Autonomous Drone and Rover Navigation

Steve Gillet
Department of Electrical and Computer Engineering
Texas Tech University
Lubbock, United States of America
stephen.gillet@gmail.com

Rishikesh
Department of Electrical and Computer Engineering
Texas Tech University
Lubbock, United States of America
rishikesh.rishikesh@ttu.edu

Isaac Mondragon
Department of Electrical and Computer Engineering
Texas Tech University
Lubbock, United States of America
ismondra@ttu.edu

***Abstract*—Mechanics and methodologies for an autonomous drone and rover navigation project that is the Bachelor's capstone project for the authors and IEEE Region 5 Robotics Competition for 2023. The object is to have the rover and drone navigate around an area with obstacles while using camera data to inform one another where to go next autonomously.**

***Index Terms*—autonomous, computer vision, drone, object detection, rover**

I. Introduction

This document lays out the basic mechanics and methodologies used in a project for the IEEE Region 5 Robotics Competition for 2023. The rules of the competition state that a ground robot will go through cardboard boxes in a particular order that will be discovered by reading QR codes inside the boxes that have the designation of the next box to go to. The identity of each box is located on top and therefore a drone will be used to read the box ID's from the top while the ground robot reads the next designated box from the bottom. In this manner the ground robot will enter a box, read the QR code for the next box, the drone will find the next box, and then the ground robot will go to that box, and the process will repeat until all of the boxes have been entered at which point the drone will land on the robot and the round will end [1].

The drone is a Ryze Tech Tello Mini Drone Quadcopter that receives string commands and returns command acknowledgements and raw video data via wifi [2] [3]. The ground robot uses a Rover 5 Robot chassis, an L298N Motor Driver, 2 Zeee 7.4V LiPo batteries, an NVIDIA Jetson Nano computer, Raspberry Pi CSI cameras, and servo motors to aim the front camera. The ground robot will connect to the drone via wifi and send the drone search pattern commands using a wifi socket in Python. The ground robot will use the front camera to look for the entrance to the first cardboard box using a trained convolutional neural network (CNN) to associate box images with movement directions [4].

The drone will then enter the box and use its second, upward-facing camera to read the QR code printed inside the box with OpenCV's QRCodeDetector function. Then it will send a list of search pattern strings to move the drone around until it finds the target box QR code also using the QRCodeDetector function. The list of string commands that the drone takes is detailed in the Tello SDK [2] and is usually some simple word and measurement if necessary, 'forward 20' for example which tells the drone to move 20cm forward. The list is kept in a separate text file that the main Python program reads off of whenever the search pattern needs to be executed, this list is configured so that the drone moves in a continually expanding spiral pattern outward and then back inward. So, the list looks something like: 'forward 20', 'cw 90' (turn clockwise 90 degrees), 'forward 40', 'cw 90', 'forward 60', etc.

Once the drone has found the QR code it stops and hovers over the target box and the ground robot aims at it using object detection and moves towards it. Once the ground robot is close enough to the box to navigate around it, it focuses on the box and uses the box CNN navigation again. The ground robot uses a YOLOv5 object detection model trained on the drone [5].

Once the ground robot goes through all of the boxes the drone then navigates to it using the ground robots upward facing camera to give the drones commands until it is directly over the camera using pixel coordinates [6].

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References

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