

ELECTRONIC CARD DESIGN FOR INCLINATION AUTOMATIC CONTROL UNIT IN SELF PROPELLED GRAIN HARVESTERS

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***Abstract.** This work presents an electronic board microcontroller to automatically adjust the angle of inclination of sieve of a machine harvester grains. The system uses an inclinometer sensor device such as varying the angle between -20 to +20 degrees and provides an analog output 4-20 mA. The signal is conditioned through a converter circuit current to a voltage from an operational amplifier circuit and has a transfer rate of the output signal with the input signal is linear and adjustable. The output signal voltage is applied directly to the analog input of a programmable integrated circuit. An operating system, through a task manager, is responsible for interpreting these values, make corrections according to a specific algorithm and show results in a liquid crystal display. The conditioned signal is amplified and a drive circuit power solid-state drives a directional solenoid valve causing the two cylinders act to correct the angle of the sieve. Initial tests indicate that the system is able to correct the convenience of tilt angle of the land by compensating for uneven ground crops.*

***Keywords:** Control of grain sieves; Inclinometers; Harvesting grain automation*

1. INTRODUCTION

This paper presents the theoretical and experimental study of a system for automatically adjusting the angle of inclination of sieve of a machine harvester grains. There are different types and possibilities of implementing inclinometers which can be used to correct for variations in agricultural areas of relief and stabilize the operation of equipment, as shown Leite et al. (2010).

A modern harvester machine match a set of operations and processes capable of harvesting, threshing and separating grain and return to the soil residue straw, stems and leaves of the crop. However, on rough terrain can present a grain losses due to the process of waste separation and cereals are not completely automated. Despite major advances in control engineering and computing, the basic operation of the harvester has remained unchanged for many years since its invention. The sieves are made of a metal frame and can contain many lines or fingers near each other, responsible for selecting and adjusting the control of the material that can pass through them. In a harvester sieves consist of a metal frame and can contain many lines or "fingers" near each other, responsible for selecting and adjusting the control of the material that can pass through them. Typically, the angle of the spacing of these lines is the perfect choice that determines the size of the material and, therefore, cleaning of grain.

In order to optimize the effects of grain loss in non-automatic machines, due to lack of control of the angle of inclination of sieve set, we developed a microcontroller board that is found in tests on a prototype bench at the Laboratory of Automation Northwest Regional University of Rio Grande do Sul. A schematic view of the electronic card developed is shown in Fig. 1.

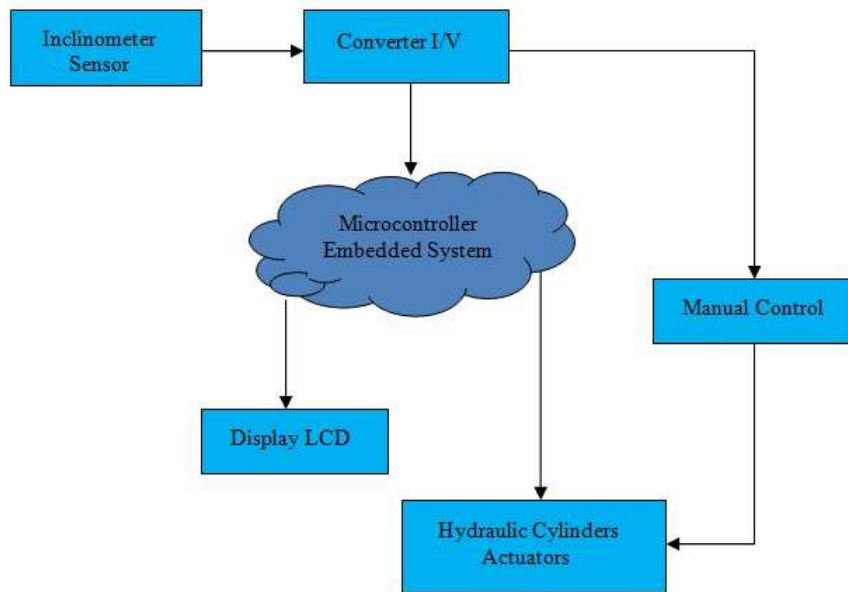


Figure 1. Functional schematic view of the electronic card

The operating system makes corrections according to a specific algorithm, shows the results in a liquid crystal display and drives the power circuit by controlling the angle of inclination of the sieves by means of two hydraulic cylinders. At this signal the control angle of inclination can also be done manually by a key.

2. DEVELOPMENT OF CIRCUITS AND PRINCIPLES OF OPERATION

In this work the set developed as a device uses a tilt sensor with variation of angle between -20 to +20 degrees and provides an analog output 4-20 mA. The signal is conditioned through a converter circuit current to voltage the accordance with fig. 2. This circuit takes advantage of the current tilt sensor generating an electrical voltage that varies linearly with input current. The converter was assembled from an operational amplifier circuit having a transfer rate of the output signal with the input signal is linear and adjustable.

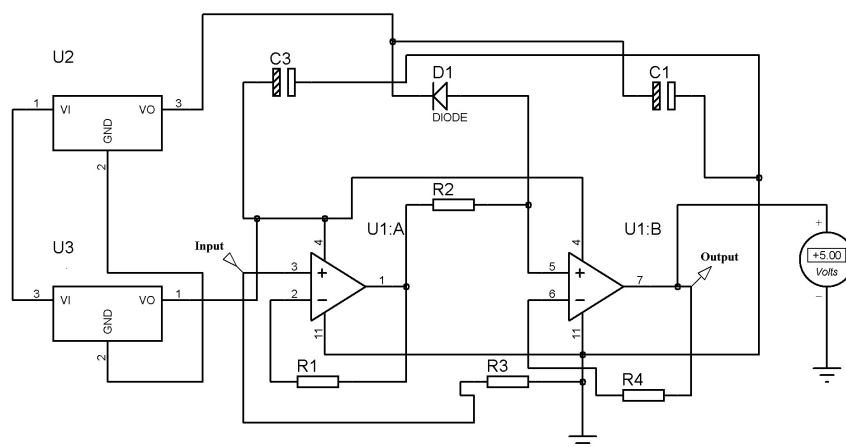


Figure 2. Electrical diagram of the converter

Figure 3 shows photograph of the circuit assembled.

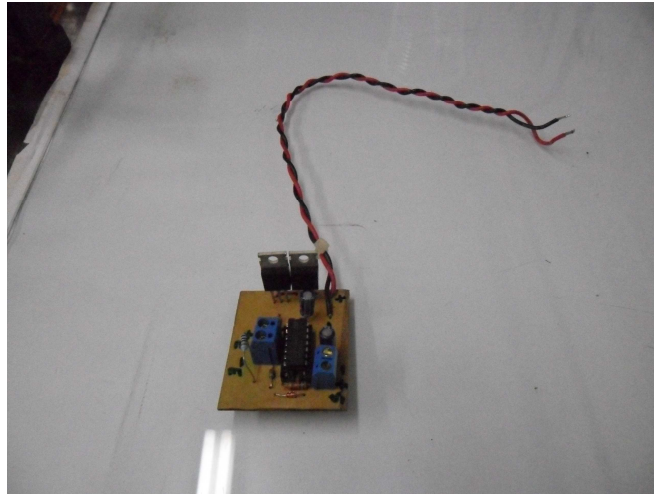


Figure 3. Photograph of circuit voltage to current converter

The output signal voltage is applied directly to the analog input of a PIC (programmable integrated circuit). An operating system, through a task manager, is responsible for interpreting these values. One feature of the management system is that it incorporates its own clock in conjunction with the tasks to be performed on each interrupt made by the tilt sensor or external interrupts.

Figure 4 shows a photograph of the signal conditioning circuit prototyped in our laboratory. This circuit has as a main microcontroller core and peripheral circuits such as LCD, memory and serial interface for communication with PC. This circuit was developed based on the works of Rasia et al. (1999).

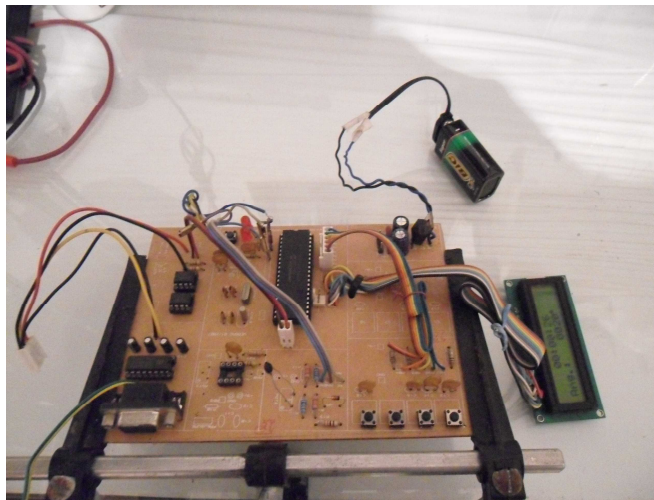


Figure 4. Photograph of the signal conditioning circuit and liquid crystal display

The working principle of real-time operating system includes the use of the ALU (Arithmetic Logic Unit) of the microcontroller and its processing capacity, ie the speed of processing program instructions. There are many tasks performed by the platform, based on a time interval called tick time this system operational. Hatike et al. (2008) have used in your works a PIC to get data from an acceleration sensor and controlling an autonomous vehicle. These microcontrollers have different characteristics and are widely employed in control systems and interfaces to simplify circuits in accordance with Souza et al. (2003). In our study these circuits and software are also used.

We have developed a program using some of these ideas. In this case, the program that controls what or which tasks can be performed is called scheduler. The scheduler is who chooses the placement of tasks to perform and who defines who stops and starts operations control.

Figure 5 shows the test structure designed in CAD being implemented. This structure was mounted on steel plates and cylinders hydraulic actuators are commercial.

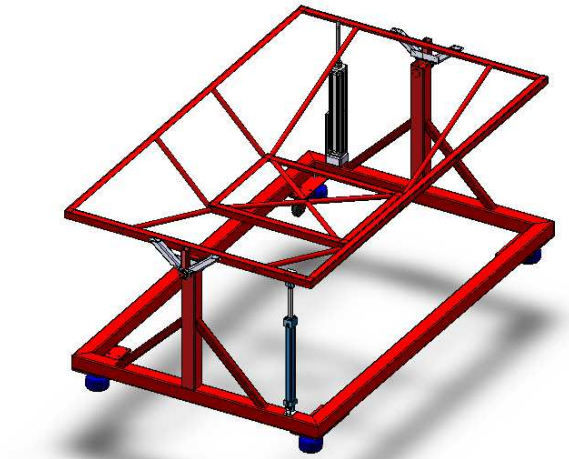


Figure 5. Test structure showing the cylinders

We also assembled a circuit for driving power using relays and solenoids to work set with system.

3. RESULTS AND DISCUSSION

The initials tests were performed on a prototype bench in a room at 300 K. The results of converting the current signal to angle of inclination are shown in Figure 6.

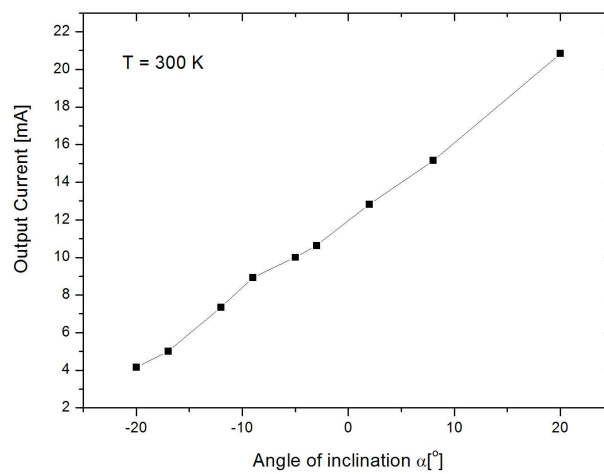


Figure 6. Output current of the converter circuit board for different angle of inclinations

The results show an almost linear behavior of the converter circuit as was expected. These characteristics are consistent with those provided by most of the tilt sensors.

We have developed a set-up to measure the electrical voltage correspondent of each angle of inclination incrementally in the room temperature. The experimental curve obtained for these measures is showed in Fig. 7.

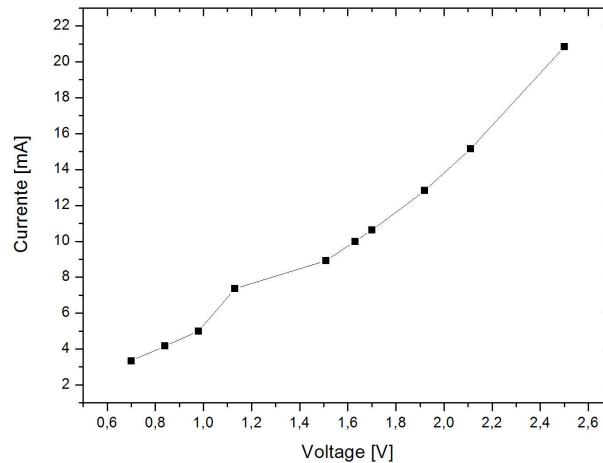


Figure 7. Curve characteristic of the current versus electrical voltage in the converter.

The motivation of this study is to evaluate the potential application of tilt sensors in precision agriculture, considering that most machines are based on non-automatic systems. However, we have developed a set of printed circuit boards and built a program or operating system to evaluate the performance of an agricultural harvester sieve. Our prototype is currently being tested in a laboratory bench.

4. CONCLUSION

This paper presented an initial study and circuit prototype that is being developed at the laboratory to implement an automatic control of the angle of inclination of sieves in harvesters. Our work aims to serve small farmers who already have non-automatic machines.

The experimental and theoretical analyses made from the circuit are a preliminary study to understand the influence of electrical voltage on the performance of the sensor using. In future work new results should be presented.

5. ACKNOWLEDGEMENTS

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