The three things to talk about

Motivation

Modelling

Control

Modelling: The Euler LaGrange energy-based method. Modelled as a 2D system due to constraints. Assumptions

Control: Type of control and obtaining measurements via computer vision.

Motivation:

Good morning/afternoon everyone. My project is the control of a rolling-balancing mechanical system, in particular the disk-on-disk system. ||

I’m going to go through the motivation for this project and why we are researching this area. Then I will speak about the modelling process. Finally, I will go through the current control method, which will involve the computer vision process being used. ||

The disk on disk system is an example of an under-actuated system. The technical definition of an under-actuated system is one which cannot be commanded to follow an arbitrary trajectory in a configuration space. What this really means is one of two things: that the system has less actuators than degrees of freedom, or there is not an actuator associated with every degree of freedom. A pendulum robot or Segway is a great example of an underactuated system. It can translate along the ground and rotate about the wheel axis, giving two degrees of freedom, but there is only an actuator for the translational degree of freedom.

Under actuation makes it difficult to control a system. Normally on a Segway, we want the person to be standing upright with the wheels underneath them while they move around. Moving the Segway backwards and forwards is simple as the actuator, the motor, acts in this degree of freedom. Keeping the person upright is not simple, but highly desirable. The motor turning the wheels does not allow direct control over the angle the Segway makes with the ground.

The Segway is not the only underactuated system, though if you are studying mechatronics in Newcastle you could be excused for thinking so. Most systems are underactuated. Cars, boats, aeroplanes and even animals are all underactuated systems. Studying these systems and developing a generalised understanding of them allows the potential of robotic systems to be realised. Constraining robots to tasks for which they are fully actuated severely limits their ability to achieve the performance they are capable of. Exploiting the system dynamics when controlling underactuated systems allows this performance to be realised.

System dynamics come in two flavours: the type you explain to your girlfriend when she asks what you’re doing, and the type where say “don’t worry about it”. Pushing and pulling a gripped object are examples of the first kind. The interaction between the actuator input and the result is pretty straightforward and by extension, it is much easier to control. These are prehensile manipulations and are the preferred method when using robotic manipulators. Robots like to grip things as it allows direct control over an objects position. Non-prehensile manipulations are much less straightforward as the object can move relative to the manipulator during a control action. To control the disk on disk system, we use the rolling type of non-prehensile manipulation.

Understanding how to control the disk on disk system using rolling can aid in the understanding of the general non-prehensile manipulation problem. Actions like rolling and throwing can extend the range of influence of a robotic manipulator beyond the kinematic workspace.