# Abstract

Contents

[Abstract 1](#_Toc78391639)

[Introduction 1](#_Toc78391640)

# Introduction

The internship was done in KUCARS-T2. The team works with control theory for UAVs. My project was to detect physical human interactions on a quadcopter platform. This was the broad idea of the project but as we explored the topic more, we were able to demonstrate this physical human interaction detection for high level task allocation for the qudcopter. The detection of the interaction was done using deep learning methods that detects it based on the position and orientation of the quadcopter. Extra sensors are not required for this detection.

There are four members who work on different projects that are related to controller design. Although each person works on their own projects, because they are all related to controller design, work can often be shared among different members of the team. For example, somebody working on state estimation might share his work with somebody working on system identification. Initially, I was using the controller architecture that was provided by the manufacrturer of the drone. Later I shifted to a quaternion based controller that was developed by the team which is more robust and had more functionalities.

I need to put interrelation between various departments here.

The project I was working on was to detect physical human interaction on a quadcopter platform and to show its application. If we can detect the human interaction, we can use that to allocate some task for the quadcopter. In my case, this task was to release a payload. The detection is done using an LSTM based deep learning model. There are three main parts to this Project. First is the deep learning model that will detect human interaction. Second is the design of the gripper for holding and releasing the payload.

And finally making sure that the DNN model will work for any platform irrespective of the dynamics of the platform. The Quadcopter platform that is used in this project is a Quander Qdrone. We use a mocap system for localization of the platform. The human interaction detection is basically an anomaly detection in timeseries data. The orientation and position of the platform is given to the DNN model after some preprocessing and based on this data, the DNN can detect the interaction.

The gripper is based on the iris gripper. We use the dynamixel ax-12a servo motor as the actuator for releasing the payload. This motor uses 12v and the commands are sent from the UART port of the QDrone. This is different from other hobbyist servo motors that work with PWM signals. This was chosen because of the high torque it offers in a lightweight form. The dynamixel motor has its own UART Protocol that must be followed when sending messages. We send a particular message over the UART port of the Qdrone when the DNN model detects a human interaction to open the gripper and release the payload. Servo motor speed can also be adjusted based on the message that we send from the UART port. We use a high speed so that there is minimum lag between the detection of the interaction and the release of the payload. We were able to demonstrate that the method works for the Qdrone. We wanted to make sure that we can use the same DNN model for other platforms irrespective of the dynamics of the platform.

To make sure that we can use this model for other platforms, we need some knowledge of the controller that is being used and the parameters of the platform. We normalize the data with respect to the platform parameters so that we can use the data from any platform. We gain knowledge of the platform using a system identification method called dnn-mrft that was developed by some of the other members of the team.

Chart, histogram

Description automatically generated

During my time working on the project, I was able to gain a lot of knowledge in the field of deep learning. This is a subject that I knew very little about from the courses that I had taken in University, but I had strong background in python programming and I had done an online course on machine learning before starting the project. It also gave me a start towards 3d printing. I was required to print some material for the gripper.

One of the main obstacles that I fced during my internship was that the quadcopter platform that I was working one was damaged. And earlier another of those platforms were damaged by some other reason and during my time in the organization. This drastically affected my progress, but we were able to qickly change the focus towards the simulation. I also took this opportunity to demonstrate my initiative and took the responsibility of contacting the manufacturer regarding the repair. This gave me an opportunity to think about the financial aspect of the project as well as improve my communication skills.

The Team was great help in my project, I was able to use some of the resources that was developed by the team and the twice a week meetings helped me learn about the projects which others were doing and it also gave me some advise on how to go about my own project. Many of the ideas that I implemented in the project was inspired by some advise that was given to me during these meetings. There were also tutorials where each member would explain his work in such a way that it can be used by others in the group. A tutorial that I found really useful for my project was explain the system identification method called DNN-MRFT.