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Design and implementation of a control card for a linear actuator of a paper impregnator

Diseño e implementación de una tarjeta de control para un actuador lineal de una impregnadora de papel

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Abstract

This paper details the design, construction and test of a linear actuator control to an impregnation of paper machine, which has the function of aligning resin impregnated paper by a linear actuator. The prototype consists of a linear power supply, a system of pulsewidth-modulated, direction and speed control for the system to operate in manual or automatic mode. Finally, the results obtained are mentioned after performing of prototype installation in the MASISA SA de CV Company.

Impregnation of paper, Linear actuator, Linear power supply, Ultrasonic sensors and optoelectronic

Resumen

En este trabajo se detalla el diseño, la construcción y la prueba de un actuador lineal de control para una máquina de impregnación de papel, que tiene la función de alinear el papel impregnado de resina mediante un actuador lineal. El prototipo consta de una fuente de alimentación lineal, un sistema de control de ancho de pulso modulado, dirección y velocidad para que el sistema funcione en modo manual o automático. Finalmente, se mencionan los resultados obtenidos después de realizar la instalación del prototipo en la empresa MASISA SA de CV.

Impregnación de papel, Actuador lineal, Fuente de alimentación lineal, Sensores ultrasónicos y optoelectrónicos

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Introduction

During the paper resin impregnation process (IPR) at the MASISA SA company in and It is necessary to replace the paper alignment control that is carried out by means of optoelectronic sensors, since in most of their optical lenses they are transparent, causing the sensor not to detect correctly over time, due to the accumulation of resin in it. , which in a certain time dries up, obstructing the detection, causing failures in the alignment control; To counteract this inconvenience, ultrasonic sensors were added to improve detection, which are particularly used by the ACCUE WEB INC and FIFE brands. For this reason, it is proposed to implement an electronic control system for a linear actuator, through ultrasonic and/or optoelectronic sensors that control the alignment of the IPR (see figure 1).

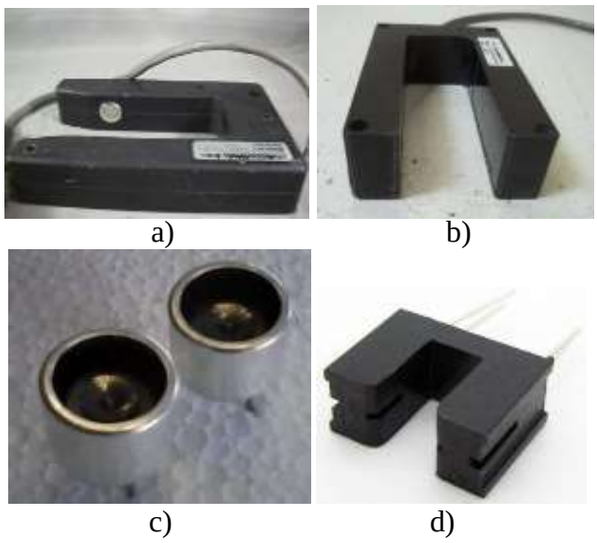

Figure 1 a) and b) Optoelectronic sensor, c) Ultrasonic sensor UCM-R40K1 (TX–RX) and d) Optoelectronic sensor ITR8102 (E–R)

To carry out the control of the linear actuator of the paper impregnator, a linear voltage source was built, it is responsible for supplying the voltage to the linear actuator at the same time that it will protect it against overcurrents, a Width Modulation system was implemented Pulse (PWM) for speed and direction control of the actuator. Additionally, ultrasonic and optoelectronic sensors were used to control the alignment manually or automatically. The block diagram of the electronic circuit design is shown in figure 2.

Figure 2 Block diagram of the electronic circuit

Power supply

A linear power supply was built using the LM723 regulator (see figure 3), which provides an adjustable output from 0 to 35 V [1]. The output voltage is adjusted by TRIMPOT2. The source was designed with an overcurrent protection parameter, adjustable by means of TRIMPOT1 in a range of 0 to 2 A, from the established value the source will be protected automatically limiting the current to avoid damage to the linear actuator, in case of a over current the source is restored by pressing the button (SW1) [2] and [3].

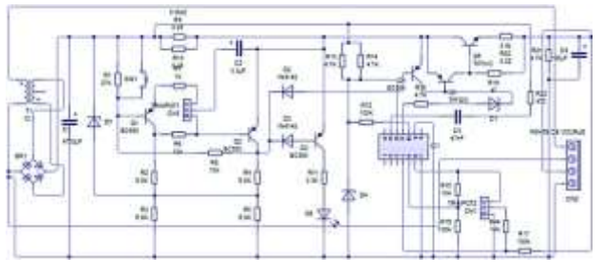

Figure 3 Linear voltage source

Speed and direction control

The speed of the linear actuator motor is controlled by the PWM KA3525A and the direction control of the linear actuator motor was carried out with the H-bridge L298N since it is necessary to change the direction of rotation of the linear actuator motor; either manually or automatically, according to the conditions required by the operator (see figure 4), the function of the diodes is to prevent the speed and direction control from being damaged by the counter electromotive force generated by the motor.

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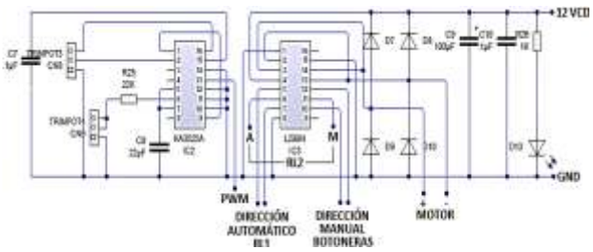

Figure 4 Withspeed and direction control

Manual or automatic control

To safely control the movement of the aerial roller of the linear actuator, two ways were implemented: manual and automatic, this was achieved using a normally open contact (NO), a closed contact (NC) and an SCR, which in turn send the signal to the L298N to control the direction.

The manual or automatic system is controlled by a relay RL2 where the NO contact is the automatic mode; which gives a voltage pulse to the gate of the SCR C106D in charge of performing the electronic interlocking, pressing the NC button activates the manual mode, interrupting the SCR power supply causing it to unlock; for manual mode (see figure 5). IPR detection; in automatic mode, it is achieved by means of the sensor that activates the RL1 relay where the NO is the input direction and the NC is the output direction of the linear actuator, in each of its contacts a bicolor LED (green and red) is connected. to indicate the sensor.

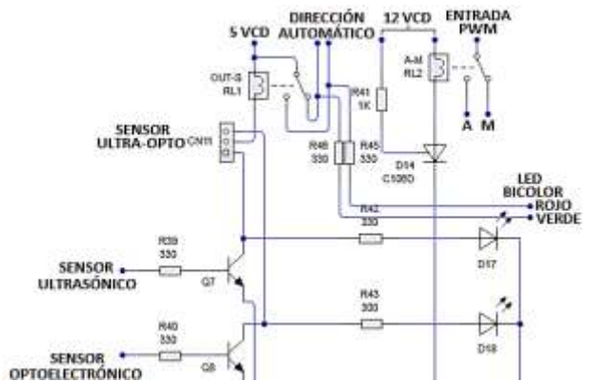

Figure 5 With manual and automatic control

Ultrasonic and optoelectronic sensors

For the alignment control of the IPR, two sensors were used: ultrasonic transmitter-receiver UCM-R40K1 (TX-RX) [2], and optoelectronic transmitter-receiver ITR8102 (E-A) [4] and [5].

With the purpose that the operator can choose the most appropriate for his process (see figure 6).

The ultrasonic sensor is designed with 3 integrated circuits, the IC (CD4046B) is a PLL (phase tracking loop) this IC was used to feed back the frequency and phase of the sensor where the frequency margins in which it will be are defined. sending and receiving the ultrasonic signal, with the IC (HD74LS14P) it is an integrated with 6 trigger inverting logic gates, which is used to invert the signal and reduce noise. Through the TL082C it amplifies the signal received from the (RX) and the signal (TX) coming from the CD4046B. At pin 1 of the TL082C the output signal is directed to a 1N4148 diode which triggers a voltage at the base of transistor BC542 to activate the relay (RL1).

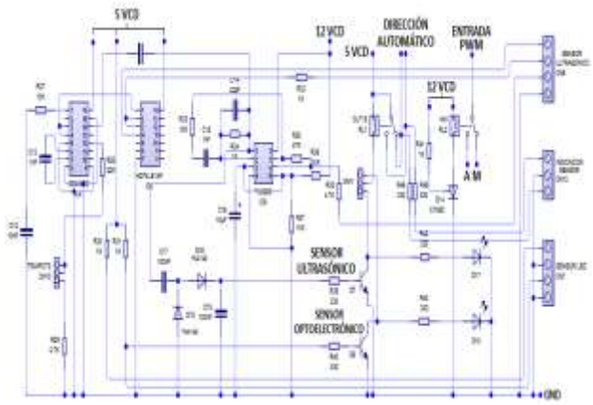

Figure 6 Ultrasonic and optoelectronic sensor

The adjustment of the detection interval of the ultrasonic sensor was made with the TRIMPOT5 potentiometer together with a 22 KΩ compensation resistor R28 (see figure 6), these send a modulated signal that is directly connected to the CD4046B Voltage Controlled Oscillator (VCO) that is a phase tracking loop [6], where the frequency adjustment is done by means of resistor R28 and capacitor C13.

Control card

Based on the different stages shown in figures 2, 3, 4 and 5, the control card shown in figure 7 for the linear actuator of the paper impregnator was made.

Figure 7 Control card for the linear actuator of the paper impregnator

Results

The control card was tested for a total of 352 hours to verify the performance of the design at the company MASISA SA de CV in the area of impregnation (see Figure 8).

Figure 8 Ptest performed in impregnator #4

Tests were carried out in manual mode in order to observe the adjustment of the paper. The implemented system detected even transparent paper by adjusting the ultrasonic sensors to a range of 5 cm.

In an industrial work environment with excess temperature caused by the impregnation process itself, it did not affect the operation of the electronic control electronic card. The manufacturing cost is 80% lower than the cost of the ACCUE WEB and FIFE brands. Finally, according to the supervision of the maintenance and instrumentation areas, it was observed that the operational prototype complies with the characteristics and parameters established in the electronic control required by the paper alignment process in comparison with the ACCUE WEB and FIFE brands.

Gratitude

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Conclusions

The built control card allowed verifying the correct operation of the design in an industrial environment.

The ultrasonic sensors improved the detection range up to 5 cm with respect to the optoelectronic sensors.

Selected business components in the card design are easily accessible and allow quick maintenance with savings of up to 80% over the ACCUE WEB and FIFE brands.

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