The CoffeeCopter

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Abstract

This paper researches if a Parrot AR Drone 1 is capable of picking up a cup of coffee. With open source code for colour and circle recognition, the drone can recognize a red circle which could function as a cup of coffee in the experiment. It is possible to program the drone in such a way that it searches the room for a red circle and then makes a picking-up motion. Further research can be done in image recognition and path planning so that a drone can be used in practice as a coffee delivery device. If this is possible it means a lot of other practical uses can be assigned to the drone as well.

1 Introduction

For years and years unmanned aerial vehicles (UAVs) were only used by the military, mostly to enhance security. Now, UAVs are available for small research groups and even consumers. When Parrot started selling the AR Drone 1 for a price many households could afford, it became interesting to research the interaction between drones and humans. One can now foresee situations where a drone is a part of a normal household. The drone would assist its owner with his everyday persuits. For this to happen, a drone should be suited to be controlled in the close proximity of a human. This in contrast to how drones were usually controlled (namely, from a far away distance).

Figure 1: *The Parrot AR Drone 1*

Shan and Sharlin (2011) found that when controlling a drone from a close enough distance, it is in the humans instinct to control the drone with speech or gestures, instead of controlling it with a device such as a game controller or a computer. If a drone were programmed to follow human instructions like, for example, a falcon does, it would make the drone a lot easier to control.

Since the AR Drone 1 has two cameras and image processing is possible, the drone seems capable of distinguishing different gestures a human can make. This can come in handy when it comes to everyday situations. For example, picking up coffee from a kitchen.

This is how it came to mind that a commonplace action such as getting a cup of coffee could be automated by the AR Drone 1. A goal was set to program a Parrot AR Drone to function as a coffee delivery device. The ideal scenario here would be an office, because it usually contains a lot of people in need of coffee and a larger distance a human needs to cover to get the cup of coffee.
A proposal was made to investigate whether an AR Drone could recognize the gesture of a raised hand, which would indicate a person being in need of coffee. This would trigger the process of getting the coffee. The drone would search for a cup of coffee, pick it up, and bring it to the person.

This proposal was narrowed-down out of necessity. Recognzing a gesture out of a human gesture did not seem to fit in the time available. A more appropriate goal was set to make sure this goal could be reached in four days time. It was decided to focus on finding a cup of coffee, and picking it up.
This process was divided in three steps:

1. Searching a room
2. Recognizing a cup of coffee
3. Picking up the cup of coffee

It was decided to focus on this part of the coffee delivery because it covers multiple problems: path planning, image recognition and 3D movement techniques. This led to the over-all question that this paper is going to answer:

"Is it possible for the Parrot AR Drone 1 to recognize a cup of coffee and pick it up?"

The hypothesis is based on the experiences of other users. It is known that the AR Drone has software containing image recognition. It is uncertain though, if the drone can also really recognize if cups are containing coffee and there are also many other technical problems a drone can face. Therefore it is hypothesized that the drone will be able to do some sort of coffee cup recognition if one gives the coffee cup some recognizable features.

2 Materials and Methods

The purpose of this experiment, is the functional implementation of the so-called CoffeeCopter. The CoffeeCopter is an enhanced Parrot AR Drone 1 tweeked to fit the funcional requirements. With a nonautomatic gripper attached to the bottom of the drone, it is possible to gently lift cups of coffee and deliver those to an intended destination.

The Parrot AR Drone is a drone with four propellers aligned in a square. With a cap and an extra body, additional protection is included. The four propellers are used to fly in both horizontal and vertical direction while steering. The derrivant in the four propellers enable the drone to move with great maneuvrability.

The operating system installed on the drone creates a working environment that enables computer-to-drone interaction. With cvdrone, opensource software written in C++, it is possible to both manually control the drone as to run custom packages with enhanced optionality. Included a retriever for the camera to correctly display and analyze the front and the bottom camera.

Is it possible to determine a path for the AR Drone based on scanning the video feed from the camera(s)? By using the model of delivering coffee, this hyphothesis can be properly tested. As the main objective is autonomous orienting and navigating, delivering the actual coffee is not the most important thing of this experiment.

In the original plan, the drone needed to search for people in need for coffee after takeoff. In the final plan, the drone needed to immediately search for coffee. There are many ways to search a room for something (Lee *et al.*, 2003). Considering the need of simplicity in this experiment, a simple algorithm was chosen for the drone to search the room. In a while-loop the drone is sent to fly in a spiral motion until it recognizes coffee.

In this experiment, coffee eventually meant 'a red circle'. A red circle was drawn on a white paper which was taped to a box. Now the program needed to recognize two kinds of images: circles and red objects. When the centerpoint of comething red and something in the shape of a circle is at the same spot, it is almost certainly a red circle.

For both recognizing circles and red objects, code samples were used which can be found in the appendices.

When the drone takes off and finds a red circle, it first needs to make sure the red circle is in the middle of its view, so that the drone would hang directly above the 'cup of coffee'. This is done by making sure that the x and y positions are (almost) the same as the x and y positions of the red circle.

Figure 2: *Recognizing a colour and shape with cvdrone software*

would take the coffeecup with it.

Since there is not yet a coffee cup but only a red circle in this experiment, the drone does not need the gripper yet but it is still interesting to see if such a movement works.

After picking up the coffee, the drone would drag the coffee with him searching for the person in need of coffee. Although this step and the rest of the process is omitted in this experiment, searching for a red circle and picking it up worked pretty well.

When the drone hangs directly above the red circle, it now only needs to make a pickup motion to lift 'the coffeecup' of the surface it is standing on. It first makes a motion backwards, then downwards. A gripper underneath the drone would now be at the same height as the coffeecup. It now only needs to move forward again, so that the gripper

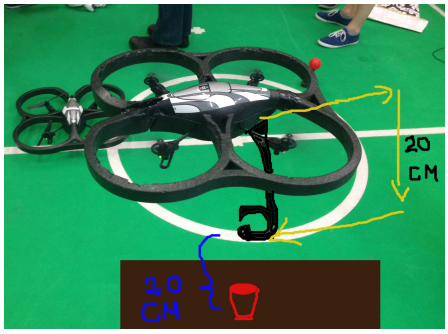

Figure 3: *The pick-up movement*

3 Results & Discussion

The drone most of the time did what
it had to do. After takeoff it started
to fly in a spiral motion until it found a red circle. When finding its goal, it calibrated until hanging right above the red circle, and then it did a picking-up motion it was programmed to do.

During the experiment a few difficulties were noticed. First of all, it was not easy to make the drone fly somehow smoothly. Sometimes it would fly in a random direction or it wouldn't stabilize up in the air. This made it hard to test the program well enough.

Sometimes it didn't recognize the red circle, although the circumstances were almost perfectly the same as in situation where it did recognize it. This could be the result of old batteries and the condition of the robolab the drone was tested in: wind or other movements can affect the drones performances

The pickup motion was not really convincing either, but definitely there. So for experimental reasons one could say the programmed movement is enough, for experiments in the feature one could make sure there are batteries available with a better durability so that testing the drone is more efficient and movements are more convincing.

So the drone does what it is said to be done, it can perform a self-governing task of flying around, recognizing an object and do something with it.

It would be interesting to complete the task of getting coffee for people by at one hand performing all the tasks like searching for people in need of coffee, planning a path in a building and delivering the coffee to humans. This would be good material for further research.

4 Literature Cited

- Ng, W. S., Sharlin, E. (2011, July). Collocated interaction with flying robots. *In RO-MAN, 2011 IEEE* (pp. 143-149). IEEE.

- Lee, J., Huang, R., Vaughn, A., Xiao, X., Hedrick, J. K., Zennaro, M., Sengupta, R. (2003, June). Strategies of path-planning for a UAV to track a ground vehicle. *In AINS Conference* (Vol. 2003).

5 Used Software

- CV Drone: *https://github.com/puku0x/cvdrone*
- For circle recognition: *https://github.com/puku0x/cvdrone/blob/master/samples/sample_hough_circle.cpp*
- For colour recognition: *https://github.com/UniversalAwareness/cvdrone-master/commit/9edc0b64e39d609afd001e3e35fbfdc87c3d53ba*