An exploration into the use of quadrocopters for poacher detection and tracking

Oliver Boyers

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1 Project motive and aim

The aim of this research is to explore the utilisation of quadrocopters in the field of nature conservation. This decision is influenced by the rapidly increasing occurrence of poaching throughout South Africa and the poaching of rhinos in particular. The inability of nature reserves to respond to poacher activity over large geographical areas such as the Kruger Park is hindering the park authorities in the apprehension of poachers. A conceived solution to this issue is to place autonomous aerial vehicles strategically within the nature reserves with the purpose of detecting and tracking poaching activities. The concept of using quadrocopters in this respect covers a large amount of subject matter. Therefore the exploration of their use will be performed in specific fields. The areas that will be explored include the following: aerial location maintenance, image processing and target following and the automation of flight. Aerial location maintenance will be explored so that external effects such as wind cannot alter a drone's fixed position. Image processing and target following will allow the drone to recognise a target and track it. Flight automation will allow the drone to navigate through environments. As the complexity of these functions is not yet known, their exploration will be performed and implemented in accordance with the time frame of the project. Although a quadrocopter of this nature should be functional in an outside environment, the testing and implementation that will be performed in this project will be indoors. An indoor environment is more suitable for the type of testing and significantly more stable for the drone. Other fields that may be explored include distance detection of objects and surfaces and, should time permit it, the 3D mapping of environments. These mapping will be used to make flight decisions based on the drone's surroundings.

2 Approach and methodology

An incremental approach will be taken in this project with the aim of creating a tracking quadrocopter. Extensive research will be performed in the field of quadrocopter automation and into existing software that can be used to work toward the ultimate goal. Research into existing IDEs and APIs will be performed to determine which is the most appropriate for the project. The first functionality that will be explored is aerial location maintenance so that the quadrocopter can maintain a stationary position in an environment that is under duress. This duress will be interfering elements such as winds and the drone being bumped by objects in the environment. To implement this, a GPS could be used to track the drone's current position and then use this information to take corrective action when the drone is moved. This method may be problematic as the testing will be indoors. Another possibility is to monitor the gyroscope and downward facing camera of the drone. If the gyroscope detects orientation movement and the downward facing camera detects a change in image the drone will take corrective action. This will only be the case if no instructions have been received by the drone to perform movement. The second functionality to be explored is the image recognition and target tracking. Initially the detection of fiduciary markers via the mounted cameras on the drone will be explored. The tracking of these markers whilst in movement will then be explored. Time permitting, this will be extended to be able to detect human faces and make the flight decisions to track faces. The third functionality would be to detect objects in the drone's immediate environment and to account for these during flight. Techniques to implement this are through the use of lasers to judge the distance of objects according to how large the angle between the lasers is or via 3D mapping. The exploration of these functionalities is time dependent and the extent of the exploration will vary according to the complexity of the function.

3 Value to science

Automated quadrocopters specialised in the field target detection and tracking can greatly benefit industries that have previously not had access to specialised equipment at this scale. Currently aerial target detection and tracking are used most prominently in military fields with huge infrastructures and budgets. The average company cannot afford this type of military equipment. The availability of these drones to conservation parks and security companies can offer brand new approaches to security management and will greatly reduce the cost of running security over large areas.

4 Relevant previous studies

The following studies are relevant to the three fields that will be in focus during this project. Namely: aerial location maintenance, image processing and the automation of flight.

4.1 Aerial location maintenance

In the study by Erhard et al. [4], a self-localisation system was implemented on a quadrocopter through the use of a cell phone. The Nokia N95 that was mounted onto the UAV created an image database whilst performing an exploration flight in the environment in which it would be flown in. These images were then used by the quadrocopter to locate itself within this environment. To do this, certain characteristics from the images in the database needed to be defined and compared against the real time image the quadrocopter transmits. The problem that occurred using this methodology was that an image database can prove very unreliable. The circumstances in which the photos are taken are in a constant state of change and so the images in the database are not always current enough to use. Images of an environment, especially those outdoors, will vary according to what time of day it is, the season in which the photo was taken and what items have moved or changed since the photo was taken. An alternative to using image referencing technology is of course to use a GPS system to track the drone's position. The ability of the drone to maintain a fixed aerial position would serve to allow the drone to take corrective flight action when affected by outside conditions such as wind or when bumped by another object. This will prove useful in both maintaining a fixed position as well as maintaining a set flight trajectory when navigating an environment. This image processing technique was also used in the case of [10] where position tracking was not possible via GPS as the indoor environment in which testing was taking place could not receive a GPS signal.

4.2 Image Processiong and target following

The UAV (unmanned aerial vehicle) that is required to reach this projects ultimate goal needs to have certain image processing capabilities. It should have the ability to recognise a human and fly according to that human's movement. The study by Zhu and Song [9] proposed an efficient vision-based algorithm for flying target following and made use of a target tracking algorithm. The study was able to get one AR Drone to track another in a closed airspace. These tracking patterns were then mapped using a global tracking system which consisted of six separate cameras. These cameras were placed on the ceiling of the environment and were used to track the 3D positions of these quadrocopters for performance measurement.

4.3 Automation of flight

The pilotless flight of a UAV as researched in [5] is possible using a visual Simultaneous Localization and Mapping algorithm that relies on an on-board monocular camera. This research also made use of an additional camera mounted onto the quadrocopter that was able to detect infrared light sources and use these to determine flight manoeuvring. Another form of flight automation that was explored was an obstacle avoidance system that makes use of fuzzy logic to make flight decisions. This concept is illustrated in the study by Olivare-Mendez et al.[7] where an optimized fuzzy visual servoing system was presented.

5 Milestones and deliverables

The majority of the implementation for this project has been planned to be execeuted during the second semester of the year as most of my course work modules are in the first semester.

Description	Proposed dates
First term	
Prepare first presentation seminar.	12/03
Study the papers and past research relevant to the project.	15/03
Finalise project proposal.	20/03
Explore possible IDE's for the quadrocopter	8/04
Second term	
Design project website	12/04
Explore programming possibilitys.	26/04
Develope simple flight automation.	21/06
Third term	
Develope flight location maintainance.	02/08
Develope image targeting and recognition.	23/08
Fourth term	
Integrate above functions into automated flight.	27/09
Possibly explore 3D mapping.	11/10
Project write up	1/11

6 Relevant literiture

Below are listed the three main areas that are being explored as well as articles that are relevant to this field.

- Stabiltity and location maintainance: [2]
- Target tracking: [8][6]
- Flight automation: [3] [1]

References

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[9] Yuke Zhu and Zhao Song. Vision-based autonomous flying target following.

[10] Jie-Tong Zou and Yu-Chiung Tseng. Visual track system applied in quadrotor aerial robot. In *Digital Manufacturing and Automation (ICDMA), 2012 Third International Conference on*, pages 1025–1028. IEEE, 2012.