

LOAD CELL PRE-AMPLIFIER AND DATA VIEWER FOR A GANTRY CRANE AT SLPA

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ABSTRACT

Sri Lanka Ports Authority (SLPA) is a leading economical center in Sri Lanka. There are several container terminals in the SLPA, from which is the Jaya Container Terminal (JCT) is being the largest. Industrial training that was assigned, was focused on as covering the entire sections of the harbor according to a schedule. JCT was the first training place that were admitted. Problem found in the Gantry Cranes and Transfer Cranes which are used to move cargo containers. Both cranes are used load cells to measure the weight of the corresponding containers while moving them. The aim of this project is to design a pre-amplifier and data viewing system for the Gantry crane. While moving a container which has 0-40 tons weight, load cell produces a current $4-20 \times 10^{-3} \text{A}$ current output according to the weight of the container. Previously, this cranes have load cell amplifier system to measure weight of the load from container. But the output of load cell amplifier is not sufficient to be measured accurately in a PLC system. So that, these load cell amplifiers weren't working properly. In that case, that output of the load cell should be amplified and system was renewed. The system consist a current to voltage converter, Microcontroller and indicator system and Liquid Crystal Display (LCD). Current to voltage converter is used to amplify output of the load cell. Also holding weight display on Liquid Crystal Display (LCD) and Microcontroller doing calibration part. After Microcontroller implementation part output goes to PLC system. When load cell output a current while moving container, it supply to this system as an input. Current converts to the voltage to acceptable value for the PLC system in the first part and then this voltage was calibrated to linear output. LCD display displays observations of the system.

Keywords: Rail mounted gantry crane, Load cell, Current to voltage converter

1. INTRODUCTION

Sri Lanka Ports Authority is a leading government institution in Sri Lanka. Currently it is a well-organized profitable institution that coordinates and administers the whole works in Port of Colombo and all other ports in the island. The specified ports now include Colombo, Galle, Trincomalee, Kankasanthurai, and Point Pedro. Nearly 50% of container cargo containers handled by SLPA in Port of Colombo. Jaya Container Terminal (JCT) is the largest container terminal among those other terminals in SLPA. In JCT, there are two types of cranes are used for the complete their task. Rail Mounted Gantry Cranes used for the loading and unloading purpose between ship and container yard. For the movement of the containers inside the yard, Rubber tired Transfer Cranes are used.

Load cell is a sensor or transducer that converts a load force acting on it into an electronic signal. Strain gauge type load cells were used in cranes to measure weight of the container while moving¹. So that operator can identify the corresponding container is suitable or not to move up. Container is over weighted, it can cause a huge damage because of the operator cannot notice the weight of the container. Maximum weight of the container is 40 tons. Output of the load cells is not sufficient to measure. At the beginning, a cranes had a system to take the output from the load cells and amplify this signal to indicate a data viewing system. All these years' cranes worked with this unsecured situation. Because of this ignorance several accidents were occurred².

In this project, designed a system to get output from the load cells and amplified it to a usable output. In this system, the output of load cell is amplified using current to voltage converter circuit.

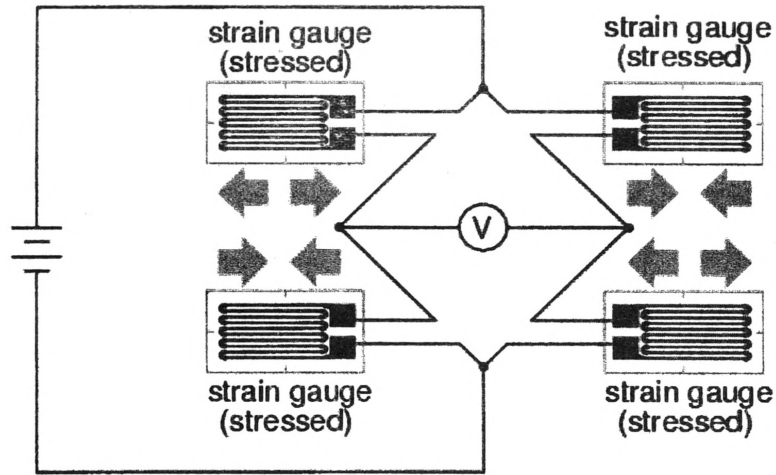


Figure 1: Strain Gauge Type Load Cell

2. METHODOLOGY

For experimental purposes, in this system implemented four Current to Voltage converter circuits, Microcontroller and Liquid Crystal Display (LED) display for the display weight of the container. The output current of the load cell is amplified by using Current to Voltage converter circuit. In the Gantry cranes, there are four converters are need due to the PLC system require four outputs of the converters separately. For the 0-40 tons container weight, load cell output 4-20 mA current. This current convert to 0-5 V using current to voltage converter³. Here M1 is the MOSFET. R1 is the resistor. I_{IN} is the input current.

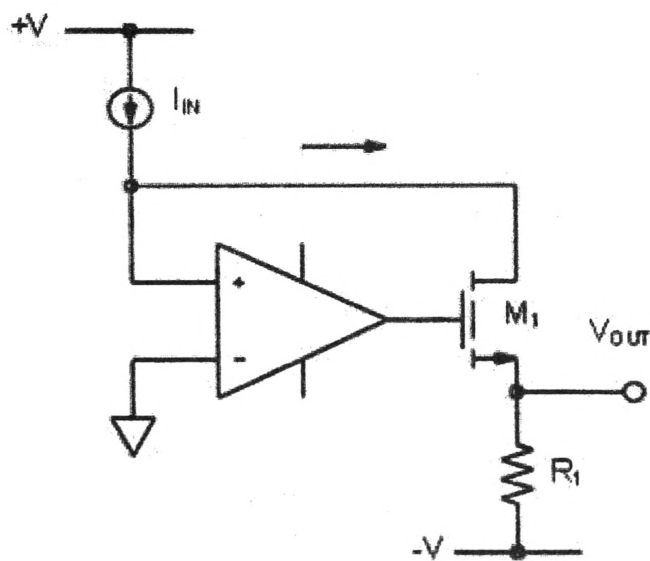


Figure 2: Current to Voltage Converter Circuit

The output voltage of current to voltage converter is send to microcontroller as an input. atMega 32 microcontroller doing the calibration part using PWM. The program was written in Bascom AVR. PWM output was supplied to the op-amp rectifier circuit. By this rectifier circuit, PWM output is amplified to 0-10 V. Using voltage divider half of this output again sends to the microcontroller as a feedback to calibration purpose.

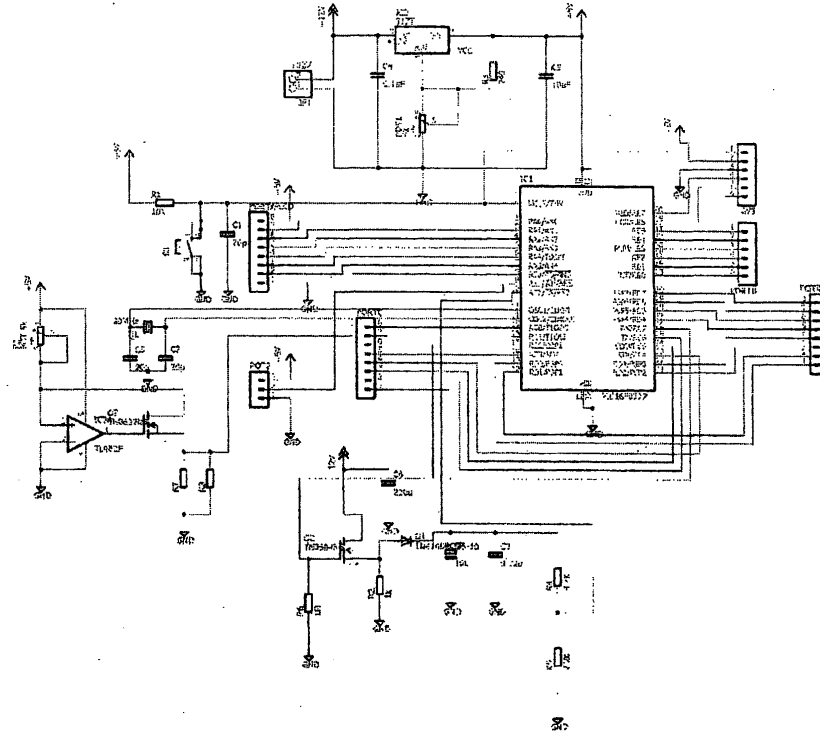


Figure 3: Circuit Diagram

3. EXPERIMENTAL

For experimental, this circuit was tested several times. Supplied $0-20 \times 10^{-3} \text{A}$ current using current source and got the output. Input current and output voltage was measured.

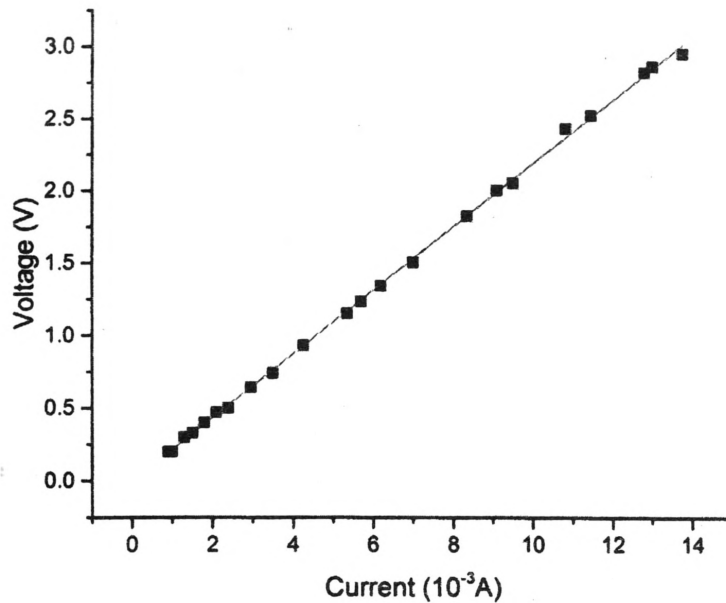


Figure 4: I-V curve of an Experimental Results

4. RESULT AND DISCUSSION

The system is designed to display weight of the containers with the indication system. When the supply current was increased output voltage should be increased. Also it should perform very precise linearity between input source current and output voltage. This system has both analogue and digital parts together. Therefore, analogue to digital conversion also needed which has been done by microcontroller. In the analogue part current to voltage performs amplifier behaviour.

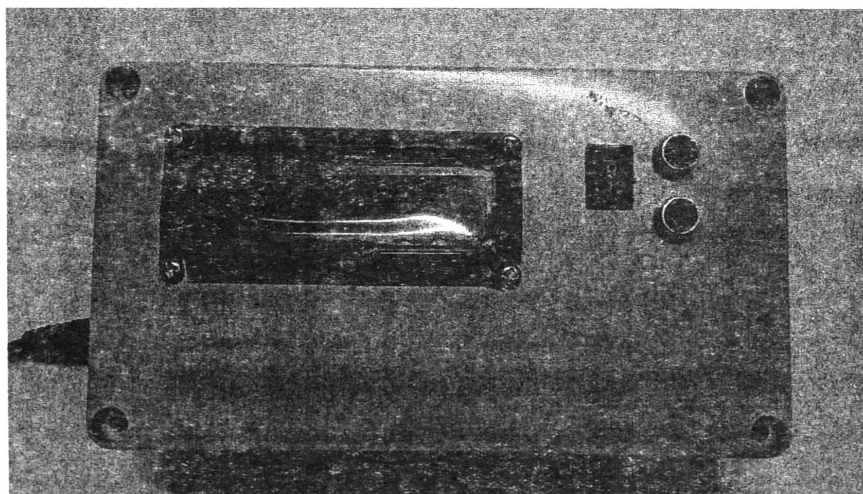


Figure 5: Completed Devices

5. CONCLUSION

Rail mounted Gantry cranes handle 0-40 tons containers which is load cell output is the 0-20 mA. Developed system converts this current to voltage output linearly. Due to this output supplied to a PLC system to further implementations, linearity is the very important factor in this project. Furthermore the system implemented a display unit for show observations to the operator. If the readings were exceeds the system, operator can prevent accidents.

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