TU Clausthal

Kolloquium zur Masterarbeit

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„Simulation based Verification of Computer Vision Algorithms“

Aerial refueling is thene aercraft to another avoiding stop overs. The automated execution of this process is called autonomous aerial refueling. Two refueling methods are known: The Flying boom method and the probe and drogue method. This thesis focusses on the latter method. A tanker aircraft carrying the fuel, deploys a drogue basket that is connected to a flexible hose railing from the tanker. The receiving follower aircraft enters in a leader-follower formation flight with the tanker being the leader. To receive the fuel, the follower inserts a probe into the drogue. A challenge for the automated execution of this manoeuvre is the location of the drogue basket. Object detection is a reasonable option for this task

A recent promising approach to realise object detection is the utilisation of Convolutional Neural Networks (CNNs). CNNs are specialised Deep Neural Networks (DNNs) that are comprised of multible layers. To detect the drogue basket, matrices of pixels from images are taken as input. With the output, the location of the drogue basket is predicted.

Like all airborne applications, safety is an essential aspect for aerial refueling. To meet the safety requirements for the automated docking with the drogue basket, the detection quality of the object detection needs to be evaluated. However, it is harder than said. Flight tests are expensive and the effort intense. It is almost impossible to provide a broad enough coverage to gain confidence. Here, the simulated testing presents a valuable lead.

To create a synthetic scenario that is realistic enough, game engines are investigated in this thesis. Persuing this idea Unity 3D is utilised to model the simulation. To create realistic overcast, light and precipitation, Unity is extended with the real time weather renderer trueSky.

To test the drogue detection, the ontology framework System Entity Structure (SES) is utilised. SESs are directed trees that are used to present families of systems in simulation environments. In this thesis an SES contains a set of scenarios which can be derived through pruning. In this way a Pruned Entity Structure (PES) is obtained. A scenario (a PES) is considered to be a test case that is loaded into the simulation environment. A test case scenario is defined by a set of factors: Overcast, precipitation, light, postion and motion.

The simulator creates annotation data (images and drogue location) where the images are used as input for the drogue detector. To evaluate the detection, the results are compared against the annotation data generated by the simulation. For this, the Intersection over Union (IoU) method is utilised.

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