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Deep Learning Approach to Detect Objects Using Drone Computing

Ashwin Kumar K[1*], Likith J[2], Nagendra Prasad[3], C Manasa[4]

[1,2,3]Dept. of Information Science and Engineering, Global Academy Of Technology, Bangalore, India
[4]Visvesvaraya Technological University, Belagavi, India

[*]*Corresponding Author: ashwinkumar9998@gmail.com, Tel: +91-9741032662*

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Abstract— There are some things which humans cannot do but a machine can one of them is some locations where humans cannot go and live in that locations by using the machines we can search that particular area for some purpose. So our project stands to solve this kind of problems by using the machine called unmanned aerial vehicle (UAV) which is Drone in our project. By using Drone in our project we can do the object detection and tracking using Deep Learning technology which helps the humans in solving this kind of problems as well it can also be used by the traffic policemen to determine the vehicle number who breaks the traffic rules, crime etc, It can also be used by an army of the country in borders to find out the terrorists who have entered their country borders, It can also be used in the cities to supply medicines and other items during emergencies, It can also be used to detect mining areas, It can also be used in the situations where earthquakes, Tsunami and other natural calamities in this time it can be used to detect humans, cows and other living things to be saved. Our project solves these problems at a greater accuracy with optimized cost as possible.

***Keywords*—**UAV, Drone, terrorists, army, police, earthquakes, tsunami

I. INTRODUCTION

Robotics becoming a fundamental aspect of modern society, further research and consequent application are ever-increasing. Aerial robotics, in particular, covers applications such as surveillance in hostile military zones or search and rescue operations in disaster-stricken areas, where ground navigation is impossible. The increased visual capacity of UAV's (Unmanned Air Vehicles) is also applicable in the support of ground vehicles to provide supplies for emergency assistance, for scouting purposes or to extend communication beyond insurmountable land or water barriers. The Quadcopter, which is a small UAV has its lift generated by four rotors and can be controlled by altering the speeds of its motors relative to each other. The four rotors allow for a higher payload than single or dual rotor UAVs, which makes it safer and more suitable to carry a camera and transmitter equipment. An onboard camera is used to capture and transmit images of the Quadcopter's First Person View (FPV) while in flight, in real-time, wirelessly to a base station.

Visual tracking is a fundamental problem pertinent to many real-world applications including video surveillance, autonomous vehicle navigation, human-computer interaction, and many more. Given the initial state (e.g., position and size) of the target object in a video frame, the goal of tracking is to automatically estimate the states of the moving object in subsequent frames. Although visual tracking has been studied for decades, it remains a challenging problem due to various factors such as partial occlusion, fast and abrupt object motion, illumination changes, and large variations in viewpoint and pose. Although drones were mostly used for military applications in the past, the recent commercial drone revolution has seen an increasing number of research laboratories working on small, affordable, human-friendly drones. The rapid development of commercial drones could have a major impact on many civilian applications, including transportation and communication. Meanwhile, several foreseeable applications on this new platform will need visual tracking as a core enabling technology. To name a few, visual tracking can make drones useful or tracking animals, finding people, monitoring real-time traffic situations, and so on.

II. RELATED WORK

In recent years, unmanned aerial vehicle (UAV) and micro aerial vehicle (MAV) have been an active area of research. They have been used for military applications but also are useful for many civilian applications such as terrain and utility inspection, disaster monitoring, environmental surveillance, search and rescue, and traffic surveillance. However, most of them are still semi-autonomous and guided by a human who is not on board. There are lots of challenges to turn a UAV into fully autonomous control. The control of UAV during autonomous flights relies on knowledge of variables like position, velocity and orientation, which can be partly calculated using the information provided by on-board inertial sensors. However, the drift of inertial sensors leads to errors during time-discrete integration, making a steadily accurate estimation of the absolute pose nearly impossible. Therefore, an absolute reference is needed.

An early autonomous navigation system for a model-scale helicopter (the Hummingbird) was developed at Stanford University (Conway, 1995). The unique feature of this system was the sole use of GPS as the navigation sensor replacing the Inertial Measurement Unit, which is conventionally favoured as the primary navigation sensor. However, indoors, the GPS will not be available, where a visual tracking system could be applied. In (Gurdan, Stumpf, Achtelik, Doth, Hirzinger & Rus, 2007) a position controller for a quadcopter was implemented using an optical tracking system by VICON is the Holodeck lab at MIT. This intelligent space is nevertheless very expensive and not transportable. A notable vision-based technique used in autonomous helicopter control, the visual odometer (Amidi, 1996), provides accurate navigational information such as position and velocity which is then combined with inertial measurements. However, outdoors, it still needs GPS for positioning. While several techniques have been applied for vision-based control of UAVs, none of them has shown a fast, vision-based control and positioning system.

Ali Rohan, Mohammed Rabah and Sung-ho–kim [1] proposed an approach to detect and track the target object, moving or still, using SSD object detector for a UAV is presented. A CNN based on SSD architecture is trained to detect a single class. In the case of single class detection, the training of CNN requires a particular approach; it is different from the normal training of the network. For this, they have implemented a training method using positive (images with object) and negative images (images with no object) for training. Also, SSD is selected because it aims to combine the performance of YOLO with the accuracy of region-based detectors. SSD provides higher accuracy for object detection than YOLO (normally used for real-time implementation). Their proposed system comprises of two parts: object detection and target object tracking. The efficiency achieved for object detection is 98% which is very reasonable for a complex system like a drone. Target object tracking with simple PID controllers is combined with the detection algorithm by designing a specific approach where x, y and z-axis (a 3d-plan) is considered. The accuracy achieved for the target object tracking based on several experiments is 96.5%.

Mohammed Rabah, Ali Rohan, Muhammad Talha, Kang Hyun Nam and Sung Ho Kim [2] proposed RPi based drone target detection and safe landing system with the integration of PID controller for target detection, and Fuzzy Logic controller for a safe landing. The proposed system is equipped with a USB camera which is connected to RPi for detecting the target and a laser range finder (LIDAR) for measuring the distance for a safe landing. To verify the performance of the developed system, a practical test bench based on a quadcopter and a target drone station was developed. Several experiments were conducted under different scenarios. The result shows that the proposed system works well for the target finding and safe landing of the quadcopter.

Widodo Budiharto, Alexander Agung Santoso Gunawan, Jarot Suroso and Andry Chowanda, Aurello Patrik and Gaudi Utama [3] proposed a fast object detection using MobileNet SSD for drone-based on quadcopter drone from Parrot. Their method using MobileNet SSD Detector can be used as an object detector with high-accuracy detection with average about 14.50 FPS and using stereo camera Minoru only 6 FPS. The resulting system is interactive and engaging and they were able to control the Parrot AR Drone easily with a low specification in hardware. Moreover, the Parrot AR Drone also can correctly recognize the common objects such as a person, desk, or chair with high accuracy.

SiyiLi, Dit-YanYeung [4] built a benchmark dataset of high diversity, consisting of 70 videos captured by drone cameras. To address the challenging issue of severe camera motion, they devise simple baselines to model the camera motion by geometric transformation based on background feature points.. The goals of this paper are three-fold: 1. Construct a unified drone tracking benchmark dataset with detailed analysis of statistics; 2. Design general baseline algorithms for camera motion estimation and integrate them into various tracking systems; 3. Conduct an extensive experimental comparison and provide basic insights into the motion model in tracking, to open up a new research direction for the visual tracking community. In this paper, they have explored the potential of conducting visual tracking on the drone platform. They propose a unified drone tracking benchmark which covers a variety of videos captured by drone cameras. To address the challenging issue of abrupt camera motion, they design simple baselines to model the camera motion by projective transformation based on background feature clues. They presented an extensive comparison of recent state-of-the-art trackers and their motion model variants on the drone tracking benchmark. The result demonstrates that by explicitly modelling camera motion, trackers can achieve substantial performance improvement under the proposed motion model. Although their proposed baseline methods are effective, some cases of failure do exist.

It Nun Thiang, Dr.LuMaw, Hla Myo Tun [5] presented a simple and effective vision-based algorithm for autonomous object tracking of a low-cost AR. Drone quadrotor for moving ground and flying targets. The Open-CV is used for computer vision to estimate the position of the object considering the environmental lighting effect.

This is also an off-board control as the visual tracking and control process are performed in the laptop with the help of a Wi-Fi link. The information obtained from vision algorithm is used to control roll angle and pitch angle of the drone in the case using a bottom camera, and to control yaw angle and altitude of the drone when the front camera is used as vision sensor. The application software was implemented using visual studio and open-cv library based on the CV Drone. It includes four main parts manual control, getting nav-data and video stream, and sending commands to the drone. They proposed the low-cost black box AR. Drone application in the vision-based robotics research area. The simple and effective vision algorithm was designed by using colour object tracking method to track the moving objects based on on-board cameras. The vision tracker also supports the position error between the drone and the object in real-time to control the drone. The performance of the system was demonstrated in conducting the experiments with the results. According to many experiments, they have found that the speed of the moving target is an important issue in this system because of the limit of the camera view.

Jangwon Lee, Jingya Wang, David Crandall, Selma Sabanovic and Geoffrey Fox [6] proposed to use Convolutional Neural Networks to allow UAVs to detect hundreds of object categories. CNN's are computationally expensive, however, so they explore the approach of moving the recognition to a remote computing cloud. Our approach enables the UAVs, especially lightweight, low-cost consumer UAVs, to use state-of-the-art object detection algorithms, despite their very large computational demands. The (nearly) unlimited cloud-based computation resources, however, come at the cost of potentially high and unpredictable communication lag and highly variable system load. We tested our approach with a Parrot AR. Drone 2.0 as a low-cost hardware platform in a real indoor environment. The results suggest that the cloud-based approach could allow speed-ups of nearly an order of magnitude, approaching real-time performance even when detecting hundreds of object categories, despite these additional communication lags. They demonstrated their approach in terms of recognition accuracy and speed, and a simple target searching scenario.

Eleftherios Lygouras, Nicholas Santavas [7] proposed an embedded system implementing a deep learning architecture trained for the identification and location of swimmers. Thus, they address the problem of precise open water human detection by conducting real-time recognition on board rescue hexacopter, as well as the accurate transportation and release of the airborne rescue apparatus. In particular, to obtain an adequate size dataset for the chosen model, the majority of the training dataset used in this research are images extracted by videos captured by the authors. Humans swimming in open waters was filmed using a UAV flying at several altitudes. Their model attained mAP was in the order of 67%, which is a very adequate figure for an onboard human detection process. The onboard image processing hardware, using the Nvidia Jetson TX1, offers the capability of real-time processing, thus avoiding the transmission of the video sequence to a ground station for processing and returning the results to the UAV, something that could lead to undesirable and crucial time delays. While the proposed rescue system was implemented for open water swimmer detection, it would be capable of detecting humans and providing emergency services to people practising winter sports activities, with only a few modifications.

Wang Chao [8] presented the design and implementation of a real-time, vision-based navigation system for an Unmanned Aerial Vehicle (UAV). The navigation system is integrated with an autonomous flight control system, visual surveying, and visual detection of marker and object (a hula hoop). Based on the autonomous control system and visual surveying, the navigation can be done from an arbitrary initial position and orientation. The autonomous control algorithm is accurate and stable with high flexibility. The usage of wide-angle lens improves the vision system. The vision algorithm is fast, robust, and computationally inexpensive.

Joseph Redmon, Santosh Divvala, Ross Girshick, Ali Farhadi [9] proposed a new approach to object detection. Prior work on object detection repurposes classifiers to perform detection. Instead, they frame object detection as a regression problem to spatially separated bounding boxes and associated class probabilities. A single neural network predicts bounding boxes and class probabilities directly from full images in one evaluation. Since the whole detection pipeline is a single network, it can be optimized end-to-end directly on detection performance. Their unified architecture is extremely fast. Our base YOLO model processes images in real-time at 45 frames per second. A smaller version of the network, Fast YOLO, processes an astounding 155 frames per second while still achieving double the mAP of other real-time detectors. Compared to state-of-the-art detection systems, YOLO makes more localization errors but is far less likely to predict false detections where nothing exists. Finally, YOLO learns very general representations of objects. It outperforms all other detection methods, including DPM and RCNN, by a wide margin when generalizing from natural images to artwork on both the Picasso Dataset and the People Art Dataset.

Jiangjian Xiao, Changjiang Yang, Feng Han, and Hui Cheng [10] presented two tracking approaches from Sarnoff Corporation to detect moving vehicles and person in the videos taken from Unmanned Aerial Vehicles (UAV). In the first approach, they combine layer segmentation approach with background stabilization and post track refinement to reliably detect small moving objects at the relatively low processing speed. Their second approach employs a fast-tracking algorithm that has been optimized for real-time application. To classify vehicle and person from the detected objects, a HOG based vehicle vs. person classifier is designed and integrated with the tracking post-processing. For vehicle tracking, their results demonstrate a reasonable tracking accuracy with low false alarm and missing detection rates. However, for the person tracking, they met a lot of difficulties to achieve good evaluation performance due to the small size of the moving persons, slow motion, and low video contrast. It means a great challenge for person detection and tracking remained in UAV video.

Tu Le, Ehsan Aryafar [11] describes implementing machine learning algorithms for the drone to perform real-time object detection and tracking using an onboard camera and low-power embedded system. They used DJI Manifold built on top of NVIDIA Tegra K1 which is a 32-bit architecture and low power onboard computer. The flight controller, Manifold, and camera are connected using 8-pin and 10-pin cables. Raw video stream data extracted from the camera are converted from YUV into RGB pixel values. The detector runs once a few frames and gives object detection result to update the tracker which runs continuously every frame to track the known object. The delay between the detector's runs can be adjusted based on the task or the accuracy threshold set for the tracker.

Min-Hyuck Lee and Seokwon Yeom [12] address the detection and tracking of multiple moving vehicles obtained by a UAV, which captures videos above the road from a long distance. To achieve this goal, they propose to integrate two systems: one is detection based on image processing, which manipulates pixels in the stationary scene, and the other is tracking based on Kalman filtering, which estimates dynamic states (position and velocity) of targets in the time domain. Object detection is performed through frame differencing and thresholding, morphological filtering, and removing false alarms based on the minimum size of vehicles. Two frames separated by a constant interval are subtracted and turned into a binary image by thresholding, which can represent the difference between the current and the past frames.Two morphological operations, erosion and dilation, are applied to the binary image to extract regions of interest (ROIs), which are disjoint alternative areas. The ROIs are the candidate areas of moving vehicles. False ROIs are removed by the minimum ROI size, which is based on the true size of moving vehicles. The centroids of ROIs are the results of detection. The centroids represent the measured positions of targets, which will be processed in the next tracking stage. Tracking is performed by Kalman filtering to estimate the state of the target. In this paper, multiple moving objects were captured over long distances by a UAV. The locations of objects are detected using a background scene. Three targets are tracked with Kalman filtering. Experimental results show that the proposed algorithm detects and tracks moving objects with good accuracy. Position and velocity errors are obtained for different manoeuvring targets and sampling times

III. PROPOSED METHODOLOGY

The proposed solution is to implement deep learning techniques and algorithms to detect, track, and classify objects from a raw video feed in real-time continuously with the help of a camera attached on the quadcopter and instruct it to move accordingly. For the simplicity the proposed system can be divided into three parts:

1. To detect and track an object in the video feed, the raw data is captured by a UAV during flight. This is followed by real-time data processing, where the system is supposed to detect and classify surrounding objects in real-time.
2. Then an object will be selected on the computer screen with the help of drawing a box using a mouse around the object. Tracking algorithm will run on a computer and track the position of the object in the video feed.
3. The final stage consists of autonomous and human-independent decision-making based on the processed data to instruct quadcopter to move in the desired location by the desired amount of distance and follow the object to be tracked.

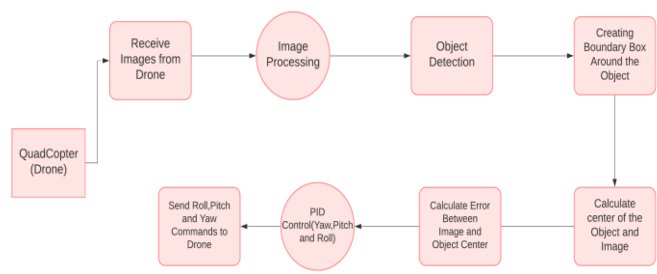

Figure 1. Data Flow Diagram.

IV. CONCLUSION

This project is aimed at creating an object detecting and tracking drone. Object tracking is a very important component of the computer vision system. Our drone has effective cameras and this makes the drone suitable for purposes of bomb detection. Thus, this aerial vehicle is apt for making us aware of live bombs and save lives in the process. With the help of thermal sensors, the drone can locate lost persons. This is especially useful at night or even in challenging terrains, our drone can easily reach places that many humans cannot, and this can be invaluable when timely rescues are critical. It has multiple applications in video surveillance, navigation, 3D image reconstruction, robotics, and disaster management, etc.

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Authors Profile

Ashwin Kumar K, Likith J, Nagendra Prasad are currently pursuing Bachelor of Engineering in Information Science at Global Academy Of Technology which is affiliated to Visvesvaraya Technological University of Belagavi, India. This is one among the first papers published from all the individuals. The main research work focuses on Deep Learning Techniques, Image Processing and Computer Vision. The team has just 3 years experience in this field of engineering and has undertaken many mini-projects in this duration. All the individuals would like to gain more knowledge on all these domains and do research work along with building projects which would be beneficial for the society.

C Manasa pursed BE in ISE from Visvesvaraya Technological University, Belagavi, India, and M.Tech in CSE from Visvesvaraya Technological University, Belagavi, India. She is currently working as Assistant Professor in Department of Information Science & Engineering, Global Academy of Technology. Her main research work focuses on Data Analytics Machine Learning, and IoT. She has 6 years of teaching experience and 3 years of Industry Experience.

