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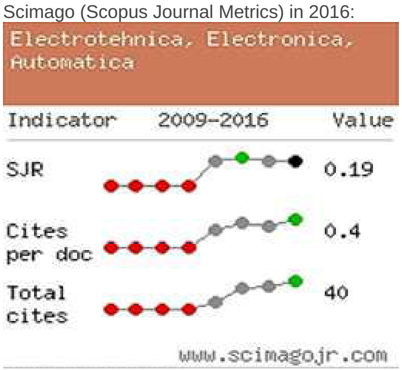

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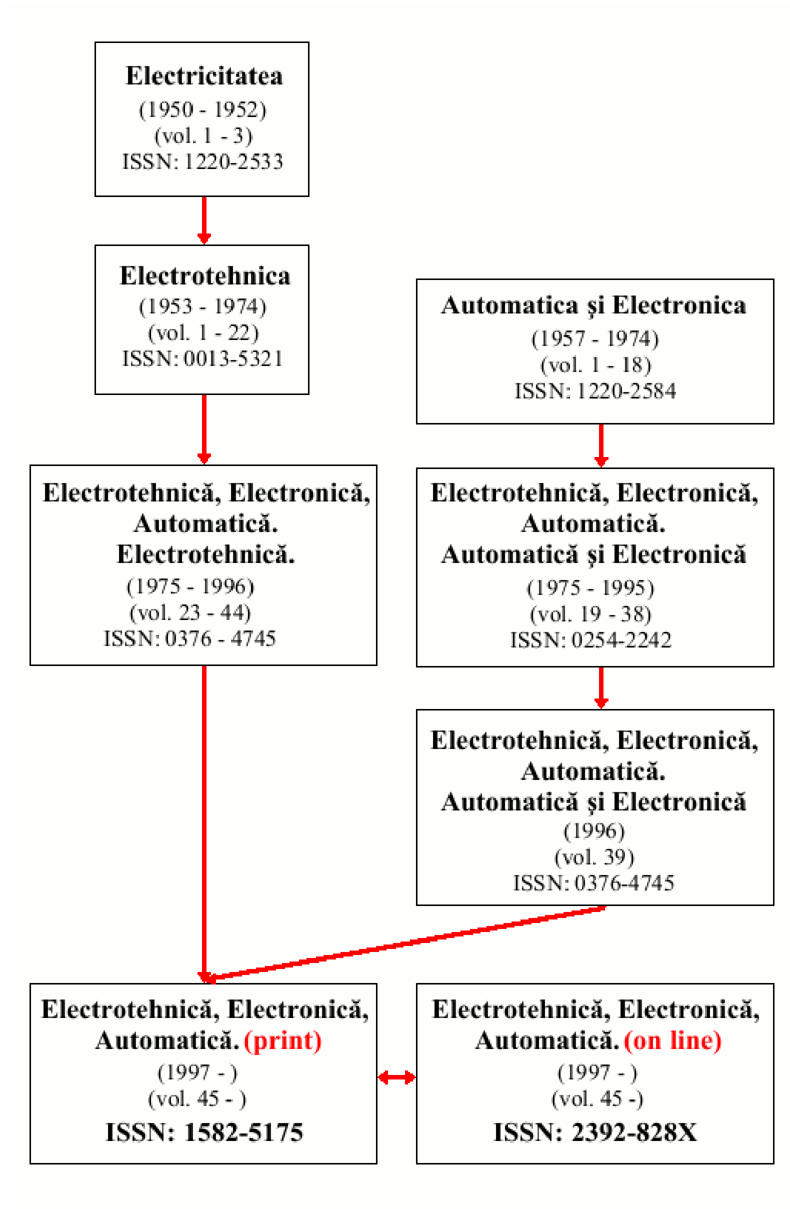

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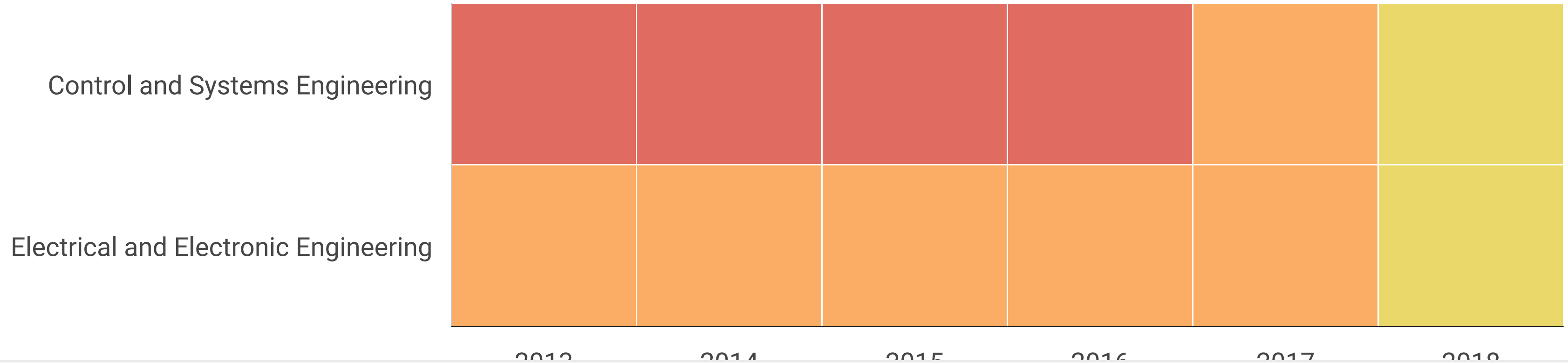

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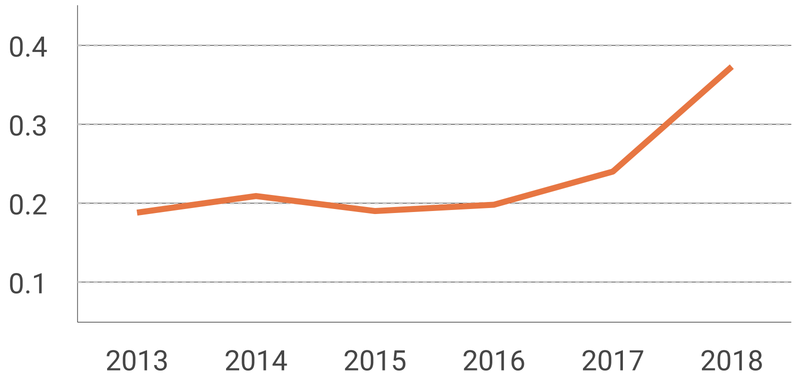

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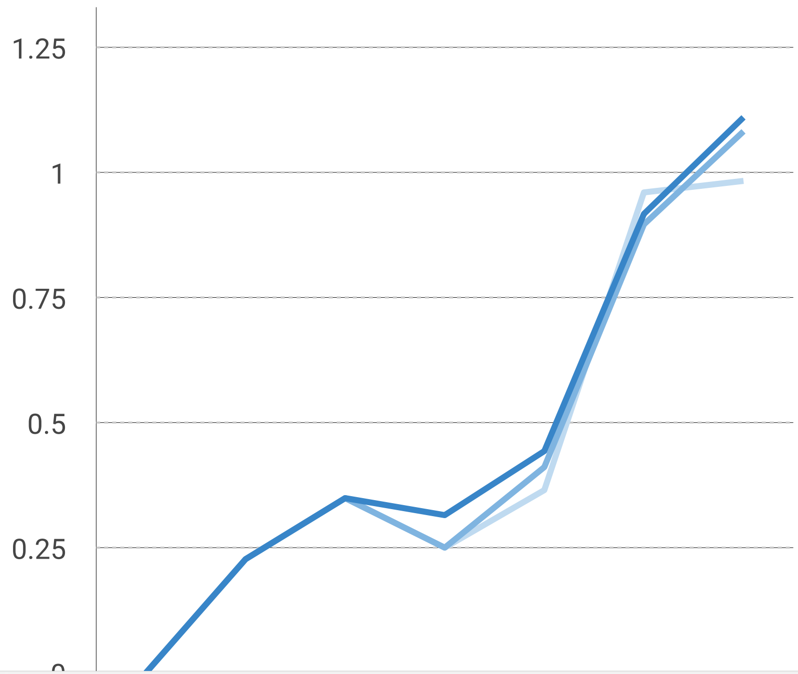

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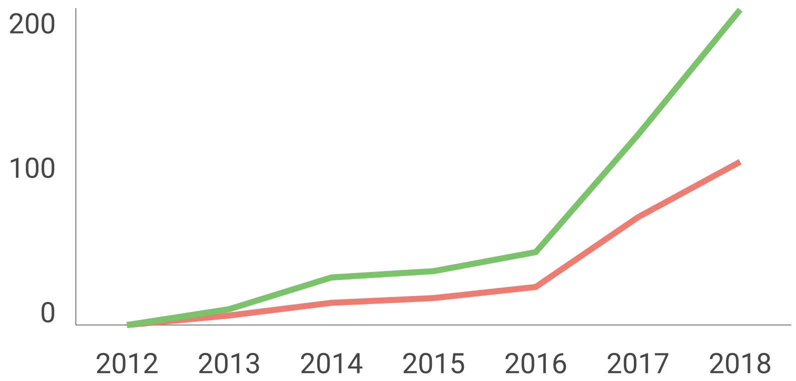

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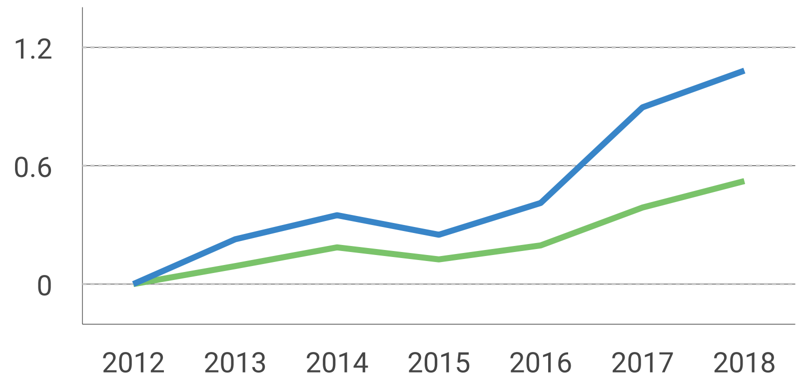

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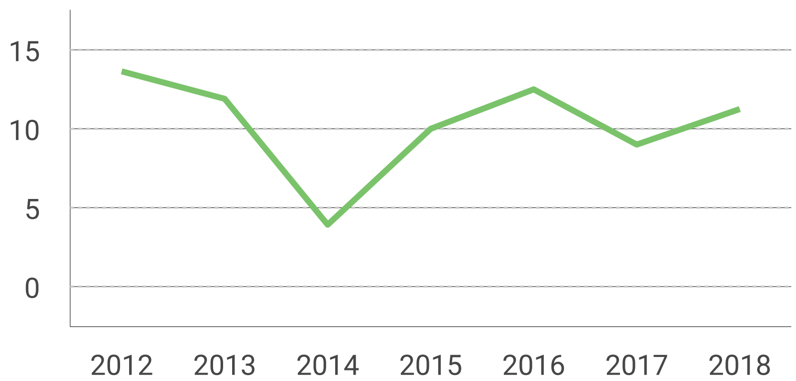

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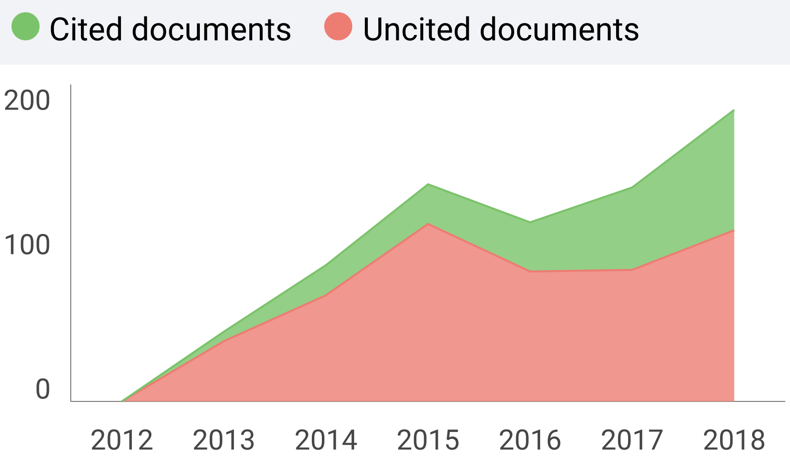

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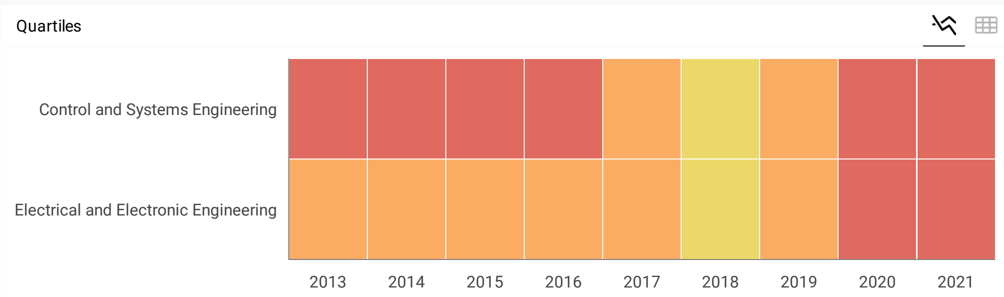

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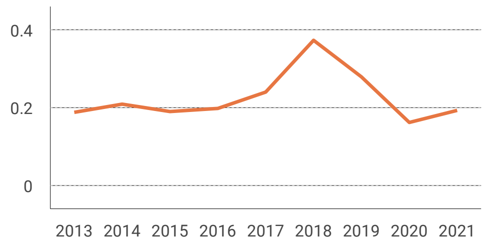

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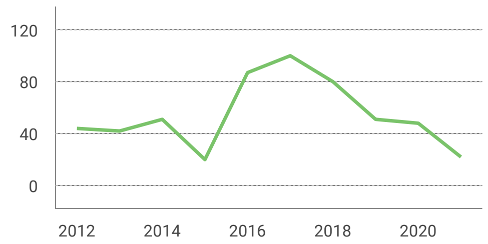

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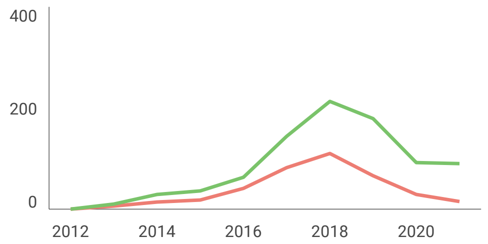

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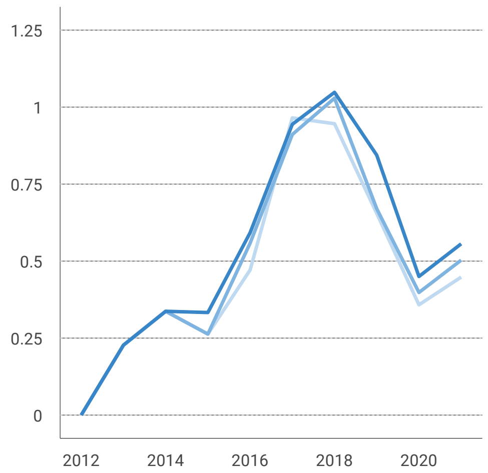

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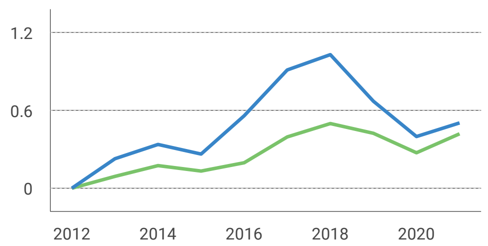

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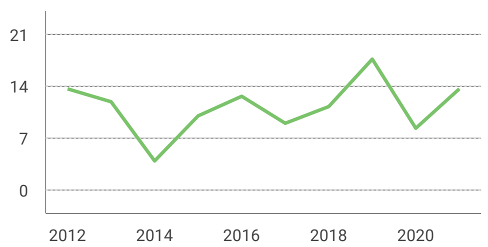

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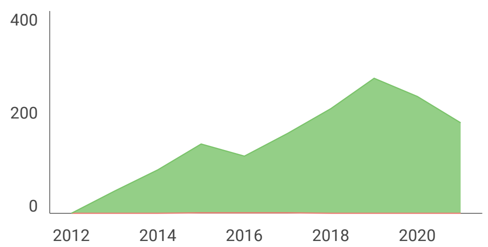

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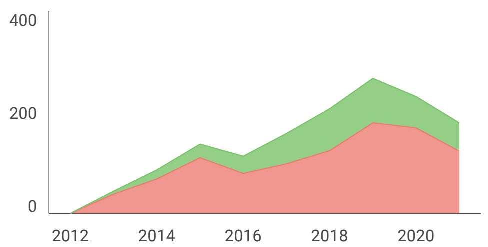

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*Implementation of Curtain Blind Rolling Automation using PLC**

WALUYO, Andre WIDURA, Yudithia Agustiawan SURYADI, Nasrun HARIYANTO

Abstract

Illuminance in a room comes not only from lighting lamps, but also from natural daylighting. However, if it is excessive, it may cause a glare. Thus, it is necessary to optimize the day lighting automatically. This paper presents the design and testing results of vertical curtain automation utilizing PLC TM221 and ladder diagram software. The program performed an analogue logic operation. The 4-20 mA current analogue signal of light sensor transmitter output was converted to 2-10 V using 50 Ω resistor, in the provision of the PLC analogue input, in recording of 0-2000 lux. In the design of ladder diagram, the sensor, as the PLC input, was the reference value for the programming of SoMachine software. It was necessary to adjust the upper and the lower limits of the curtain on the limit switch, connected to the curtain motor. Hereafter, it was conducted the tests of lux values. The initial step, in the automatic open and close curtain program making, was to determine the visual comfort specified reference value of 230 lux in the classroom. As the reading sensor under or same as 350 lux, the curtain would go up. Otherwise, it would go down. As the curtain rose, it would continue to rise up to 230 lux, it would remain motionless, and it would be locked on the sensor reading between 220 and 238 lux. Otherwise, it would continue to go up to 230 lux, to the upper limit set by the limit switch. As the sensor reading of 239 lux and above, it would turn off as the sensor reading under or same as 350 lux. Otherwise, the curtain would go down, and it would read whether the sensor reading under or same as 201 lux. As the curtain went down, it would continue up to 230 lux, it would be quiescent, and it would be locked on the sensor reading between 220 and 238 lux. Otherwise, the curtain would go down continuously to get 230 lux, up to the lower limit set. As the sensor read same as or under 201 lux, it would turn off the 350 lux (or less) sensor reading and the curtain would go down to the lower limit. The obtained results of the design, the curtain could open and close automatically. The automatic motion of the curtain was based on the illuminance in the room. The opening of the curtain was to keep the illuminance of 230 lux in the room and it would be held to the value between 220 and 238 lux. The locked curtain was done so that it was not too sensitive to any change in the sensor signal.

**This paper has been presented in 2018 International Conference on Electrical Engineering and Computer Science (ICEECS), 13 November 2018, Discovery Kartika Plaza Hotel, South Kuta, Bali, Indonesia.*

Keywords: *curtain, daylighting, illuminance, ladder diagram, PLC*

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Implementation of Curtain Blind Rolling Automation using PLC[1]

WALUYO[1], Andre WIDURA[1], Yudithia Agustiawan SURYADI[1], Nasrun HARIYANTO[1]

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Keywords: curtain, daylighting, illuminance, ladder diagram, PLC

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1. Introduction

A building design should be new paradigm to improve occupants' visual comfort utilize daylighting and a challenge for design [1], [2]. An optimal energy use can improve comfort and reduce energy consumption [3], [4]. The improving building performance and reducing energy consumption are correlated where building standards recognize to provide natural daylighting [5], [6]. It is one of energy saving, and its controlling is substantial for comfort [7], [8]. A work satisfaction and productivity are contributed by lighting condition [9] and a solar shading effective automatic control is important to enable efficient lighting [10]. Thus, an appropriate window is nearly zero energy good design [11]. On other hand, for energy efficiency, glass windows and curtain walls were coated [12]. Nevertheless, a high luminance contrast can raise discomfort glare [13], so that a correctly calibrated model is important to get reliable data [14].

Based on above literatures, this shows that it is important, visual comfort for occupants and efficiency of energy use, especially electricity. Thus, it was necessary to design a automatic control of curtain in relation with illuminance. This paper presents a design and research results on the automatic control of vertical curtain blind roller in a laboratory room based on the illuminance that received by the sensor. The system utilized a local PLC (programmable logic controller) TM221 hardware and Somachine Basic Software. This was also conducted testing. The contribution was the logic operations as analogue ones and the current transmitter could be adapted to the voltage of default PLC analogue input. This system used resistor components to change the output of the sensor, so that it did not need additional circuits.

2. Materials and Methods

This research was continuation from previous researches [15-18].

[1]This paper has been presented in 2018 International Conference on Electrical Engineering and Computer Science (ICEECS), 13 November 2018, Discovery Kartika Plaza Hotel, South Kuta, Bali, Indonesia.

Nevertheless, the previous research conducted and discussed in relation with environmental monitoring. While, this research concerned on the automations for controlling the environmental parameters. In the beginning, it was necessary to provide the hardware components. These components were circuit breaker 2 A, 2 pieces, TR-LXT1A4 light transmitter, M221C116R Schneider PLC, SPST relay 2 pieces, servo motor AC 220 V, 110 W, limit switch and window rolling blind curtain. The circuit breaker (CB) was used as safety in the event of over current fault which probably could damage other components. The light transmitter was a light sensor as the PLC input and used for the automatic reference value of open and close curtain. TM221 PLC, as a control of automation, that would carry out commands on each component based on the incoming input signal. The SPST relay was as a switch for curtain up and curtain down orders. The limit switch was used to determine the upper and lower limits of the curtain.

Figure 1 below is the design diagram that has been carried out according to the power supply 220 V, 50 Hz.

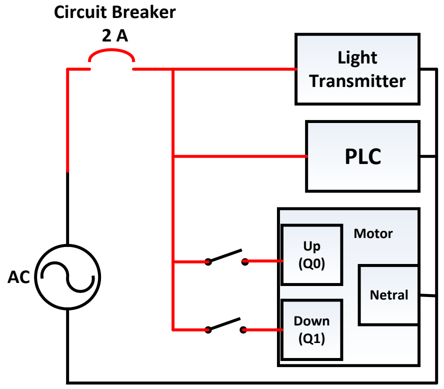


Figure 1. Plan of controlling diagram of window curtain

It supplied the light transmitter, PLC and electric motor of curtain blind roller. On the curtain blind roller, it is provided the push buttons to be raised and lowered.

The real condition of the blind roller curtain and the controller consisted of the vertical curtain blind roller, power supply and push buttons, PLC and kit, and light transmitter. A computer or laptop was for making the SoMachine Basic program ladder diagram and uploading it to PLC. They were connected to each other. The wiring diagram consists of the light transmitter, PLC and relays of curtain blind roller.

The real analogue transmitter of light is 4-20 mA. However, the default analogue input of PLC is 0-10 V_{dc}. Therefore, it was necessary resistors for conversion the current to voltage quantities. However, due to not from zero of the current quantity, consequently, the voltage could not be from zero too, as instead, it was from 2 up to 10 V_{dc}.

The program performed analogue operations of the curtain, although the output of the PLC was digital or logic operations. This system used the resistor components to change the output of the sensor, so that it did not need additional circuits. The light transmitter sensor output was converted using the 50 Ω resistor, by two parallelized 100 Ω resistors. Thus, the input entering the PLC became 2-10 V_{dc}. These values were still in the provision of the TM221 PLC analogue input, which had the values of 0-10 V_{dc}. Therefore, the output value of 4 mA was equal to 2 V_{dc}, represented 0 lux, and the output value of 20 mA was equal to 10 V_{dc}, represented 2000 lux.

To obtain from the sensor, it was programmed on the PLC and its output in **Q0** and **Q1**, and connected to the relay coil. The output PLC was logic quantities, to turn on the motor of curtain blind roller through coil relays of contactors. Nevertheless, the curtain blind roller was operated typical in analogue. The design of software was to program the PLC using SoMachine Basic.

Figure 2 shows the used flow chart program.

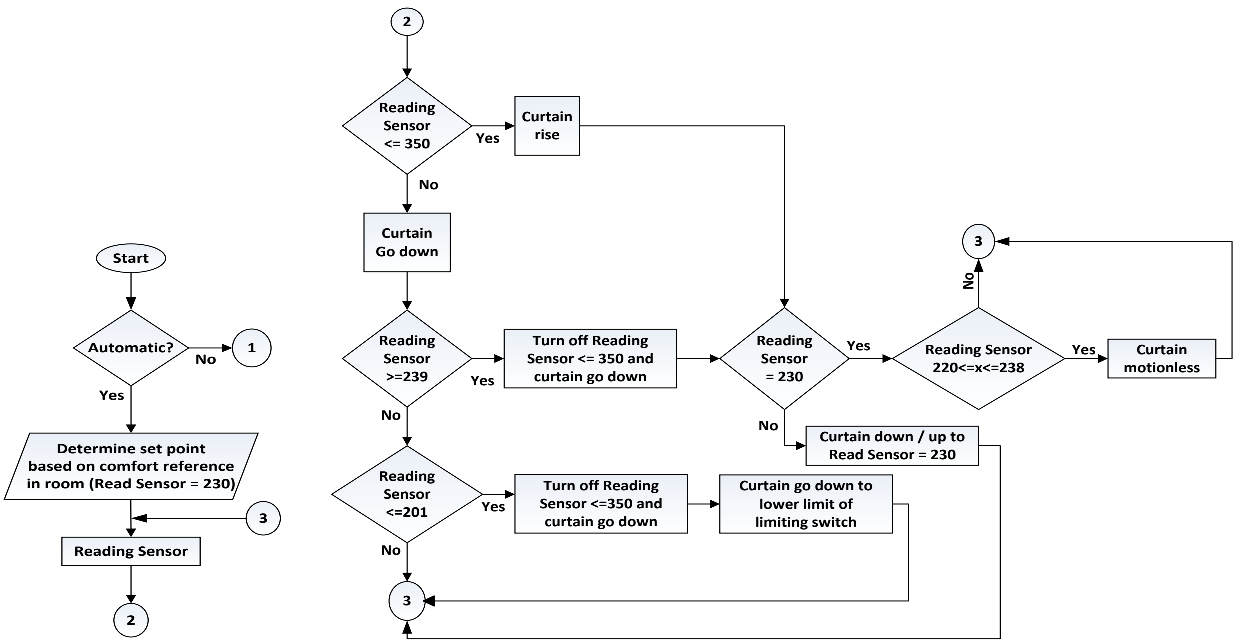


Figure 2. Flowchart diagram of software design

The sensor read the state of light or illuminance in the room, and, the set point value was entered into SoMachine software for the convenience of room lighting. The increasing or changing curtain is limited to the set point value. Nevertheless, the decreasing curtain is not limited to the set point, but only limited by a limit switch at the lower position.

The sensor of the PLC input was the reference value for the SoMachine software programming. It should be adjusted the upper and the lower limits of the curtain, using the motor connected limit switch. Furthermore, the testing of lux values was conducted in the research object. The initial step, in making the automatic curtain open and close program, was to determine the lux comfort reference value in the classroom. The specified reference value was 230 lux. If the read sensor ≤350 lux, the curtain would go up. Otherwise, it would go down. After the curtain rose, it would continue to rise up to it reached the value of 230 lux. The curtain would remain quiescent. Hereafter, it would be locked on the sensor read of 220 ≤ x ≤ 238 lux. Otherwise, the curtain would continue up to 230 lux. The curtain would go up to reach 230 lux, to the set upper limit of the limit switch.

When the read sensor ≥ 239 lux, the program would turn off the sensor read ≤ 350 lux, and the curtain would go down. Otherwise, it would read whether the sensor read ≤ 201 lux. After the curtain got down, it would go down up to 230 lux. If it was 'yes', the curtain would be motionless. Subsequently, it would be locked on the sensor read 220 ≤ x ≤ 238 lux.

Otherwise, the curtain would go down continuously to get the value of 230 lux, up to the lower limit, that has been set on the limit switch. If the read sensor wa ≤ 201 lux, the program would turn off the read sensor ≤ 350 lux, and the curtain would go down, and drop to the lower limit of the limit switch.

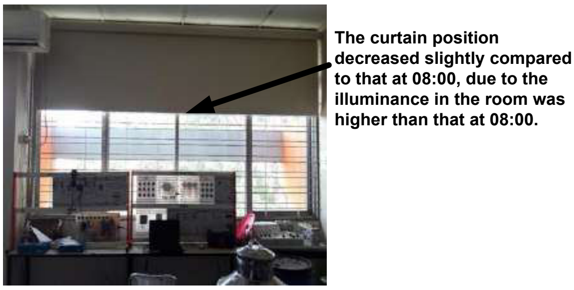
3. Results and Discussion

The results of the design have been already running. The testing results were conducted on September 22nd, 2018, in 20-404 room, at Institut Teknologi Nasional Bandung campus.

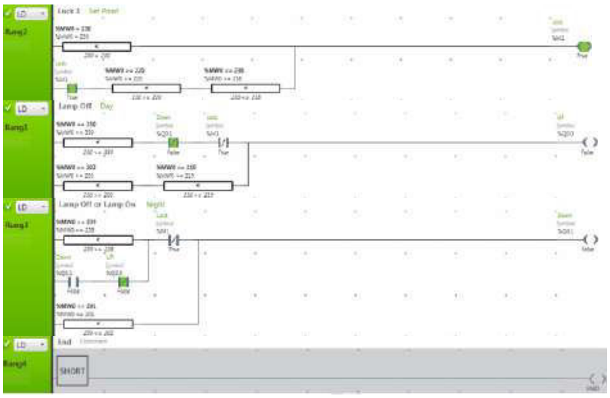
The curtain blind roller motion and ladder diagram SoMachine Basic software were at 7:00 a.m. o'clock. The curtain opened fully to the upper limit set by the limit switch. The illuminance value that was read by the PLC was 228 lux. Therefore, the PLC commanded to continue, open up and obtain the value of 230 lux. The readable value in the PLC was 228 lux, so that the rising curtain in **Rung 1** at **% Q0.0** would light up with a green light indicator. This case indicated that the curtain would continue to rise up to the value of 230 lux.

The curtain blind roller motion and ladder diagram of Somachine Basic software were also at 8:00 a.m. o'clock. The curtain began to go down and shut up. It came down because the sunlight started to enter the room. The read value on the PLC has reached = 230 lux, where it was the convenience reference value in the room. The curtain would remain within the limit of the read values by PLC at **220 ≤ X ≤ 238** lux. The PLC value, that has been read, has reached = 230 lux, so that the curtain would be held or still in the values of 220 ≤ X ≤ 238 lux. It can be seen in the set point in Rung 2 with the address of **%M1** lit with the green lamp indicator.

Figure 3 shows the curtain blind roller motion and ladder diagram SoMachine Basic software at 09:00 a.m. o'clock.



(a) Partly closed blind roller curtain position



(b) Ladder diagram running

Figure 3. Curtain position and ladder diagram at 9:00 a.m. o'clock

The curtain experienced a decline. The value read on the PLC has reached = 230 lux, where the value was the convenience reference value in the room. The curtain would be remained within the limit of the read value by PLC at 220 ≤ X ≤ 238 lux. The curtain had dropped a little because the read value was same as 239 lux. Therefore, the reading value had reached = 230 lux, so that the curtain would be held back or still in the values of 220 ≤ X ≤ 238 lux. This case can be seen in the set point in Rung 2, with the address of **% M1** lights up with the green lamp indicator.

The curtain blind roller motion and ladder diagram SoMachine Basic software were at 10:00 a.m. o'clock too. The curtain dropped slightly from the previous one and the curtain was motionless. The read value on the PLC has reached = 230 lux, where the value was the convenience reference in the room. The curtain would be remained within the limit of the read value by PLC at 220 ≤ X ≤ 238 lux. The curtain had dropped a little because the value that was read as ≥ 239 lux.

Therefore, the reading value had reached = 230 lux, so that the curtain would be held back or still in the value of 220 ≤ X ≤ 238 lux. This can be seen in the set point in Rung 2 with the % **M1** address lights up with the green lamp indicator.

The curtain blind roller motion and ladder diagram SoMachine Basic software at 11:00 a.m. o'clock. The curtain dropped slightly from the previous one and furthermore it was motionless. The read value on the PLC has reached = 230 lux, where the value was the convenience reference in the room. The curtain was remained within the limit of the read value by PLC at 220 ≤ X ≤ 238 lux.

The curtain had dropped a little because the read value was ≥ 239 lux, so that the reading value had reached = 230 lux, and the curtain would be held back or still in the values of 220 ≤ X ≤ 238 lux. This case can be seen in the set point in Rung 2 with % **M1** address lights up with the green lamp indicator.

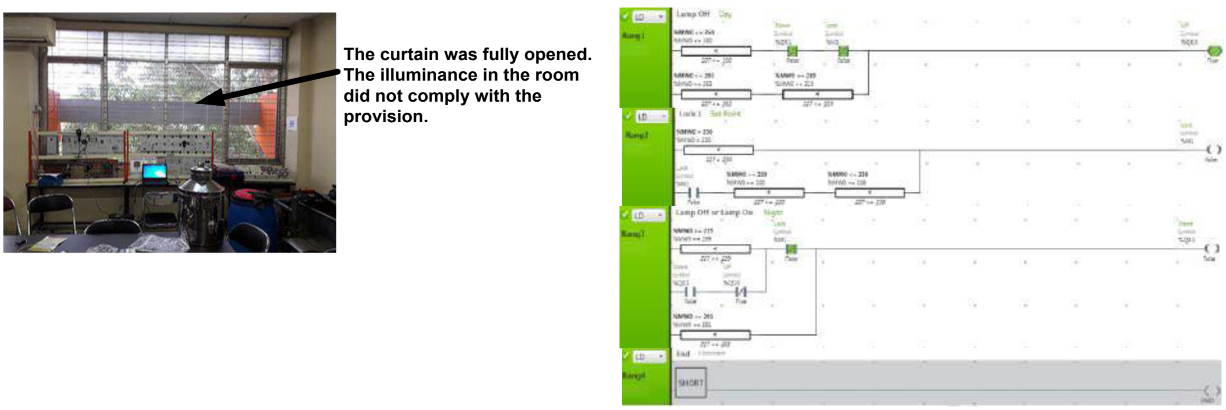
The curtain blind roller motion and ladder diagram SoMachine Basic software were also at 12:00 p.m. o'clock. The incoming light in the room was reduced, due to the weather condition at that time was cloudy, so that the curtain opened fully to the upper limit set by the limit switch. The value, which was read in the PLC, was 226 lux, so that the PLC instructed continuing open up, to obtain the value of 230 lux. The readable value in the PLC was 226 lux, so that the Up curtain in Rung 1, at the address of % **Q0.0**, would light up with a green light indicator. This case indicated that the curtain would continue to rise up to the value of 230 lux.

The curtain blind roller motion and ladder diagram SoMachine Basic software were at 1:00 p.m. o'clock too. The condition of the light entering the room was almost the same as 12:00 p.m. The curtain still opened fully to the upper limit of the limit switch set. The value, which was read in the PLC, was 227-228 lux, so that the PLC commanded continuing open up, to obtain the value of 230 lux.

The readable values in the PLC were 227-228 lux, so that the curtain rose, in Rung 1, at the address of % **Q0.0** would light up with the green light indicator. This indicated case that the curtain would continue to rise up, to the value of 230 lux.

The curtain blind roller motion and ladder diagram SoMachine Basic software were also at 2:00 p.m. o'clock. The incoming light decreased because the weather at that time was cloudy and it would rain lightly, so that the curtain opened fully to the upper limit set by the limit switch. The read value in the PLC was 221 lux, so that the PLC commanded continuing open up to obtain the value of 230 lux. The readable value in the PLC was 221 lux, so that the rising curtain in Rung 1, at the address % **Q0.0**, would light up with the green light indicator. This case indicated that the curtain would continue to rise up to the value of 230 lux.

Figure 4 shows the curtain blind roller motion and ladder diagram SoMachine Basic software at 3:00 p.m. o'clock.



(a) Fully opened blind roller curtain position

(b) Ladder diagram running

Figure 4. Curtain position and ladder diagram at 3:00 p.m. o'clock

The condition was the same as 2:00 p.m., so that the curtain opened fully to the upper limit set by the limit switch. The read value in the PLC was 221 lux, so that the PLC commanded continuing to open up, to obtain the value of 230 lux. The readable value in the PLC was 221 lux, so that the rising curtain in Rung 1, at the address % **Q0.0**, would light up with the green light indicator. This case indicated that the curtain would continuing to rise up, to the value of 230 lux.

The input used the form of analogue signal, so that the changes were very sensitive to any change in the light in the room. The program operated the analogue logic and could hold the curtain to not be too sensitive to any change from the input. The read value in the PLC at 0 mA was 200 lux. This case was caused by that the value of the voltage entering the PLC was 2-10 V_{dc}. The program that has been created can meet the conditions during the day because the light in the room was kept the intensity with the value of 230 lux. The upper and lower limits of the curtain were limited by the limit switch. The window was blocked by the trees surrounding in front of the window of the room and the measurements were done when the outside weather was cloudy so that the incoming light was not maximal. The program could be used on different curtains, due to each room has a different minimum and maximum light intensity.

At 4:00 p.m., 5:00 p.m. and 6:00 p.m. o'clocks, the system was not tested due to the cloudy and rainy weather, so that the curtain was remain opened fully to the upper limit set by the limit switch. The program instructed the curtain to go down to the lower limit of the limit switch for night conditions, when the light was turned on.

The manual program used a selector switch to be processed using a three condition push button, namely up, down, and break conditions.

4. Conclusions

The design and results of vertical curtain automation utilizing PLC TM221 and ladder diagram software have been successfully implemented. The obtained results from the design indicated that the curtain could open and close automatically. The automatic open and close curtain was based on the illuminance in the room. The opening and closing of the curtain was to keep the lux value of the illuminance in the room of 230 lux and it would be held to the value between 220 lux and 238 lux. The locked curtain was done, so that the curtain was not too sensitive to any change in the signal from the sensor, although the reading on the sensor was very sensitive to any change of illuminance. In the morning, the blind roller curtain would be opened, and in the evening until night, it would be closed.

Nevertheless, it was conducted locally and only utilizing PLC. In near future, the design and implementation will cover a wider blind roller curtain, integrated using wireless monitoring and using Vijeo Citect SCADA software.

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