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Piezoresistive Contactless Position Measurement And Control Using Arduino: An Innovative Approach

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Abstract

A position control mechanism for contactless position measurement has been proposed using servomotor. The servomotor is controlled by a microcontroller based arduino uno board. The motor in turn controls the position of the object whose position is to be detected. The paper proposes an innovative approach to devising a smart sensor. The servo mechanism provides feedback information which in turn helps to improve the accuracy of positioning.

Index Terms — Piezoresistance, servomotor, arduino uno, microcontroller.

1. Introduction

Sensor technology is moving at an incredible pace. Because of this, new opportunities are open. The potential the field of sensor offers for innovation has led to the declaration of the year 2013 as "The year of sensor". This paper is dedicated for the above.

Contactless position sensors are an integral part of industry. The existing contactless position sensors are highly evolved and have high performance, but at the same time they are no novice when it comes to cost. A cost effective Piezoresistance based contactless position measurement system was proposed in [1]. In this paper a control mechanism has been proposed for the same. The research was carried out in KLESSCET, Belgaum during February – June 2013.

2. Design and implementation

The block diagram of the proposed position control system is given in figure 1. The sensor assembly is connected to the arduino uno board which is in turn connected to a computer. A servo motor is connected to the board, which controls the linear movement of the magnet (which is the object of interest) towards or away from the sensor assembly. Now with some initial position of the magnet, the sensor produces some voltage which is read by the microcontroller onto the computer. The voltage readings and the corresponding position of the magnet are tabulated and stored as a look up table in the arduino. Now with the obtained voltage reading the position of the magnet can be ascertained by concerting the lookup table. The magnet can be made to move towards or away from the magnet by controlling the amount of rotation of the servo motor through arduino.

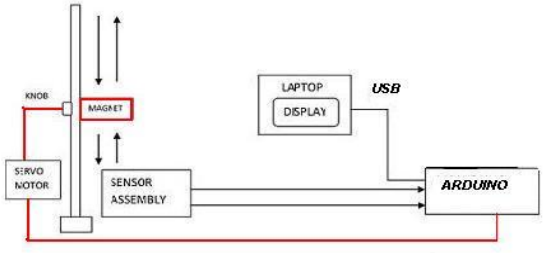

Fig1. Block diagram representing the position control system

As shown in the figure 1 the path which is highlighted forms the control path. The sensor assembly in fig1 is elaborated in fig2. As explained in paper [1], it consists of a piezoresistive pressure sensor NPC-1220, with a protrusion in the form of a tube. With necessary hardware setup and proper programming, this pressure sensor is made to work as a position sensor and a control mechanism has been incorporated.

The pressure sensor tube is extended further in the form of an air chamber. An iron plate is placed on top of the air chamber such that it is compressed completely. The sensor is connected to the arduino uno board, which can be programmed through arduino IDE. Now when a magnet is brought near the pressure chamber, the iron plate moves up towards the magnet. This reduces the pressure on the sensor and the corresponding output voltage of the sensor reduces. These voltage readings and the corresponding distance through which the magnet is moved are tabulated. The voltage values can be displayed on the computer. Thus by correlating the distance at which the magnet is placed with respect to the sensor and its output voltage, the position of the magnet can be identified as shown in fig 5. The above procedure is repeated until the effect of magnet on the iron plate wears out.

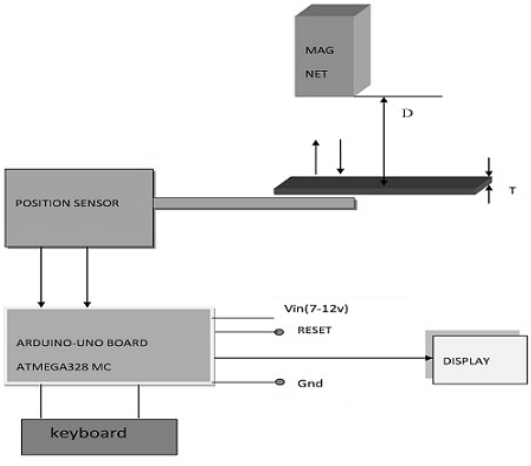

Fig 2. The sensor assembly

Now based on the voltage reading of the sensor displayed on the computer, the end user may want to move the object towards of away from the sensor setup. This control mechanism is achieved as follows: Arduino is programmed to control the servo motor, which in turn rotates to desired amount, which in turn moves the object towards or away as shown in fig 3. The clock wise rotation of the motor moves the object away and anticlockwise rotation moves it towards the assembly. Further work needs to be carried out in controlling the position precisely.

3. Experimental results and discussion

The setup is made for the measurement of the position of the object (in this case a magnet) and also to control its position using the servo motor assembly. To achieve the control mechanism, the rotary motion of the servomotor is converted to linear motion using a threaded bar- mesh assembly. The servo motor is positioned such that its fan meshes with the threaded bar fixed to the sliding bar. The servo motor and the sensor are connected to arduino board which is in turn connected to the computer. As can be visualized, by controlling the servo motor rotation, the position can be controlled which forms a closed loop control mechanism. The figure shows final result displayed on the command prompt indicating the distance of the object from the sensor assembly.

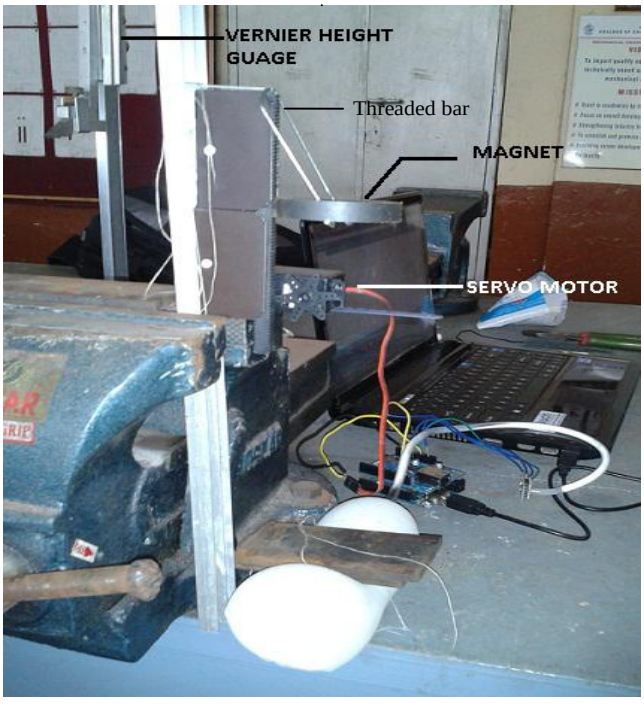

Fig3.Overall experimental setup.

Fig 4 shows the voltage readings of the sensor displayed on the arduino IDE. The sensor is connected to the analog port 1 of the arduino board. The readings of other ports are random and insignificant.

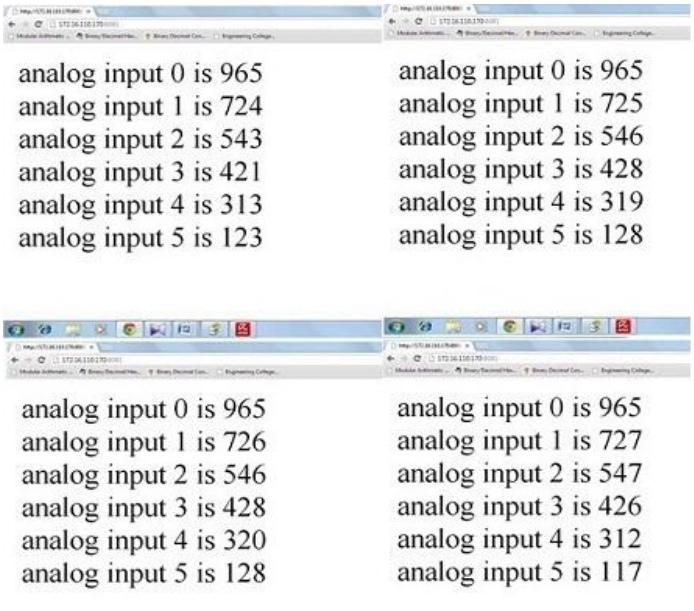

Fig4. The voltage readings of sensor read through arduino on analog port 1.

Table I shows the voltage readings and the corresponding distance of the magnet measured

experimentally. This table is stored in arduino as a lookup table. The table is consulted every time a new voltage reading is obtained and the corresponding distance value is displayed.

TABLE I. Voltage Vs distance readings read through arduino

Voltage readings (in mV)	Distance of magnet from sensor (In cm)
727	0
726	17
725	16
724	15
723	14
722	13
721	12

Finally the microcontroller on arduino is programmed to read the sensor, search the lookup table and display the distance value as shown in fig 5.

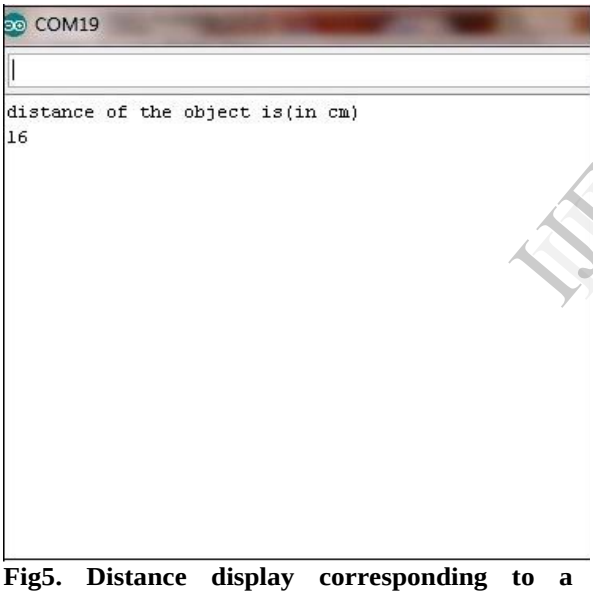

Fig5. Distance display corresponding to a particular voltage reading.

4. Conclusion and future work

An innovative approach for position control for contactless position measurement using servomotor has been presented and proved experimentally with certain limitations. A more generalized method is required in order that the sensor be used for any particular application. The proposed method is cost effective. The position control range is restricted due to the servomotor rotation being only from 0-180 degree. The results show that the system indeed works as desired. But further work is needed to improvise the system and make the hardware setup as compact as possible.

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