Follow-up Notes

As the system starts with some new assumptions, there is still a lot of future work should work on in the future. What I contributed the most is the system identification and the modelling. For the dynamic mathematic modelling, there are still lots of elements should be considered, such as the accurate air resistance and actual top inertia. To calculate the actual drag force, the data base of various propeller that I uploaded to the GitHub will help get the coefficients. The correctness of modelling is still in doubt, which needs to be double checked. For example, different DOF is required to use different methods to derive the equations of motion. It is very easy to make a mistake. The directions of the forces and angles need careful consideration. Especially for the 3 DOF system, there are even two different coordination systems are required to think about, which requires to convert some equations to a different form.

Besides the things made in the graduate thesis, all the simulations were updated from one input (force) to two inputs (servo speed command). The updated control model will help to control the physical robot. However, one major problem left is about finding the duty cycle of the rotors. Because the input of the system is set as the servo speed command. And there is a linear relationship between the servo speed and the thrust force. So it is not necessary to find the duty cycle at this moment. The dead zone of the servo speed command is about 880. The thrust constant was calculated as mentioned in Chapter 3. Those data were collected by Park. Due to the lack of measuring tools, the data may not very accurate because they were not measured by hands but using the software. There are should be a complex relationship between the speed command and the thrust force, which related to lots of parameters, such as the drag force and the voltage constant. The easiest way is to use measuring equipment to detect the actual data. Such data should be further verified and tested in the future.

On the other hand, all the files that drive hardware utilize C++. Park had improved the efficiency of the system, but it still can be further optimized if you are good at coding. I’m not a coding person, so I didn’t change much for the coding files. What I did was just simply changing the parameters in the file, and it works. The Arduino Pro mini has some problems right now. I cannot upload any files to that. I’m not sure it’s because of the mistake from the board or my laptop. The similar situation happened before, but it fixed when I simply changed the laptop. In addition, the cart part is not working as well, there is one white wire disconnected to the cart and I don’t know where should I put it back. You should double check Charlie’s thesis and try to fix it. I think it is a very small problem for someone who is good at Arduino and circuit.

The operation process is to upload the files into the Arduino Pro mini at first. Please make sure shut off all the power and put the small switch in the middle OFF,

图片包含 电子产品, 电路

描述已自动生成

and disconnect the three colors’ wires as well.

图片包含 室内, 自行车, 小

描述已自动生成

After uploading the files, take off the USB and connects the Arduino Mega to your laptop instead. Also, connects the three colors’ wires, which will provides the communication and power to the mini board . After that, connects the battery and turn on the main switch. The small switch on the top should turn to PDB side. The last step is opening the serial monitor in the Arduino IDE, then put random characters to run the rotors, just simply follows the instruction.

Based on the working characteristics of the system, the system was linearized at the equilibrium point to obtain the system linear model, which greatly reduced the difficulty of the system tuning and the control design. PID, LQR, and pole place controls were then successfully implemented on both the simulations and hardware. For the software part, there is only a small adjustment that made to apply and run of the controllers. Most of the coding works are based on previous work. Due to the lack of times, only basic control theories were applied to QTIP control. Some advanced control theories, such as optimal or predictive control, and sensing can be further developed to get better performance.

For the Simulink part, the parameters of the model can be easily changed when there is a change in the components of the system. So, some subsystems were developed as they can be easily changed and substituted.

For the mechanical part, first of all, the reflective plate that created from Bell was very huge and heavy, so it was taken off and didn’t show up in this paper. This reflective plate was used to limit the pendulum’s pitch and roll rotations to prevent the ball joint. However, this is too big that caused a deformation on the cart. This reflective plate should be further designed.

图片包含 人员, 室内, 墙壁, 地板

描述已自动生成

Second, there are some problems on the driving wheels. The cart was designed with three wheels that one omnidirectional wheel with two parallel wheels. That means there will be a constraint on the cart’s moving directions and accelerations, because two wheels are constrained by the omnidirectional wheel. Only one motor drives the cart. On the other hand, the wheels are very small, almost let the cart’s bottom touch the ground. In addition, the material of the wheels contact area are was far from satisfactory. The wheels were simply wrapped with tape.

The material of such area should be replaced to rubber or something used for tire. Therefore, the wheels should be redesigned and replaced in the future. The wires are exposed to the air without organization. They are dangerous and can be easily destroyed. Those wires should be careful arranged with a cage or fixed inside the cart. The same applies to the propellers, when running the quadrotor, it is easily cause a finger cut due to its high speed. Therefore, some protection equipment can be applied around.