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CONTROL SYSTEMS DESIGN FOR AUTO JUDGEMENT CHECK MACHINE IN ROTOR ASSEMBLY LINE USING PROGRAMMABLE LOGIC CONTROLLER

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ABSTRACT

This paper discusses the problems that occur in an automotive manufacturing industry. This research was taken from problems claim to say that this manufacturing company receives product magneto with height taper size is too large. To anticipate avoiding the same mistakes, this research and analysis to the design of auto judgment check machine to replace the previous inspection jig. The design of machine control system is using 3-type sensor Keyence GT2 P12 as an input device which serves to perform measurements on the product. Controller used is PLC Keyence KV-1000 is communicated with Keyence VT3-W4T HMI as a device process. Through the design of this auto judgment check machine control system, subsequent inspection results are displayed via the HMI (Human Machine Interface). HMI display raises the condition whether the product is good or no good. The results of this design have carried out trials in order to prevent the same error occurs on the rotor boss check and eliminate the potential for human error.
Keywords: auto judgment check machine, rotor assembly line, sensor keyence GT2-P12, PLC keyence KV-1000, HMI keyence VT3-W4T

1. INTRODUCTION

This research was conducted at an automotive manufacturing company. Among the products are Electric Cooling Unit (ECU), alternator, starter, and so forth. The problem faced is their product claims Magneto quality no good. Magneto is an electricity generator that uses permanent magnets to generate a current that serves to regulate ignition timing, distributing current to the ignition system of the engine, battery charging, and distributes current to the lighting systems of motorcycles. Magneto is composed of two main parts, namely the rotor and stator. The rotor is part of an electric motor or an electric generator rotor that rotates on an axis. The stator is part of the electric motor or the electric dynamo which serves as a stationary on the rotor system.

In the manufacturing process there are processes boss rotor rotor check. This process serves to inspect diameter, runout, and taper height of the rotor. Boss process rotor check swing measurement was performed using a jig. The jig consists of a stand that serves to inspect taper height and two dial that serves to inspect runout and diameter. Because they use the dial, the result of the inspection is very dependent on the operators when reading the results of the inspection on the dial. In addition, there are indicators of good or no good product on the jig. Therefore, the design and manufacture of auto judgment check machine to eliminate the potential for human error and prevent the same problem occurs in the process. This research discusses the design of the machine control system check auto judgment in order to show indicators of good or no good product so as to eliminate the potential for human error.

In previous researches, Ardi et al. (2012, 2013, 2014, 2015) [b, c, d, e, f, g, h, i], have designed and conducted an analysis of the various applications of machine automation PLC-based in manufacturing industry, sensor applications, and HMI (Human Machine Interface). Alphonsus et al. (2016) [a], he make a review on the applications of programmable logic controllers (PLCs). Buhrer et al. (2015) [j] design a manufacturing automation system using an Orchestration Engine in PLCs. G. Valencia-

Palomo et al. (2011) [k] design an auto-tuned predictive control based on minimal plant information using PLCs. Milik, A. (2015) [l] design a PLCs control program hardware implementation selected problems of mapping and scheduling. Putman et al. (2015) [m] design virtual fusion by integration virtual components into a physical manufacturing system.

2. THEORETICAL BACKGROUND

2.1. Auto Judgement Check Machine

Auto judgement check machine is an inspection machine that will be used in boss rotor check process of assembly rotor line. This machine checks the dimensions of rotor assembly include diameter, run-out and taper height. The dimensions of the rotor assembly measured using three sensors. Furthermore, the sensor will send the data to be processed in the PLC which is the device process of this machine. Then after processing in the PLC, the PLC will send a signal to the display or HMI and indicator lights and buzzer that will indicate did dimensions of the rotor assembly according to standards that have been determined or not. If according to the standard display will show the product is good, and the green indicator light turns on. But if the product is not compliant or no good, then the display will show the product is no good, and the red indicator light and buzzer active. Here is an illustration of auto judgement check machine in Figure 1.

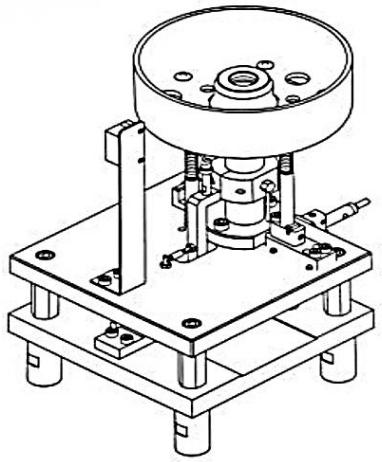

Figure 1. Auto judgement check machine

2.2. Programmable Logic Control (PLC)

PLC is a device used to control a process or machine. The working principle in outline is receives input from an input device. Its use is based on a program stored in it then generates output for moving the output device. PLC is the 'heart' of the control system. With a program stored in the memory of the PLC, in the execution, the PLC can monitor the state of the system via a signal from an input device, and then based on the logic of the program determines the control action sequence output equipment outside.

PLC can be used to control simple tasks are repetitive, or to interconnect with each other using a similar computer via a communication network to integrate the complex process control. Definition Programmable Logic Controller according Capiel (1982) are: electronic systems that operate digitally and are designed for use in industrial environments, in which the system uses a programmable memory for storage internally instructions to implement specific functions such as logic, sequence, timing, counting and arithmetic operations to control machines or processes through modules input-output digital and analog.

A significant advantage possessed by the PLC is a controller device that is the same and can be used in a wide range of control systems. To modify a control system and the rules of the exercise of control, which have to do is enter a set of instructions that differ from those used previously. Replacement of the control circuit is not necessary. The result is a device that is flexible and cost-effective.

2.3. Sensor

The sensor is a type of transducer used to detect or measure something, which is used to convert a physical quantity into another physical quantity or change a variety of mechanical, magnetic, thermal, and chemical beam into voltages and electric currents (Petruzella, 2001). Transducer from word "traducere" in Latin, which means change. So the transducer can be defined as a device that can convert an energy into

another form of energy (CS Rangaan et. Al., 1990).

2.4. Photoelectric Sensor

Working principle of pphotoelectric sensor is based on the reflection of light that received, due to a change in position or distance of a light source (infrared or laser) or its target, consisting of light source and receiver pair. Photoelectric sensor uses light to detect the presence or absence of an object. Detection occurs when the light beam of the sensor is blocked or reflected by the object is detected. There are three kinds of sensors that will evolve more specifically according to the needs of industry.

2.5. Diffuse

Inside these sensors are integrated transmitter and receiver. This type of sensor sensing distance is relatively short between 2 other sensor types, ranging from 10 cm to 50 cm (adjustable and shared some types).

2.6. Retro Reflective

Retroreflective sensor uses reflective media (passive) or a cat's eye to reverse the beam of the sensors. This reflected light has a different polarization. This sensor has sensing relative distance farther than diffuse type.

2.7. Through Beam

The sensor beam has a pair of sensors consisting of emitter (transmitter) and receiver (receiver). The advantages of this type of sensor is has a very long sensing distance and a narrower angle sensing.

3. RESEARCH METHODOLOGY

3.1. Jig Concept before Improvement

Magneto is composed of a stator and rotor. The focus of this thesis is in the process of making the rotor especially the boss rotor check. Process boss rotor runout check is the checking process, diameter, and taper height of the rotor. For type 0 * A has a diameter of 85 mm with a tolerance allowed is +0.1 mm. Likewise with runout tolerance +0.1 mm size. Tapper height has a size of 2.5 mm with a tolerance of ± 0:25 mm. Figure 2 shows an illustration magneto type 0 * A.

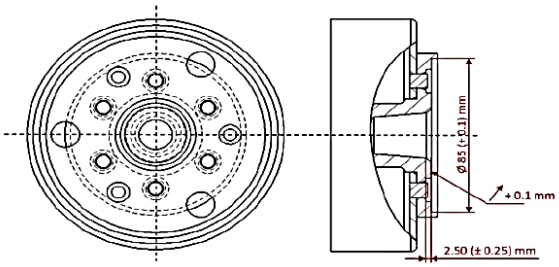

Figure 2. The illustration of magneto type 0 * A

Boss process rotor check swing measurement was performed using a jig. This jig consists of a stand to hold the rotor and two dial to make the measurement. Dial used with accuracy 0.01 mm. Figure 3 shows the inspection jig before the improvement, the swing measurement jigs used on the boss rotor check.

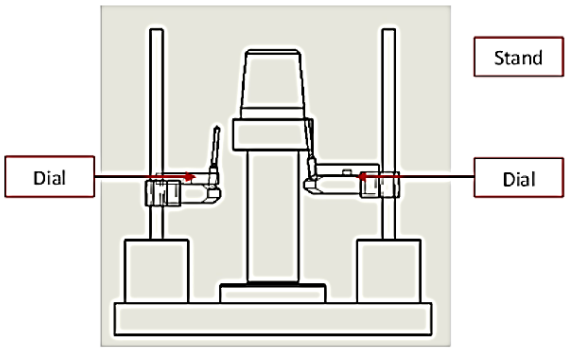

Figure 3. Inspection jig before improvement

Inspection tapper height indirectly was done by using part of the stand when the magneto screwed into the jig. Stand in diameter that has been adapted to the size of a standard magneto. So if the size of the products does not meet the standards, then the indicator pointer will not point to zero when the product is installed on a jig. While runout and diameter measurements using two dial. Figure 4 shows an illustration position dial on the product.

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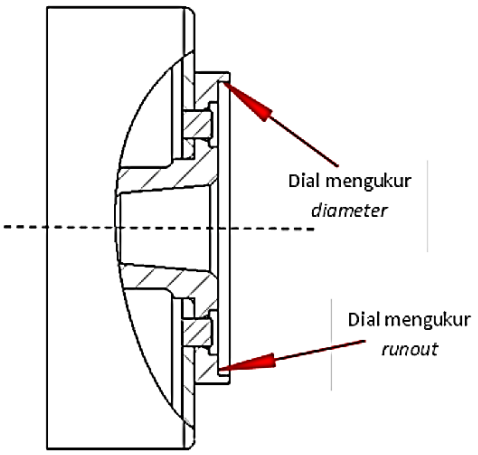

Figure 4. The illustrations position dial on the product

3.2. The problems that occurred in the Machine

Based on the analysis of the problems that occur in the process of boss rotor check there are three, namely:

1. Dial is not visible as it is covered by the product, so the operator the trouble to read the dial indicator pointer.
2. Because it is still using dial, there are no indicators of product good or no good so the result is very dependent inspection with the operator while reading pointer dial indicator.
3. Checking the height taper only use the stand, so it is not visible whether the product is good or no good.

Figure 5 shows the process of boss rotor check.

Figure 5. the process of boss rotor check

3.3. Planning for Machine Improvement

Based on the concept that has been analyzed, then made the design of the machine in accordance with the concept of such improvements. Figure 6 shows the design of the machine.

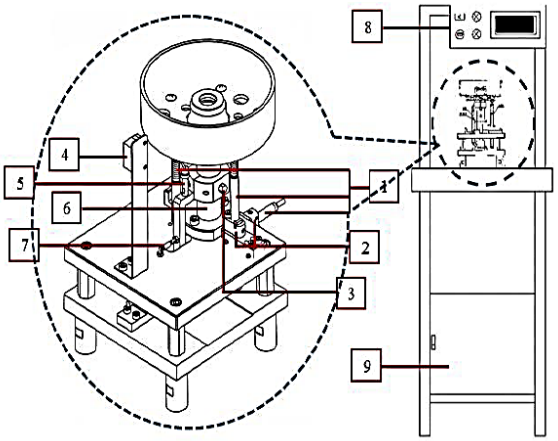

Figure 6. The design of auto judgement check machine

The description for the design of auto judgement check machine, i.e:

- Sensor head: to check tapper height, run out, and the diameter.
- Mounting bracket: for gripping the sensor head.
- Fiber sensor: to check the product turnaround.
- Photoelectric sensor: to check whether or not the product.
- Contact offset: as an extension sensor head.
- Stand: as a buffer product.
- Spring: to restore contact offset to its original position.
- Control Panel: as a HMI, the indicator light and buzzer.
- Main Panel: as a component of the control (PLC, power supply, and other electronic components).

4. DESIGN AND TESTING

In the design of electrical and control systems, it used tools that can support the performance of the machine. Figure 7 shows a block diagram for design of control system machine.

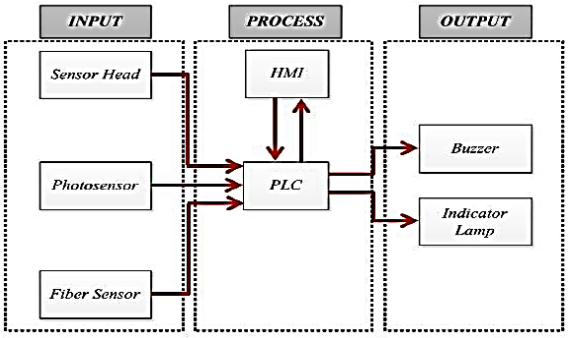

Figure 7. Design of control system machine

4.1. Control System Design

In a auto judgment check machine, the PLC consists of a power supply Keyence KV-U7, the CPU unit Keyence KV-1000, Keyence KV-input module B16XC, and output module Keyence KV-B16TC interconnected. Figure 8 shows the power wiring diagram PLC. External input module used is Keyence KV-B16XC. External output module used is Keyence KV-B16TC.

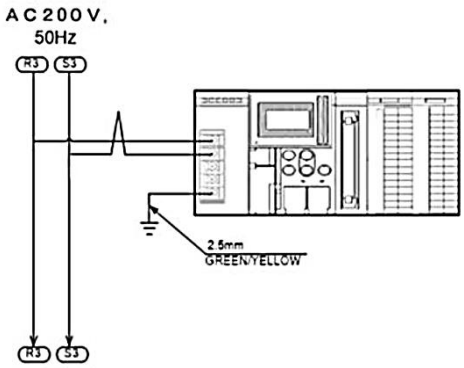

Figure 8. Wiring of PLC diagram power

4.2. Wiring of the Human Machine Interface

Wiring of HMI touch screen Keyence VT3- W4T type is intended to connect a touch screen with PLC voltage source. Figure 9 shows the wiring HMI.

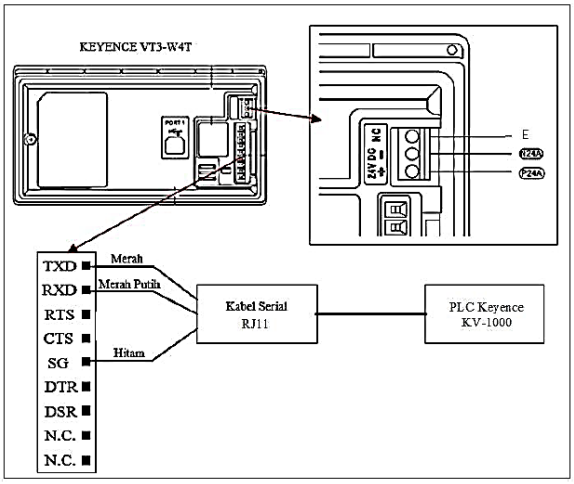

Figure 9. Wiring diagram of Keyence VT3-W4T

4.3. Testing

The control system has been designed and all input devices and output devices installed on the machine to go through the testing phase. Testing is done to discover any potential or cause system failure. The test measures machine working system check auto judgment is described in the following, i.e.:

- Machine work as a desired sequence.
- Normal conditions.
- When the machine is turned on, the screen of HMI and indicator lights on the PLC, sensor and amplifier are ON.
- At the time of selection of the type in the HMI screen, do not select more than one type.
- When the product is installed, the indicator light turns on and the screen displays the photosensor product indicator good or no good.
- Inspection taper height walking and taper height no good if there are indicators on the display and activate the indicator lamp and buzzer.
- If the display shows that the taper height OK then no indicator active NG (Not Good).
- When the operator rotate the product, the indicator moves padalayar.
- After several plays, If products NG indicator of products on display will be active with the buzzer and the red

indicator lamp is on, and if it's OK just green indicator lamp is active.

- Once the product indicator is on, the screen will display the cycle time and the amount of product good or no good.
- When the product is removed from the machine all the indicators are off.
- The condition is not normal, if no product is installed, the indicator of the product on the screen can not be active.

5. RESULT ANALYSIS

Based on the testing result, it shows whether the results are as expected or not. Auto judgment check machine is made to replace the swing measurement jig on the rotor boss check. It is necessary for trial if the machine detects the auto judgment can check the product good or no good. Here are the results of a trial which contain comparative measurements using manual methods (using dial) and measurements using the machine check auto judgment. Figure 10 shows auto judgement check machine.

Auto judgement check machine has *an indicator lamp* and *buzzer* to sign the *good or no good product,* so the inspection is free from operator visual check. In HMI, this machine has also *cycle time* and *counter* indicator that show the number of both *good* and *no good* product has been inspected.

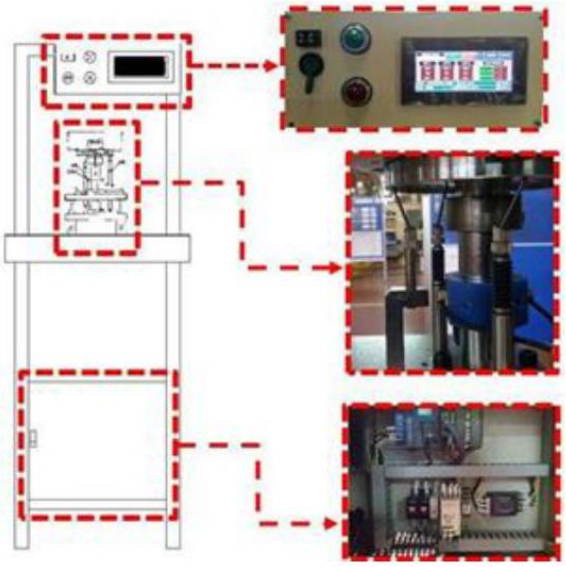

Figure 10. Auto judgement check machine

6. CONCLUSION

This paper have discussed about the research on the design of the machine control system check using the auto judgment Keyence KV-1000 PLC that communicated with Keyence VT3-W4T HMI as a device process. The sensors used for the inspection diameter, runout, and taper height is 3 pieces Keyence sensor GT2-P12 are connected to the amplifier GT2-71N. These sensors produce analog data is then processed by the amplifier into digital data. Amplifier send data to the PLC for further processing so that it can be displayed on the HMI and activate the indicator light and buzzer. If the product is good then the green light will come on and if the product is no good red light comes on and a buzzer will sound. In addition, the machine's potential for human error can be eliminated.

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