Detection-The most effective and the best suited way in current scenario is radio frequency detection with the help of proximity sensors to detect, monitor and identify the objects [9]. Distance range is approximately 1400 ft. and can detect location of enemy drone with the GPS coordinates, the operator of drone and the altitude at which the drone is flying. However, if the UAV is autonomous it'll not send signals to operator, instead there will be fixed and decided actions that will be programmed such as location, destination or multiple destinations (areas, of which live information is required), image and video storage so that there should not any kind of wave communication/ satellite communication.

Live Satellite Image Object Detection-

This can be done using real time google maps geolocation tracking [10] [8] and related services but is not suitable at each and every time. Since, if the object is moving at relatively adjustable speed it will not be convenient to adapt this method always.

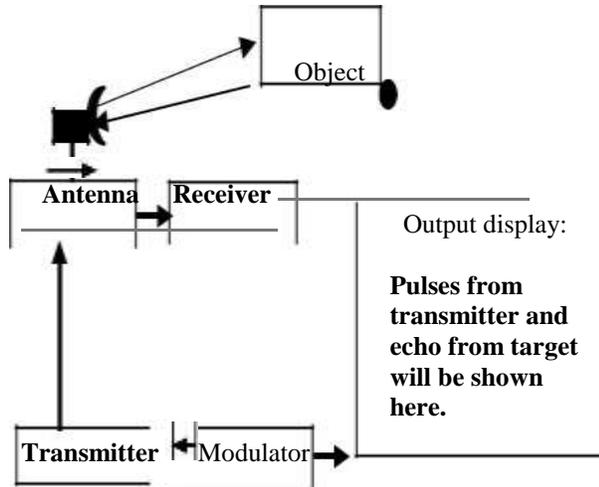


Fig 1: Compact Surveillance Radar

A portable and convenient radar system having wide coverage area and is able to track and identify objects but are needed to make advanced as there is need to identify whether the object is drone or bird. These radars are highly energy efficient and of very less weight making them widely used when required in detection and identification process [6].

Laser scanner and implementation of stereovision to detect objects at a long range –

Currently this mechanism is for driving assistance for cars and 4 wheelers and is also known as obstacle/ object sensing unit for a longer range. The root of this concept is combined use of above mentioned concepts that we can try to adapt in drones at the very first time. The objects will be identified using laser scanner and thus stereovision will be used for stabilization and detection purpose. The stereovision technique[14] will consists of few steps ensuring obstacles detection and then the laser scanner works by detecting the object (here drone) in its accurate way using algorithmic approach thus no need to worry about the increase in hardware and eventually cost. To enhance the object detection when the camera is zoomed while rotation and processing quarter PAL images via stereoscopic sensors can be used.

Proposed Methodology

A) To make an energy efficient semi-autonomous UAV detection drone which will be capable to detect and classify objects using the concept of computer vision [8] [11] and neural network wherein the image will be identified and captured using a Jenix 1080 px [5] 12MP full HD camera with NiSi 100 mm filter holder ring as external lenses so to cover long

distances and low light image capturing. Longer the focal length clearer is the distant object [3].

B) Compact surveillance radar technique (CSR) embedded on drone which is considered as lightweight, low cost far and wide viewing one with consumption of low electricity. It can be derived from ground surveillance radar [6] to detect far and nearby objects and having no weather effect on it. This radar works on the principle of ultrasonic waves transmission having transmission frequency 20,000 KHz and above, thus can travel through any medium. This technique is used by only static systems. Along with Ultrasonic system the camera will be equipped with IR capable thus detecting nearby objects in dark. We can make use of this concept so that the detector drone will be able to detect and classify the enemy drone/UAV object and not birds or any flying things. We can develop an algorithm based on deep neural networks[2][12] which can auto-zoom the camera and will force the CSR mode to start automatically once the distant object is detected in order to initiate its detection for processing and sending the information of spotted UAV/ drone to the controller.

C) Since advanced micro-camera[4][5] is present which is capable of rotating 360 degrees (we will be calling this rotating mechanism that will be made by us as Lizard's eye algorithm) and hence making the drone capable of capturing the images and live video feeds of the area with date and time mentioned and thus when the enemy drone will be visible, our haar-cascade[11] based intelligent and trained algorithm will identify the particular drone accurately no matter how efficient the light exposure is. Thus detecting and tracking drone will be easier.

D) All the transmission circuits will be interfaced with obstacle/ object detection circuit and object recognition using a scanner which makes use of laser functionality for detection, tracking and concept of stereovision [14] for identification of enemy drone. This implementation will be done using neural network and Haar like object detection algorithms ensuring cost and energy efficiency with promising accuracy about 96%.

Advantages over Current Scenario

- 1) Long range/distance can be covered with low energy and low time until the drone's battery power permits.
- 2) Accuracy is achieved as compared to available static solutions.
- 3) With adaptation of compact design it is easy to add more features like signal jamming and emp (electromagnetic pulses) attack on the enemy drone.
- 4) Hidden objects/ UAVs behind the trees, structures can be easily spotted without worrying about the efficiency of mechanism.

5] Low light or low resolution is no longer a problem.

Issues in existing technologies:

Distance:	Lower observation/detection range because of static usage.
Inefficient during night:	Low adaptation of night vision along with IR sensing.
Power:	Battery consumption is also an issue and needs to be resolved.
Live tracking:	Real time sending and receiving the feeds is a problem from longer distance.
Accuracy:	It resembles the accuracy in detection of latitude and exact location.

How auto identification of drones/ UAVs will be done?

- a] Initially there is no need of the drone to continuously fly in air surveillance mode. Instead it will act as static object detection system with running CSR acting as ground to air radar and identification mechanism [1].
- b] As soon as the object detected as enemy drone or UAV after accurate identification by our smart trained neural technology [8] [11] via the lizard’s eye camera, the signal of detection will be sent to the base where the controller of our drone will reside.
- c] The data in the form of video feed, captured image, CSR detection source, position and latitude all the collected data will be included in the signal, the transmission over which will be done through wireless and cryptic manner.
- d] Thus because of the live video tracking mode of that particular identified object using computer vision adapted stereovision and laser scanner[14], the enemy or unwanted drone will be live broadcasted to video screen device where the controlling and surveillance unit is present.
- e] The broadcast will not be done using direct satellite communication or unsecured direct RF transmission as there might be chance of detection of our own system by the enemy drone and data hacking of our system.
- f] We can use Wi-Fi modules (like ESP 8266 for prototyping) having high range and then Wi-Fi – repeater- Wi-Fi technology for several meters enabling more secured and cryptic data and information transfer within comparative less time.
- g] The algorithms will be entirely based on neural networks and computer vision using programming language as Python, which is most suitable AI styled language. As soon as the UAV from a distance of 0.45 to 1.8 Kms is detected the drone system will track the object and will simultaneously send the enemy drone’s

coordinates with time as well in real time implementation. This is all for static system converting into moving or flying one enabling to detect objects not only in air, but ground and water as well. The drone will take off after few delay/ duration provided by system user or controller so to ensure that the boundary is secured and there’s no dangerous threats around.

h] We will be using the concept of statically bounded geo fencing technique as a backup and safety plan. Geo fencing makes it possible for real time monitoring of areas or fixed boundaries surrounded by virtual fence or simply a virtual mapped and fixed boundary, and automatic detection when tracked mobile objects such as drones enters or leave these areas. This uses the concept of satellite imaging identification and detection, which will be implemented on the detector drone’s sub-system of surveillance. Thus having the prime advantage that if the UAV/drone or flying object from the enemy side is hidden in our boundary behind trees/ structures their location and time since hidden will be traced out easily instead of sending the drone and thus working for a sustainable, energy and cost efficient drone detection model.

- i] Thus real time tracking and monitoring analytics will help to make the boundary/ our area/ country more secure.
- ii] Ease in identification using our classification based neural sorting algorithm.
- iii] The circuit seems complicated initially but is the most preferable way as embedding of the sensors, interfacing and making them work like as mentioned makes the detector gadget drone unique in its class.

System Requirements:

For prototype purpose components that will be used are [15]:

- 1] Frame for quadcopter or drone as per load and requirements.
- 2] Motor or Rotor and propellers – For maneuver and fly purpose – 4 units.
- 3] Electronic speed controls.
- 4] Flight and function controller unit with display.
- 5] Radio transmitter and receiver (Remote control with 4 channels).
- 6] Battery- LiPo with 3000 mAh and 3SIP 20C specification thus giving more time to drone to be able to fly.
- 7] Charging unit – IMAX B6 Lipo balance charger. The above ones are required to make drone.

For CSR:

- I] Amplifier and mixer.
- II] Splitter.
- III] Data acquisition/ Ramp generator.
- IV] Attenuator.

