Control of a Ball-Beam System

Background

As a typical control system, the control of the ball-beam system is excellent in testing and evaluating different control methods. The fundamental principles within this control system can be found in many industrial applications, such as precise position control in production line. In AUE, A ball-beam system has been constructed in Spring 2004 semester. As shown in the following Fig.1 of this physical system, a metal ball is placed on a metal beam, where it is allowed to roll with one-degree of freedom along the beam due to the gravity. A stepping motor is attached to the beam at the central position through a gearbox such that the beam can be driven and turned by some proper angle. A controller needs to be designed so that the ball's position can be manipulated at some expected position.

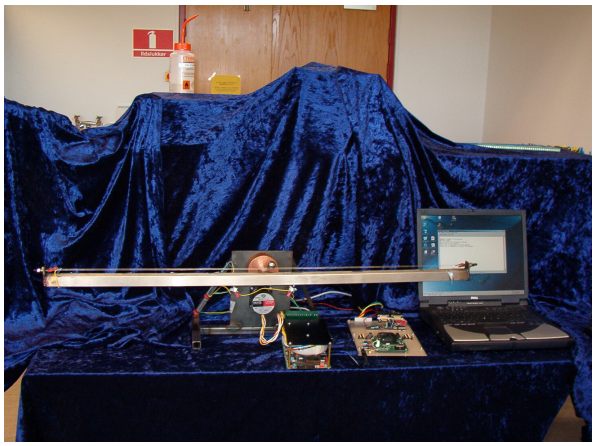

Fig.1 AUE Ball-Beam System

Problem

In Spring 2004 Group 671 has obtained many satisfactory results after they built this physical system by using a stepping motor and implementing the designed controllers into TI MSP430F149. However, there are still many open problems, for example, due to the stepping motor's "digital behavior" and properly plus some measured disturbance, the final operation of the whole system (ball and beam) can't smoothly stay at the expected position, small fluctuations of the beam angle and the ball position can be obviously observed. One test result is shown in Fig.2. Furthermore, there is always some steady offset properly because of the strong nonlinearity of the stepping motor. Therefore, how to improve the performance of the current system becomes a very interesting investigation.

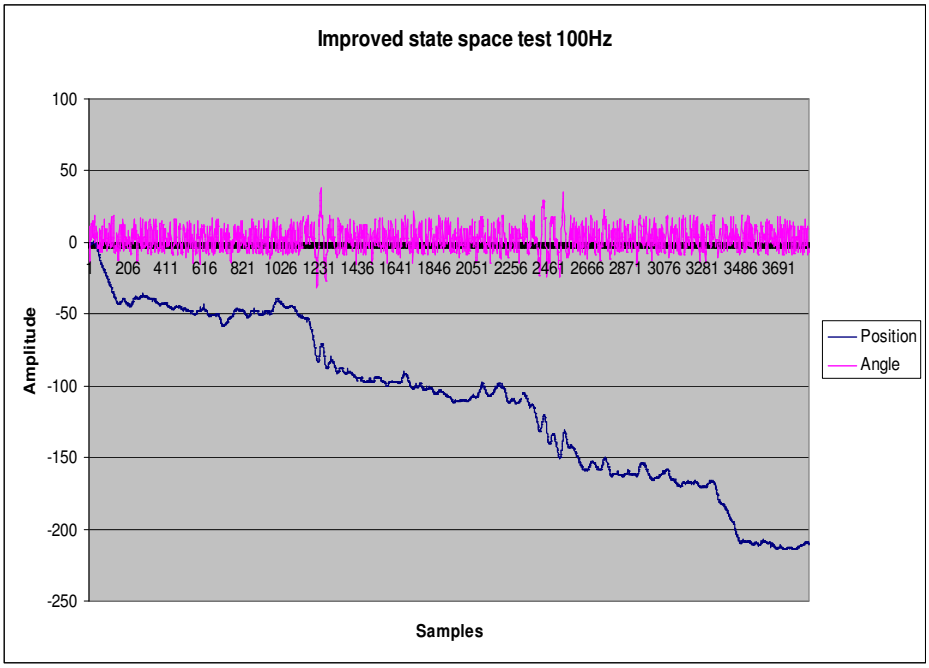

Fig.2 One Testing Result (Group 671, spring 2004)

Objective

The objective of this project is to improve the current system, which can include:

- Hardware improvements: for example, using a DC motor instead of the current stepping motor; improving the current measuring methods/instruments, etc..
- Software improvements: for example, designing and implementing new controllers based on the improved system.

Since this is a further project based on this system, better system performance, e.g., smaller/no final fluctuation, and less/no steady offset are expected through this project.

More Information (can be available upon requirement)

- DE-6 Gourp 671(Spring 2004) report: Control of the Beam and Ball (http://www.cs.aue.auc.dk/research/lce/beamball/index.htm)

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