

Design of an Automated System to Test GFCI CT Using Labview

M.Hajanizar¹, N.Subbulakshmi²P.G. Student, Department of VLSI DESIGN, Sri Ramakrishna Engineering College, Coimbatore, Tamilnadu, India¹Assistant Professor, Department of ECE, Sri Ramakrishna Engineering College, Coimbatore, Tamilnadu, India²

ABSTRACT: Nowadays automation plays a major role in industries for testing and measurement process which will reduce the overall efforts and saves time, energy, reduces human error and completion of work within a short span of time. This can be achieved with less cost by using NI kit and its intervention in industrial automation. There by large industries prefer automated system majorly to increase production cost and also the resultant product with better quality, this can be achieved with National Instrumentation. This paper presents the design of automated system using NI kit to test and measure the electrical parameters of GFCI-CT (Ground Fault Circuit Interrupter – current transformer) such as Impedance(Z), Impedance angle(θ), and Parallel resistor(R_p) using NI kit and LABVIEW.

KEYWORDS: Ground Fault Circuit Interrupter-Current Transformer; NI kit Impedance(Z); Impedance angle(θ); and Parallel resistor(R_p);Labview.

I. INTRODUCTION

Automation is used in various control systems for operating tools such as machinery, boilers and heat treating ovens, processes in factories, steering and stabilization of ships, aircraft and switching in telephone networks with less human interaction [4], Some processes has made fully automated. Benefit of automation is that it saves labours working time, it also saves energy, labour, materials, improves quality, accuracy and precision. Automation has also been achieved by various means including, pneumatic, mechanical, hydraulic, usually in combination.

The simplest types of control are on-off control. A simple example is that thermostat used in home appliances. An example is the thermostats used on household appliances. All the elements constituting the measurement and control of a single variable are called a control loop. Control that uses a measured signal, feeds the signal back and compares it to a set point, calculates and sends a return signal to make a correction, is called closed loop control. If the controller does not incorporate feedback to make a correction, then it is open loop. Loop control is normally accomplished with a controller. The theoretical basis of open and closed loop automation is control theory. Sequential control may be either to a fixed sequence or to a logical one that will perform 2 different actions depending on various system states. An example of an adjustable but otherwise fixed sequence is a timer on a lawn sprinkler. Computers can perform both sequential control and feedback control, and typically a single computer will do both in an industrial application.

Che-Seung Cho [1] has implemented PC based real-time fabric inspection algorithm to extract a minimal size of defect by lines and also is designed to find defects over 1 mm in width and length and applied to five representative defects with inspection speed of 250 mm/s, and hence got perfect recognition rates of 60% on spot with a large difference of illumination. Also F. Marino [2] has implemented VISyR, a visual system to automatically detect the hexagonal headed bolts that secure the rails to the sleepers and also to detect other types of fastening bolts employed in railway infrastructures has been derived strictly because of the flexibility of our FPGA-based implementation. VISyR analyses video at 201 km/h and at 10km/h, reaching a composite velocity of 152km/h for the tested video sequence covering more than 9 km. VISyR constitutes a significant aid to the personnel in the railway safety issue because of its high reliability, robustness and accuracy and its computing performance allows a more frequent maintenance of the entire railway network. Álvaro González [3], has implemented VISUAL Inspection of Signs and panEls (VISUALISE) is able to get several luminance measurements of a sign in the range from 15 to more than 100 m. It is also capable of

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

classifying a sign or panel into a certain class of material by comparing the luminance measurements with a model obtained through a prior calibration process in addition is able to get several luminance measurements of a sign in the range from 15 to more than 100 m. VISUALISE supposes an advance with regard to road signposting evaluation. It represents a boost for the improvement of the state of maintenance of the road's signposting. Actually, the better awareness of road's signposting state will allow for the planning of more efficient road maintenance and, consequently, optimization of the budget allocated for this purpose. This will definitely help to improve road safety. Thus Automation/Real time visual inspection plays vital role in industries nowadays.

Today automation is practiced in every type of manufacturing and assembly process. Some of the larger processes include electrical power generation, oil refining, chemicals, steel mills, plastics, cement plants, fertilizer plants, pulp and paper mills, automobile and truck assembly, aircraft production, glass manufacturing, natural gas separation plants, food and beverage processing, canning and bottling and manufacture of various kinds of parts. Robots are especially useful in hazardous applications like automobile spray painting. Robots are also used to assemble electronic circuit boards. Automotive welding is done with robots and automatic welders are used in applications like pipelines.

Paper is organized as follows. Section II describes steps involved in finding R_p (Core loss of the current transformer) value. The Description of ground fault circuit interrupter current transformer (GFCI CT) along with formulas to calculate R_p values is given in Section III. Section IV provides detailed information about NI kit and modules used to find R_p value. Section V represents the usage of Labview and concept involved in performing the process to find R_p value. Section VI presents experimental results showing results obtained using NI 9174 CDAQ and NI myRio kit. Finally, Section VII presents conclusion.

II. RELATED WORK

Nowadays Automated systems play vital role in many industries for reducing the human error, to increase quality of product and also to increase the production cycle. Here automated system used in real time to find the electrical parameters of the GFCI CT using NI kit. These can be achieved by following steps summarised as follows,

1. Electrical parameters mainly R_p (core loss of the current transformer) has to be found and that is done by calculating voltage and current from the GFCI CT such that impedance can be found, for calculating R_p value impedance and impedance angle are needed. This can be achieved by connecting GFCI CT and resistor (10ohm) in series such that sinusoidal signal generated from the analog output module NI 9263 passes through it. And then the voltage drop across GFCI CT and resistor can be read back using analog input module NI 9232.

2. For finding impedance, according to Eddy current transformation law,

$$Z = V/I$$

Where V = Voltage drop across GFCI CT, I = voltage drop across resistor.

3. For finding impedance angle formula used is given by,

$$Z' = \text{Phase voltage} - \text{Phase current}$$

Where Phase voltage is obtained from the voltage drop signal obtained across GFCI CT using Tone measurement vi using labview. Similarly, Phase voltage obtained from the voltage drop across resistor signal.

4. R_p value can be calculated using formulas given in Section III, where formulas employed directly into formula vi there R_p can be obtained.
5. Finally testing conditions can be employed based on fixed values of electrical parameters such as impedance, impedance angle, R_p etc. For GFCI CT impedance should be greater than equal to 150kHz, for impedance angle value should be greater than equal to 90 degrees for pure inductor and finally for R_p (core loss of the current transformer) the value should be greater than or equal to 200kHz. Thus Pass or Fail can be displayed using dialog box vi from labview.

Thus by following these methods core loss of the current transformer (R_p) can be obtained automatically using this automated design.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

III. GROUND FAULT CIRCUIT INTERRUPTER CURRENT TRANSFORMER

A ground fault circuit interrupter (GFCI) is a gadget that used to conceal an electric power circuit when the current flowing in an unexpected path is observed [5], i.e through a person or water. It is used to lower the danger of electric shock, which may cause heart burns. It works by noticing the current leaving power source of one side, and current entering the other side is compared. If entering and leaving current are not equal, then there is leakage of current and suddenly GFCI shut the electric power circuit.

Fig 1 shows the current transformer model, in that R_p is the core loss of the current transformer and should be greater than 200 k ohm at 3.25 kHz. In industries LCR meters are used to calculate Inductance, capacitance and resistance [18]. But later companies prefer R_p value and that can be calculated only manually. Formula used to find R_p is given below,

$$R_p = R_s * (1 + 1/D^2) \quad \dots\dots\dots (1)$$

Where, $R_s = z/\sqrt{1 + \tan(\text{radians}) * \tan(\text{radians})} \quad \dots\dots(2)$

$$\text{Radians} = \text{Radians}(\theta) \quad \dots\dots(2(a))$$

$$D = R_s/X_s \dots\dots\dots(3)$$

$$X_s = R_s * \tan(\text{radians}) \quad \dots\dots\dots(4)$$

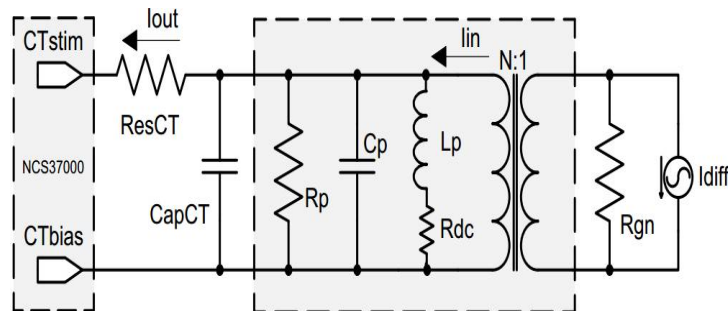


Fig. 1. Current Transformer Model

IV. AUTOMATED SYSTEM USING NI KIT

Automated system has been developed by using NI CDAQ 9174, Analog input module NI 9232, Analog output module NI 9263. NI CDAQ 9174 Chassis can hold 4 C Series modules with USB, Ethernet, or 802.11 Wi-Fi connectivity. 60 NI C Series modules from that some has been chosen to form a definite system. A 4 familiar scope 32-bit counter/timers made into chassis and it is controlled through a digital module, Continuous waveform measurements with parallel streaming, NI-patented high-speed, can be accomplished using CDAQ and it can process up to, digital I/O 7 hardware-timed analog I/O, or counter/timer operations simultaneously [7]. The NI 9232 is a 3-channel C Series dynamic signal acquisition module for providing industrial measurements from integrated electronic piezoelectric (IEPE) and non-IEPE sensors with NI Compact DAQ or NI Compact RIO systems [16]. It incorporates software-selectable AC/DC coupling and delivers 99 dB of dynamic range and IEPE signal conditioning for proximity probes, accelerometers, and tachometers.

Fig 2(a) shows the CDAQs input supply 9-30V 15W Max, Fig 2(b) shows USB cable for interfacing with pc, Fig 2(c) shows Power, Ready, and Active conditions of CDAQ shows the status of NI series modules, Fig 2(d) shows slots for holding 4 series of NI modules, Measurements taken in a minute with NI-DAQmx software and automatic code generation using the DAQ Assistant.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

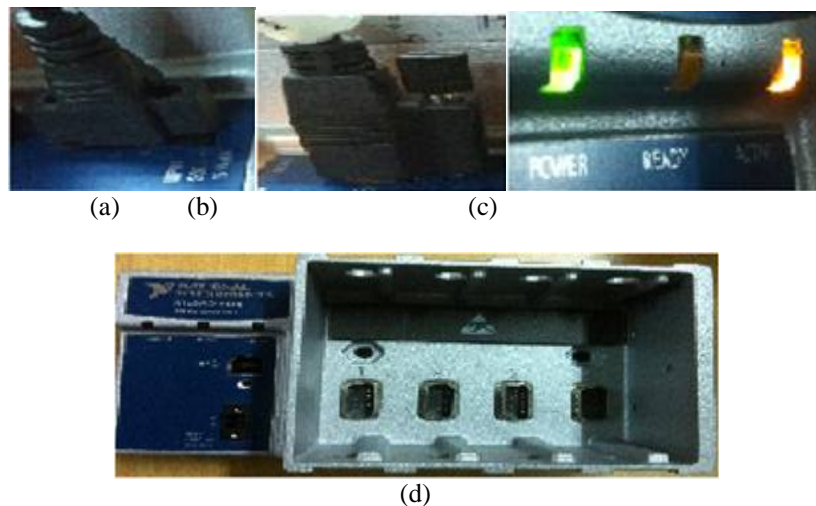


Fig 2(a)CDAQ input supply 9-20V 15W Max, (b)USB cable, (c)Power, Ready, and Active conditions of CDAQ (d)4 slots for holding NI modules.

The three input channels simultaneously digitize signals at rates up to 102.4 kHz per channel with built-in anti-aliasing filters that automatically adjust to your sample rate. The NI 9263 is a 4-channel, 100 kS/s simultaneously updating analog output module for any NI Compact DAQ or Compact RIO chassis. It also features ± 30 V overvoltage protection, low crosstalk, short-circuit protection, NIST-traceable calibration, fast slew rate, high relative accuracy. The NI 9263 module [15], includes a channel-to-earth ground double isolation barrier for safety purpose.

Fig3(a) shows the analog input module NI 9232 is a 3-channel C Series, which is used to read analog signals of maximum ± 10 v each. It incorporates software-selectable AC/DC coupling and delivers 99 dB of dynamic range and IEPE signal conditioning for proximity probes, accelerometers, and tachometers. Fig3(b) shows the analog output module NI 9263 is a 4 channel device used to generate signals greater than 3Khz, as 100KS/s can be generated from four channels of analog output module.

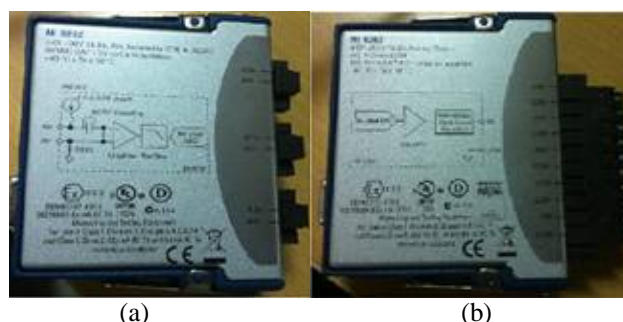


Fig 3 (a) NI 9232 Analog module, (b) NI 9263 Analog output module

V. LABVIEW CODING AND CONCEPT USED

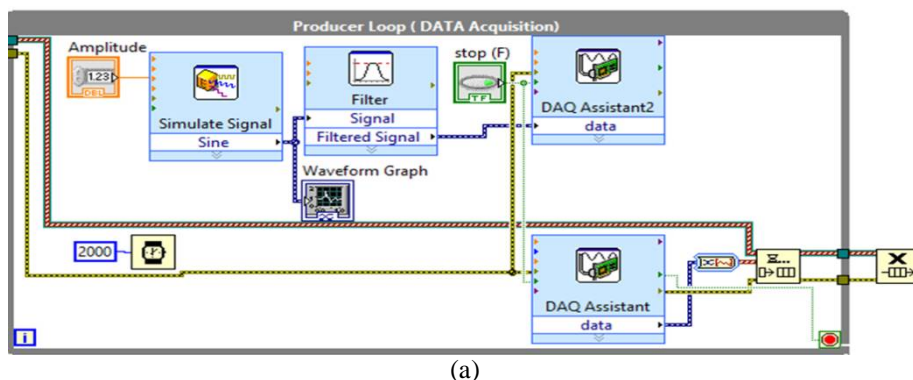
The LabVIEW (short for Laboratory Virtual Instrument Engineering Workbench) is a system-design platform and development environment for a visual programming language from National Instruments.

International Journal of Innovative Research in Science, Engineering and Technology

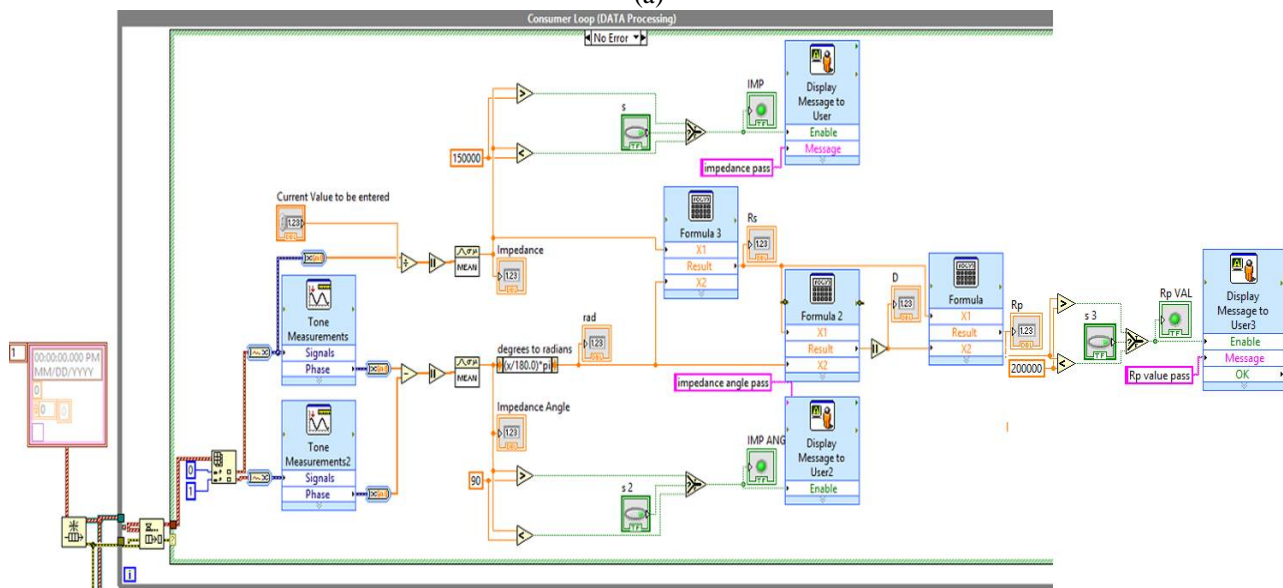
(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

Fig 4(a) shows the concept of producer loop, used to hold generation part and data's obtained during the process is feedback to queue Fig 4(b) shows the consumer loop concept, with queue handling method in order to reduce the exceptional usage of memory. Since while loop involved it can run up to infinite iterations, the producer consumer loop with queue handler plays vital role in avoiding loss of data.



(a)



(b)

Fig 4 (a) Producer loop concept, (b) Consumer loop concept

The producer consumer concept in which the signal generation can take place inside producer loop and processing on signal, mathematical calculation part prevails inside consumer loop. The major data loss can be obtained by usage of queue handler since enqueue element near producer loop enqueue data into queue and dequeue element releases the data into consumer loop.

Here DAQ Assistant helps to contact analog output/input modules by selecting measurement type such as voltage, current etc., depending upon NI module, then channel selection (more than one channel can be selected [10]), and then configuring the task where number of samples and sampling rate can be chosen. Tone measurement to separate Phase angle from waveform signal, mathematical express vi to emulate formulas (given above 1,2,2a,3,4).

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

VI. RESULTS AND DISCUSSION

As a result of automated measurement system made with Labview and NI kit it saves more time than the measurement made with the APLAB MT 4090 LCR meter [6], Here the testing of GFCI-CT and measurement of its electrical parameters using NI CDAQ 9174 along with the Analog output module NI 9263 to generate out sine waveform of Analog input module NI 9232 to read the voltage drop across CT and resistor.

Fig 5(a) shows GFCI CT, used to stop current flow in unintended direction i.e., to prevent electric shock, Fig 5(b) shows CDAQ hardware implementation using labview, Fig 5(c) shows Front panel with final result of testing and electrical parameters obtained from CDAQ implementation.

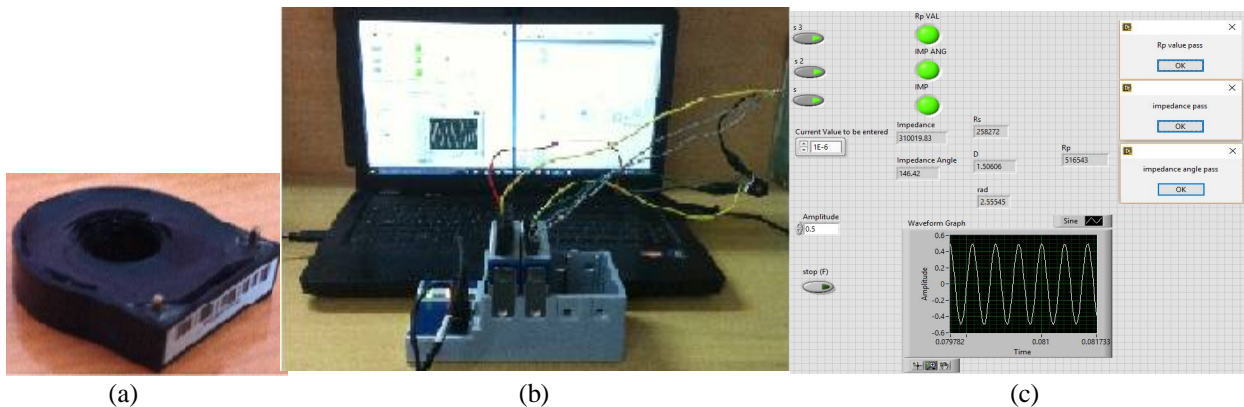


Fig. 5 (a) shows GFCI CT, (b) shows CDAQ hardware implementation, (c) shows final result obtained at front panel in labview

NI myRIO includes Xilinx FPGA customizable I/O and dual-core ARM® Cortex™-A9 real-time processing elements which provide students seamless software experience and which helps students for doing real time projects with help of xilinx embedded in it [14].

Fig 6(a) shows myRIO hardware implementation, where myRio includes Xilinx FPGA customizable I/O and dual-core ARM® Cortex™-A9 real-time processing elements used to do real time projects, where it has inbuilt signal generation upto 5khz with maximum sample rate of 500 kS/s. Fig 6(b) shows result obtained from myRIO using labview, where Analog input express vi and Analog output express vi used instead of DAQ assistant used for CDAQ.

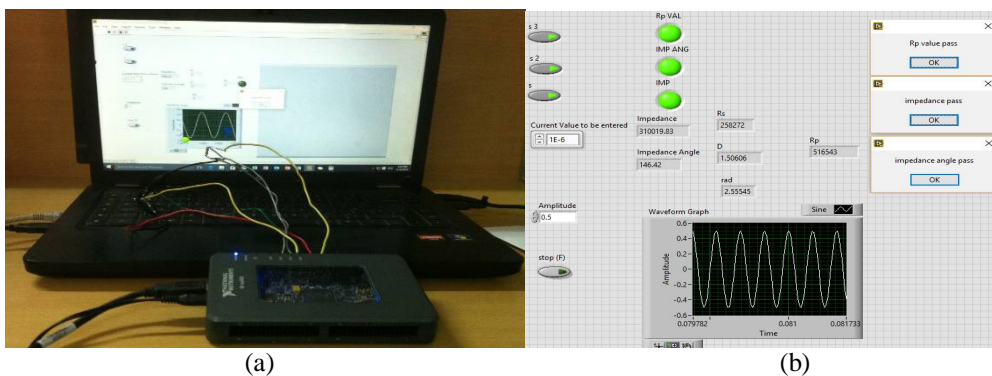


Fig 6 (a) MyRio hardware implementation, 6 (b) Results obtained from MyRio using labview

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

Here for myRIO implementation [9], [11], [12] the simple change in labview code is analog input express vi and analog output express vi [8], instead of DAC assistant used for CDAQ implementation.

VII. CONCLUSION

Hence the automated system has been designed to test and measure the electrical parameters of ground fault circuit interrupter current transformer (GFCI CT) using National Instrumentation (NI) kit such as NI 9232 Analog input module and NI 9263 Analog output module, where NI 9232 Analog input module used to read the generated signal from NI 9263 Analog output module i.e it is used for measurement purpose especially in many industries where automated systems employed, Whereas Analog output module NI 9263 used to generate analog signals of maximum 5khz where sampling rate and number of samples required for generating the analog signal can be controlled using DAQ assistant vi available in labview. Both NI 9232 Analog input module and NI 9263 Analog output module are C – Series modules used with NI 9174 CDAQ module. CDAQ module used to integrate both NI 9232 Analog input module and NI 9263 Analog output module with labview to control signal generation in analog output module and process the obtained data from the analog input module. Using labview code processing takes place on data's and desired output can be obtained for GFCI CT, and hence automated system reduces time taken by to calculate Rp value of each GFCI CT thereby production will increase as well as quality of measurement also get improved without human error.

REFERENCES

- [1] Che-Seung Cho., Byeong-Mook Chung., and Moo-Jin Park., "Development of Real-Time Vision-Based Fabric Inspection System", IEEE Transactions on Industrial Electronics, Vol. 52, No. 4, pp. 457-465, August 2005.
- [2] Marino, F., Distanto, A., Mazzeo, P.L., and Stella, E., "A Real Time Visual Inspection System for Railway Maintenance: Automatic Hexagonal Headed Bolts Detection", A Real Time Visual Inspection System, Vol. 25, No. 6, pp. 669-677, 2004.
- [3] Álvaro González., Miguel Ángel García-Garrido., David Fernández Llorca., "Automatic Traffic Signs and Panels Inspection System Using Computer Vision", IEEE Transactions on Intelligent Transportation Systems, Vol. 29, pp. 578-589, 1998.
- [4] <https://en.wikipedia.org/wiki/Automation>
- [5] <https://simple.wikipedia.org/wiki/GFCI>
- [6] <http://www.ni.com/white-paper/8198/en/#toc4>
- [7] <http://www.ni.com/tutorial/7114/en/>
- [8] <http://www.ni.com/myrio/setup/getting-started/>
- [9] <http://www.ni.com/f/students/12/7074/en/>
- [10] <http://www.ni.com/video/3094/en/>
- [11] <http://www.ni.com/tutorial/14621/en/>
- [12] http://zone.ni.com/reference/en-XX/help/373925B-01/myrioreference/myrioref_exp_ai/
- [13] <http://www.ni.com/tutorial/4656/en/>
- [14] <http://www.ni.com/myrio/what-is/>
- [15] <http://sine.ni.com/nips/cds/view/p/lang/en/nid/208806>
- [16] <http://sine.ni.com/nips/cds/view/p/lang/en/nid/210281>
- [17] <https://en.wikipedia.org/wiki/LabVIEW>
- [18] www.ni.com/pdf
- [19] </manuals/374045a.pdf>