

## Control Systems Modification in Height Lever Checker Machine Using the Laser Sensor

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**Abstract:** In this study, it discusses the problems in an automotive manufacturing company. Automotive parts clutch cover is one of the company's manufacturing products. Height lever checker machine is a machine that used to check the height of the spring sun, contained in the coupling house. This machine consisted of a powerpack, control components and a dial indicator. The problems that occurred in this machine is an increase in demand for home products clutch of 700-900 pieces per day, therefore, it is necessary way to reduce cycle time on the line. One way is by modifying the system checks of the machine height lever dial indicator into the laser sensor. The new machine should be able to reduce the cycle time of 4 sec so the cycle time on the new machine gets maximum of 20 sec. Replacement machine is made consisting of a laser sensor as a tool to check the height of the spring sun previously using a dial indicator. PLC (Programmable Logic Controller) controller system uses Mitsubishi Q series to enter the process and output, HMI (Human Machine Interface) as the display information in the process and as entering the data. These modified machines can reduce cycle time of up to 4 sec so as to increase production capacity and maintain the quality of products produced.

**Key words:** Height lever checker machine, laser sensor, control systems modification, cycle time, quality

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### INTRODUCTION

This research was conducted in a manufacturing company that produces some automotive components. Among the automotive components, namely: body related parts, drive train and engine parts. One of the components of automotive drive train is divided into sections clutch cover and clutch disc. Drive train is used as a successor to the power of the flywheel (driving shaft) to a driven shaft in which the input rotation will be the same as the output rotation. In the drive train, there is the clutch cover. The clutch cover works as the transferor power from the flywheel passes disc clutch transmission gearbox to the car. This product serves as a determinant of whether power from the flywheel successfully transferred or not. Therefore, to get a quality clutch cover, it requires tools with a high level of accuracy.

An automotive part clutch cover is one of the company's manufacturing which growing rapidly. The clutch cover products are supplied to meet local and export markets. To meet the demand for products delivered in accordance with the local and export market demand, the products and quality checks carried out in accordance with established standards. One of the checks

carried out is checking the height of spring or the spring sun diaphragm linking products with gearbox transmission clutch cover. In the process of checking there are some problems that are found. The problems found in the process of checking the flatness of altitude diaphragm spring or the spring sun that previously were manual with a dial indicator and then using a gripping clamp clutch cover to make the checking process. In the process, the resulting cycle time is 24 sec while the line assembling clutch cover 2 wants to increase the amount of production capacity. So, it needs a way to reduce cycle time on the machine.

Thus, this research relates to the modification of the machine height lever check in order to reduce cycle time and maintaining product quality using the laser sensor, how to design and create a program for the machine to process the home clutch to be processed and according to production requirements and how to design and make the machine in order to reduce the cycle time of production.

In previous researches, Ardi *et al.* (2015, 2013), Valencia and Rossiter (2011) and Putman *et al.* (2015), it has designed the various sensor applications on the machine automation PLC-based in manufacturing industry

and also using the HMI (Human Machine Interface). Valencia and Rossiter (2011) design an auto-tuned predictive control based on minimal plant information using PLCs. Putman *et al.* (2015) design virtual fusion by integration virtual components into a physical manufacturing system.

**MATERIALS AND METHODS**

**Manufacturing process products:** The manufacturing process coupling house has several stages of the process that must be followed from the initial stage (stamping) to be the product finished product. Figure 1 shows the flow process of clutch home manufacturing.

**Assembling line:** Assembling line is line for manufacturing clutch home assembly. Assembling process is a continuous process of sub-assembling for processing workpieces in accordance with the existing process flow. The number and type of construction as well as machinery and other equipment needed in the assembling process is very varied in accordance with the demands of process flow. The process of assembling the workpiece is an advanced process to assemble the parts. After the assembling process, part directly into a good finish.

**Assembling line of clutch cover:** In assembling line of clutch home, there are some of the machining processes. The processes are contained in the assembling line clutch cover, among others: flat river caulking, balancing, balance caulking piece, lever copying, height lever check, release load and load character check. Figure 2 shows the assembling processes of the clutch cover.

At the clutch home assembly process, there are 8 steps in processes. In line assembling clutch cover 2 increased demands for the product which it occurred in product demand of 700-900 pcs per day. While the line on the line capacity is still low, so the improvement is necessary in order to increase line capacity by lowering cycle time machine, one of which is to decrease the cycle time machine check height lever found on line assembling clutch cover 2. Based on the sequence of work processes clutch assembly cover, there are the problems faced on the line that is located at the height lever check.

For the process of checking the elevation height check using dial indicator lever yield cycle time of 4 sec. While the repair process using the lever adjuster is not modified by the machine check new height lever because the process is contained in the new machine and the old.

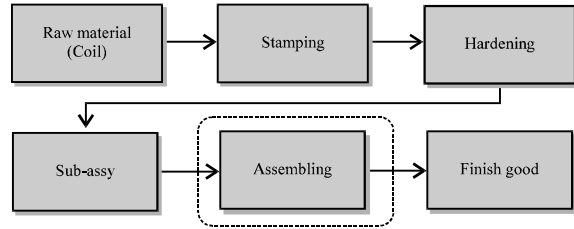


Fig. 1: The flow process of clutch home manufacturing

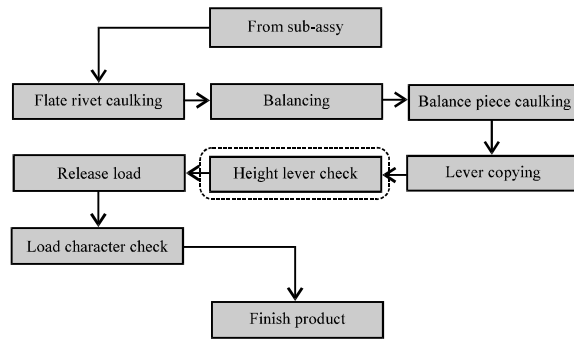


Fig. 2: The assembling processes of clutch cover

Therefore, it needs to be modified to reduce cycle time in the process. Modifications made on this machine are to replace by checking products using a dial indicator with a laser sensor system.

**Height lever check machine before modifications (manually):** Height lever check is a process to check the flatness of altitude on diaphragm spring lever found on the home clutch whether the parts according to the standard height of lever between one another. Height lever check process is performed by using a machine, it called height lever checker machine. Figure 3 shows the height lever check machine before modification.

The height lever checker machine in clutch cover on the line is operated manually by the operator. This machine consists of a jig, clamping and dial indicators, selector switches to select mode 3 or 4 clamp as well as push button for on-off clamping. In this machine, there is a panel box containing electronic components to control of the movement of the clamp.

**Working principle of the height lever check machine before modifications:** The working principle of the machine is associated with a sequence of the work done by the operator, processing systems and motion actuators. Based on the condition of the machine first, we did an analysis using fish bones. From the analysis of the fishbone diagram, it can be concluded that the old

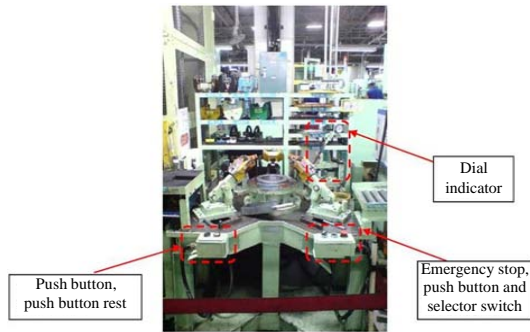


Fig. 3: The height lever check machine before modification

machine has many drawbacks, causing the length of time the process of checking the spring part sun in the house the clutch. It can be concluded that the necessary modifications to the machine. Modifications were done is to change the system of a dial indicator checking into a laser sensor which then transforms the entire control system on the old machines.

**Comparison between dial indicators with laser sensor:**

Based on previous data it can be seen that there is a change in the system of checks that cause system-wide change control. It needs to do a comparison between the old measuring tools in the form of dial indicator with a laser sensor. In this case, dial indicator can be used immediately and requires only periodic checks whereas for shorter range than the laser sensor. For laser sensor has a longer range than the dial indicator and maintenance-free while for the use needs to be done the right settings to match the desired result.

**RESULTS AND DISCUSSION**

**Design:** Based on the desired specifications, so we designed a modified the height lever check machine automatic. Figure 4 shows the design of layout the height lever check machine modified. Based on Fig. 4, there are many differences from the previous machine. There is a new mechanism which is a modification of the previous machine. For more details, here are the parts of the layout machine lever height check modified: main panel; clamp; hydraulic set unit; motor DC, encoder and cylinder; display panel unit.

**Pneumatic circuit:** Height lever check machine use a pneumatic cylinder to drive the new checking mechanism.

**Hydraulic circuit:** In the height lever check machine is using a powerpack. Powerpack is a driving source that is

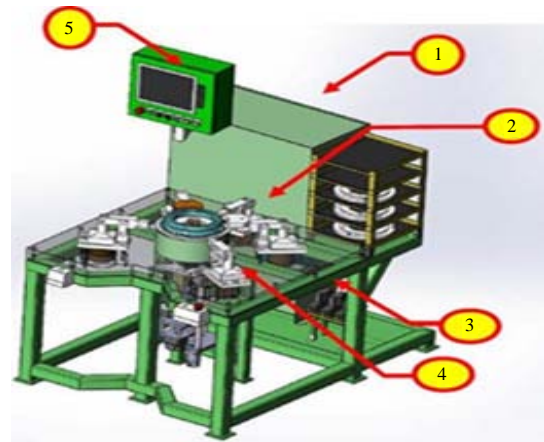


Fig. 4: Design of the height lever check machine automatically

used on this machine to drive the hydraulic cylinder that is used to clamp parts clutch home. Powerpack is used to locally make while the solenoid valve is used to artificial toyooki. Locally made system power pack consists of a motor, tank, filter, oil cooler, pressure relief valve, pressure gauge, 4/3 solenoid valve and hydraulic cylinders. In this case, for example, to select the use of 3 or 4 clamps, then use the button on the HMI menu section of the manual.

**Design for programming:** Having done the design of the program, it divided into two major parts, namely: manual mode and automatic mode. Here are the explanations.

**Manual mode:** In the manual mode, the machine is designed to move in accordance with a command from the operator. Operators can perform machine control in accordance with the button on the control panel.

**Automatic mode:** In this mode the machine can do the appropriate clamp, selected in accordance with the products you want processed. Running program is a program that is used when the machine can be run in accordance with the commands given without any error. Auto mode is divided into several parts: select clamp, error detection and the program running.

**While the function of each part of the program, namely: error detection:** Before the motion in accordance with the clutch cover, the machine needs to detect environmental conditions so that in accordance with security requirements and other requirements that have been determined. A prerequisite is the machine can run while the electric power is on, the wind pressure is appropriate and the jig according to the clutch covers to be

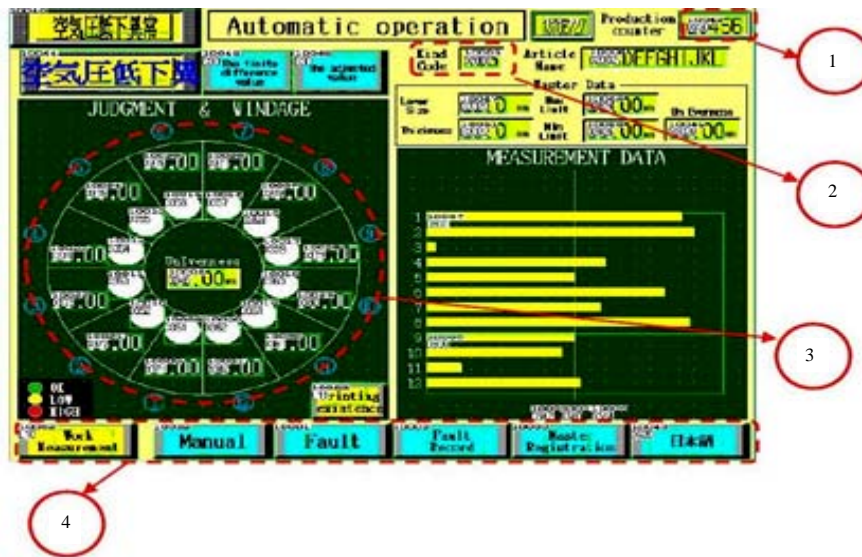


Fig. 5: Touchscreen display on the height lever check machine

processed. If one of these conditions is not met, the machine will detect the error and alert notification through signals through a pilot lamp or tower lamp and buzzer.

**Choose the clamp:** Select the clamp is part of a program used to make the selection of the type of clutch cover clamp to be processed.

**Program running:** The height lever check machine will execute the program to run the process in accordance with the type of product.

**Control systems:** Based on the needs desired by the industry, we designed a machine with a control system based on PLC controller. As the main control, PLC will control the various inputs and outputs. PLC controller will receive a trigger from the input module and the sensor button and then all inputs will be processed by the PLC controller and executed in accordance with a program that has been compiled to PLC controller. The control system comprises: a controller center, input modules and output modules.

**The display of HMI touch screen:** Design HMI display on this machine serves to see the condition of the machine and to perform a specific function settings. HMI display is the result of the check lever height which is processed by the PLC controller and displayed on the HMI. Before starting to design an appearance on the HMI, there are several variables that need to be regulated when we create a new project in the GT Designer software 3. After configuring the HMI display, it creates the look which is required by the machine. Figure 5 shows an example of a

touchscreen display on the machine height lever check. Based on Fig. 5, there are many functions that are on display of the automatic operation lever height check machine. Number 1-3 are numerical display, number 4 is screen switching.

**The programming design:** Before designing the programming, firstly we performed the analysis of the machine work system or flow process. PLC programming is based on the working system of the machine. Machine work system is influenced by the work steps the operator and standardization performed by maintenance. This machine is divided into two main modes, namely: manual mode and automatic mode. In auto mode, only a few buttons on this machine that can be used are: the start button and emergency stop button. In this auto mode, the machine in accordance with the movement of the workpiece is selected. Meanwhile, the manual mode is used to control the machine with buttons that have been there as needed, for example to select clamp used in the process. Before executed mode selection, the operator has needed to turn on the water pressure, turn on the ELCB (Earth Leakage Circuit Breaker) and press the button on the master. When the machine has an error such as emergency stop interruptions during the process, the operator must perform the work steps in accordance with the process flow. First, turn off the emergency stop by the operator. After that, the operator presses the reset button buzzer. Buzzer reset button will reset the buzzer. The reset button will reset all error indicators such as: lights and a master reset on. Then, the operator returns the machine to the position of home position by pressing the returns and manual aux.

**Testing:** This testing is testing against several test components in detail. This testing was conducted to determine the abnormality in the manufacturing of tools that can be handled well. In this case, we do the job of testing machines (programming). Testing the machine work is a representation of the programming. Testing is conducted in the area of manufacturing companies.

Testing cycle process is conducted to test programming that has been compiled into PLC controller. Testing programming includes the process under the normal conditions, the auto system, manual systems, error detection systems, warning systems that exist on the machine. Testing the machine in normal conditions is done by conditioning the machine in standby position, then pay attention to indicators that should be on. Under the normal conditions, the machine does not receive input from the outside in the form of keystrokes.

Testing in manual mode is the testing done when manual mode is active. Tests in manual mode includes all the buttons are active. Testing auto mode is a test that is done when the machine is in auto mode. This means that the machine will move according to sensor detection performed by the machine and the machine will display a warning when the error is occurred abnormal conditions and other indicators automatically.

Error detection system that existed at the useful program to warn the operator or foreman in case of abnormality in a process carried out by the machine. Error detection systems that exist on this machine will be indicated by the touchscreen. Testing the system error is performed by the error in question, so the appearance of the touchscreen can be seen.

**Part measuring testing:** Testing is conducted on the results of testing the quality of the liver through the measurement part. Standard quality is the main lever height lever product plus  $\pm 0.90$  mm for lever in coupling home products dst-type and rivet-type with a maximum deviation  $\pm 0.50$  mm. This quality standard can be represented by a height measurement lever on the sun spring.

The height lever is obtained by looking at the difference between the high-altitude lever before the repair and after repair heights. Testing is conducted by the height of the house coupling dst-type and rivet-type of 20 time for each type of house in the clutch and take the average of each lever. Based on the results of the experiment 20 time the height of the lever, the lever heights are in accordance with the standards that none exceeds  $\pm 0.50$  mm.

**Cycle time testing:** Testing is conducted to test the results of changes in cycle time for modifications that



Fig. 6: The new modification machine

have been applied. In this testing, we conduct for 25 time for the same product. The desired standards in this experiment maximum cycle time of 20 sec. Based on the results of 25 experiments that have been done, the cycle time is already within the required standards. Cycle time produced no exceed 20 sec. From the results of the testing cycle time, it can be concluded that the cycle time is generated by the machine to meet the standard.

**Analysis:** Analysis of the results includes some components in accordance with the purpose of making tools. Analysis of these results will be reviewed based on the cycle time step of the operator and the machine condition after modifications. The main purpose of the new machine is to reduce cycle time. Therefore, we show the data cycle time on the height lever check machine after the trial on the machine.

The parameters used in this test are the same product that is dst-type. Based on the data, cycle time is reduced in the height lever machine trial check after check lever machine new height. Design the machine's height lever check can reduce the amount of cycle time due to the height lever check which is performed by the operator by 4 sec.

**The machine condition after modifications:** Figure 6 shows the realization of the machine that shows the parts as a whole. The front section which consists of: operation panel, clamp, push button and emergency stop. The other parts are: tower lamp used for machine indicators, touchscreen to display information machines and pressure switches to provide information when there is a decrease in air pressure.

The components are mounted on the control panel and wiring in accordance with the provisions of the

specifications. In this control panel can be seen laying each of the components are mounted on the control panel such as: earth leakage circuit breaker, circuit protector, power supply, relay, transformer, contactor and PLC controller.

### **CONCLUSION**

In this study, it has discussed about control systems modification in height lever checker machine using the laser sensor. The height lever check machine can do the job according to the demand of engineering, maintenance and production. The programming is used the software of GX Developer PLC by ladder diagram. The program consists of two operating modes, namely manual mode and auto mode and consists of an alarm system for machine safety process. Cycle time on the new machine could fall to 4 sec compared to the previous machine. In auto mode, the machine can process different types of parts and machines can work in accordance with the desired result. In the next this research, it required the addition of a sensor to determine the pressure of the incoming the hydraulic oil pump if the pressure drops, then the machine will not perform the process. A safety

system is required for water service unit and pressure switch, so it is not easily stepped or changed by others.

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