BALL AND BEAM:
MODELING AND ANALYSIS

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Abstract

The condition of feedback linearization of a non-linear system had been a classical problem in control theory especially regarding the ball and beam equipment. Therefore many control engineers have tried to solve this problem using different approaches. This project explained the important of stability concept. The objective of this project is to position a stainless steel ball at the desired point along the length of the beam using a torque or force applied to the beam angle as the control input. The mathematical model of the equipment has been derived based on the concept of rotating mechanical system and free body (ball) rolling down a plane. This equipment is interfaced to a computer and the controller is written in C.

The controller designed is a two loop controller to improve the stability of the system. The inner loop (slave loop) ensures that the servo angle θ tracks a desired angle, θ_d and the outer loop (master loop) controls the ball position. The important aspect of this design approach is that the inner loop response must be faster than the outer loop. This is done by implementing Proportional plus Derivative (PD) controller for the inner loop and Proportional plus Integral plus Derivative (PID) controller for the outer loop. The response of the output can be obtained using Matlab.

TABLE CONTENTS

1.0 INTRODUCTION

Many physical systems like the rocket during launching and the inverted pendulum system are unstable. These unstable systems can be stabilised by applying feedback control. Feedback control refers to an operation that in the presence of disturbances, tends to reduce the difference between the output of a system and some reference input. A good example of this is an oscillator where the oscillations are neither increase or decrease, each cycle being identical to the previous one. However for most practical systems this condition is to be avoided.

1.1 Objective

The purpose of this project is to position a stainless steel ball at the desired point along the length of the beam using a torque or force applied to the beam angle as the control input. The beam is made to rotate in a vertical plane by applying a torque at one end and the ball is free to roll on conductive plastic and stainless steel shaft along the beam. The beam angle is adjusted by applying certain voltage to the motor which is directly attached to the beam. The beam angle is measured using a potentiometer attach to servo motor and connect to 72 teeth anti-backlash gear. The position of the steel ball along the beam is measured using a conductive plastic in