Project Deliverable

Functional Requirements List and Performance Specifications for

Non-Linear Internal Model Controller Design for a Robot Arm with Artificial Neural Networks

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Introduction

The aim of this senior project is to model the Quanser Consulting Plant SRV-02, use conventional system identification to develop an input-output relationship of the Quanser plant and then develop a non-linear internal model controller with Artificial Neural Networks(ANNs) for the system. This project deliverable summarizes research from secondary sources providing a description of the system functional requirements list and the performance specifications.

Physical Description

The Quanser Consulting Plant SRV-02 consists of an arm, base, and stand. The stand contains a motor driving the arm through a gear train in the base. When electrical energy is supplied to the motor the result is mechanical energy, torque, at the output shaft. The gear train moves the arm and this creates the 1st degree of freedom(DOF). There are also springs attached from the arm to the base. This along with friction in the rotary flexible joint forces the arm to move independently creating a 2nd DOF(Dempsey,2007). DOF's are proportional to the degree of the system plant, more on this in the functional description. The top down view of the system is shown in Figure 1 below. A side view of the system is shown in Figure 2 on the next page.

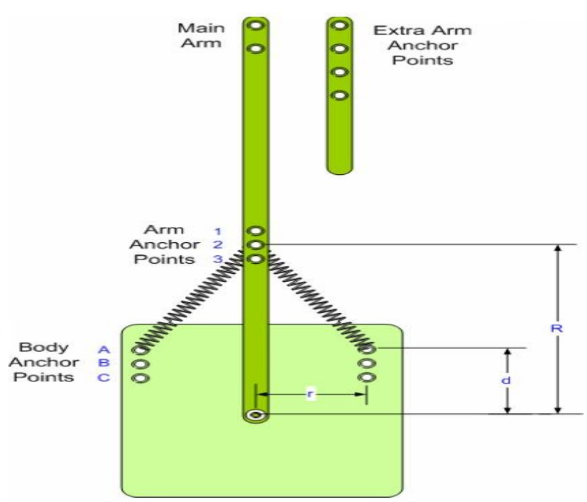

Figure 1 - Top-down view of the system showing the arm and base. Note the output shaft of the motor connected to the arm through a gear train in the center of the base(Edwards).

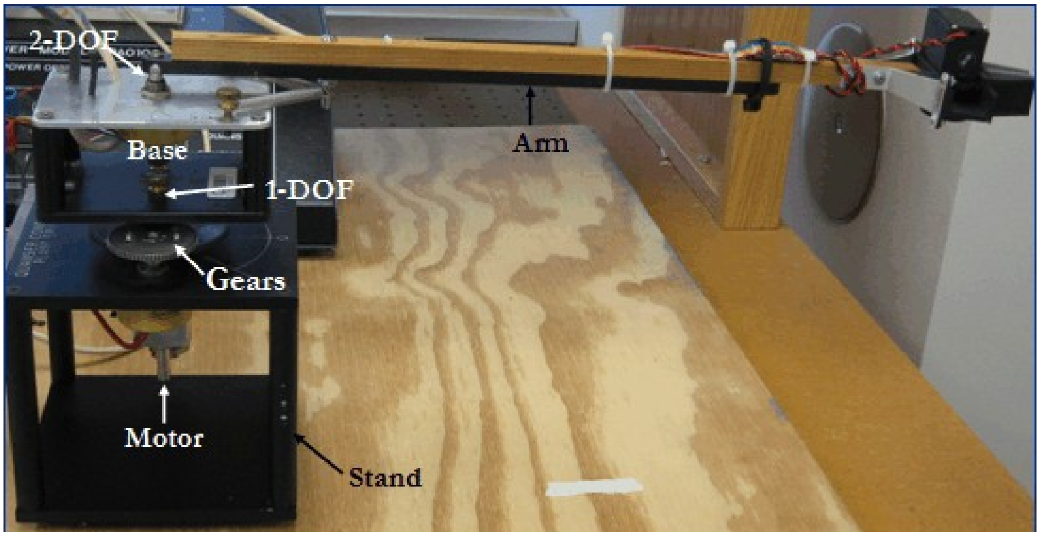

Figure 2 – Quanser Consulting System SRV-02 – Stand, base, arm and gears are shown. There are arrows pointing out where the DOFs originate (Dempsey, 2007)

The hardware shown above communicates with a 1.46Ghz Pentium-based computer with an internal A/D and D/A acquisition card. The system can be described using a low level system block diagram as shown in Figure 3 below. The system is also connected to a sophisticated power amplifier for driving the entire system shown as the amplifier in Figure 3 below.

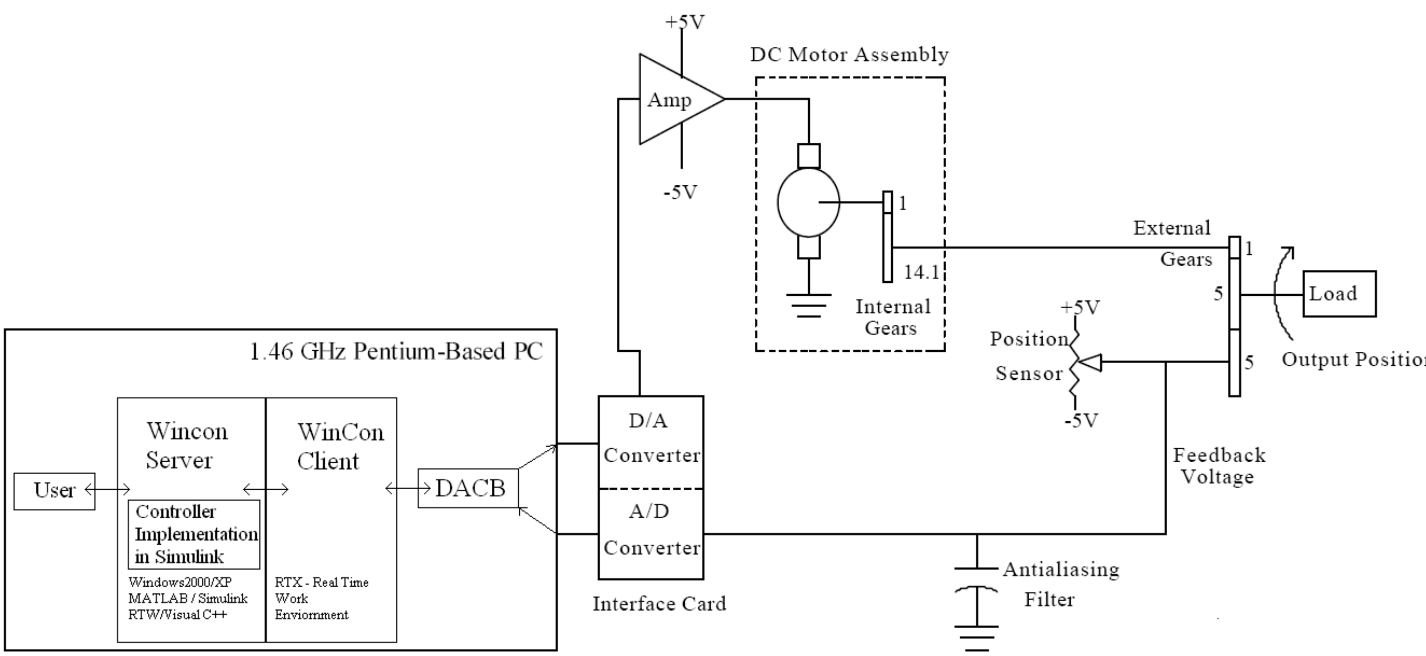

Figure 3 – High level block diagram. Note the PC, interface card, gears, feedback voltage loop and anti-aliasing filter(Le).

Functional Requirements and Performance Specifications

This project flow will be such that controller complexity will increase with every step in effort of achieving all performance specifications. These specifications will be the standard of comparison for each controller design. The list below shows these set of specifications.

• Percent Overshoot	5%
• Time to Peak	50ms
• Time to settle	200ms
• Closed Loop Bandwidth	2hz
• Peak Closed Loop Frequency Response	3dB
• Gain Margin	5.0
• Phase Margin	60 degrees
• Steady State Error	1 degree
• Controller Execution Time	1ms

The controller development flow, where each step can be considered a functional requirement, is shown below.

1. Single Loop – Proportional , Proportional–Derivative Controller
2. Single Loop – Feed Forward
3. Feed Forwards with Artificial Neural Networks
4. Internal Model Control with Artificial Neural Networks
5. Internal Model Control with Artificial Neural Networks using experimentally determined plant model.