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Placement Sensor Modification of Photo Interrupter and ATDC Sensor on the Minolta Bizhub-421 Photocopy Machine

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ABSTRACT

Minolta photocopiers produce very good and reliable photocopier quality during their lifetime with the condition that the toner must be replaced with the original. If it is replaced by refilling, then refilling can only be done an average of three times. Meanwhile, replacement by refilling is needed by small and medium business units (SMEs) in an effort to save costs. Recharging that exceeds the average three times will cause the Minolta photocopier to have an error with code C032. Therefore, this paper was conducted to increase the frequency of the toner refill process as a solution for the Minolta Bizhub 421 machine to minimize losses due to interference with code C032. So, the machine can be refilled repeatedly without interruption, as well as adding error information via SMS using an Arduino microcontroller. Method was used experimental of placement sensor modification of photo interrupter and ATDC (After Top Dead Center) sensor. The results showed that after modifying the sensor placement, the number of refills could be increased to an average usage of toner exceeding 12 refills before the error code C032 occurred. This was because of the opto sensor was covered by toner powder and with an indicator that controlled the toner rotation it had reached set point. Then, with SIM 800L, which sends SMS and miss call notifications to users with a success rate of 98% and 2% error. Therefore, it helps users of the Minolta Bizhub 421 photocopier can more easily supervise the toner tube.

KEYWORDS: *Arduino microcontroller, Photocopier, Toner, Opto-sensor, SIM800L.*

1.0 INTRODUCTION

1.1 Background

Minolta photocopiers are made with the best technology, using an automatic control system equipped with maintenance and repair manuals. This photocopier is distributed throughout the world including Indonesia and there are almost no public complaints about using the Minolta Bizhub 421 photocopier. However, for users who take into account and consider the operating costs associated with replacing sensor parts or ink or toner filling control modules, as well as purchasing bottles filled with original toner, are considered to be detrimental, but at risk for the duration of use. This research was conducted to get the best solution so that the occurrence of interference on the part of the developer can be minimized. A number of sources related to this research have been declared successful using photo interrupters and ATDC (After Top Dead Center) sensors. The photo interrupter sensor is a sensor that functions to count the number of rotations of the toner tube and the ATDC sensor is a sensor that controls the process of filling ink (toner) into the hopper.

According Hirayama [1] succeeded in making a settling toner meter, consisting of a toner quantity detector configured to detect the amount of toner in the toner layer on the surface of the toner carrier component based on the detection results of a change in capacitance detector. According to Wijayanti [2], successfully used the optocoupler sensor to test wind speed and direction. Yanti [3] succeeded in using an optocoupler to measure wind speed. Permana [4] managed to use the photo interrupter sensor to measure Arduino-based rain. According Derek [5] succeeded in designing a wind speed measuring device using an optocoupler sensor based on the Arduino Uno microcontroller. Arief et al. [6] with the same method has been succeeded to improve the quality of palm oil in Indonesia because of the separation system of processing method by applying the automatic separation system by using a microcontroller. Hamzah et al. [7] conducted research regarding with the same field and different topics. It is clear that a process of separating palm kernel from the bunch by way of slamming into a rotating drum by applying a microprocessor based on an instrument that can be programmed to control the machining process automatically resulting in improvement of production [7]. Laka et al. [8] conducted research for e-waste

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PC can be processed and reused, which used as a machine prototype computer numerical control (CNC) three axes that can be used for studies. Imnadir et al. [9] also studied the applying an online process control system is crucial for enhancing machine efficiency and production quality during the Covid-19 pandemic [9].

Based on the results of the application of the optocoupler/photo interrupter sensor [1]-[9], monitoring or measuring the number of rotations using the optocoupler/photo interrupter [10],[11] can be used as further research material that is applied to the photocopier developer section. The optocoupler sensor is used to counter the number of toner tube rotations. In this study, the placement of the optocoupler sensor was placed in a different location or modified, so that the conditions that have so far made it easy to cover up dust or leaks in the toner tube can be minimized, with the aim that the life of the developer part can be prolonged without errors [12].

One of the main parts of the photocopier is called the developer part. This section functions as the process of pouring ink or toner into the hopper. The toner tube is replaced when the supply of toner in the photocopier runs out, which is indicated by an indicator appearing on the monitor display. The toner tube is rotated using a stepper motor.

When the amount of toner in the hopper has reached the minimum limit, the stepper motor should get a trigger pulse from the controller unit, so that the stepper motor works, which controls the toner tube to rotate, and the toner is poured into the hopper. At that time, it turned out that the photo interrupter sensor was not working, giving data that it detected a rotating toner tube. This is what raises the C032 error message, as a result, the controller unit stops the photocopier. This indication assumes that there has been an error in the photo interrupter sensor or it is not working which is considered damaged or does not produce a signal. The main cause after previous research was that the photo interrupter sensor was covered by dust or toner which leaked while rotating and hit the photo interrupter sensor. Purchasing a new toner tube as a replacement for a toner tube that has run out when using a photocopier is indeed recommended. However, refilling the toner cartridge with refill toner is very often done because most photocopier service users make far greater cost savings. In Figure 1 shows the condition of the interrupter sensor in the developer section.

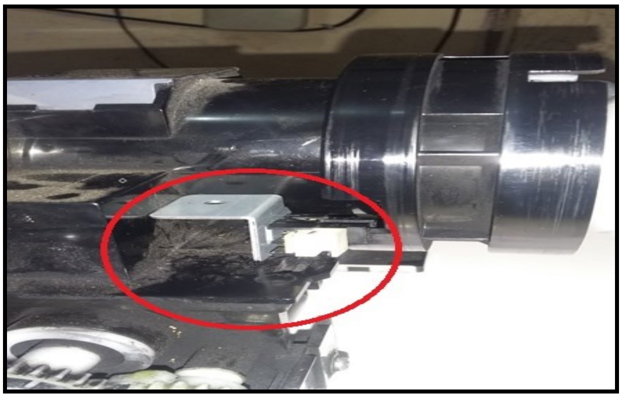

Figure 1: Condition of the toner tube

If this is maintained, then replacement of the toner bottle movement sensor spare parts requires quite an expensive cost, while the work process of the photocopier is delayed for a long time until the ordered parts arrive.

1.2 Basic Working Principle of Photocopier

In Figure 2 shows a schematic diagram of a photocopier component with an explanation. The belt (drum) inside the photocopier is made of photoconductors that control the placement of static electricity. In term to make an original paper copy, place it on a glass surface. Then the photoconductor belt (platen drum) is positively charged (but for some models it is negative) by winding it with a corona wire.

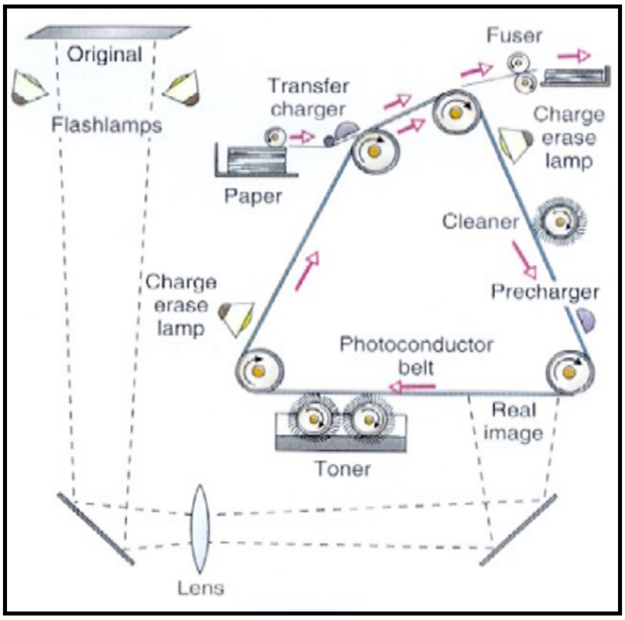

Figure 2: Image of the internal components of the photocopier

The following discusses the positively charged belt (drum). The light shines on the original. The black areas of the paper block light and static electricity stays in these areas while light is reflected in the white areas and the photoconductor (i.e. the belt) has to conduct electrons to neutralize the positive charge when light is shone on it. The positively charged belt (drum) region attracts negatively charged toner particles. Put white paper to make reproductions and filled with corona wire. Negatively charged fans are attracted to the paper and form images. It is then heated and pressed to blend the image onto the paper creating the final copy. The charge image left on the drum is wiped off by opening the wiper lamp under charge and the toner is removed by the cleaner. Now ready to make another copy by repeating the procedure [4].

1.3 Toner Bottle Sensor Mechanism

The Toner House Position Detection Mechanism is shown in the following figure. The sensor detects the Toner Bottle in its original position. When the Toner Bottle is in the home (stationary) position, the toner supply port should be the same as the position shown in Figure 3.

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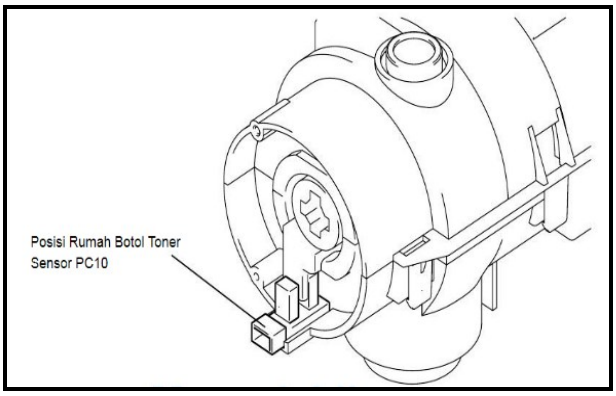

Figure 3: Toner Bottle

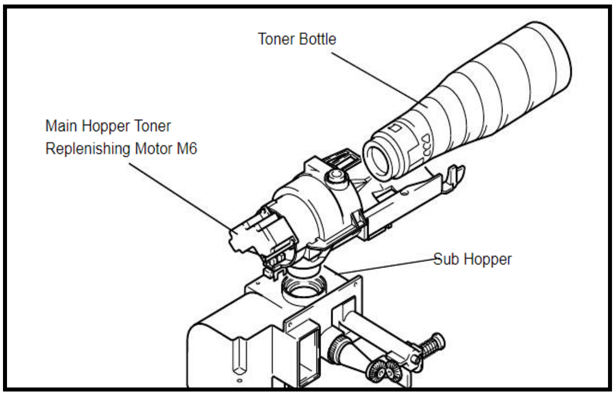

Figure 4: Sub hopper toner

1.4 The Working Principle of the Developer

The ATDC sensor transforms the T/C reference (14% conversion factor) to the proper voltage value and outputs it. Whether or whether the output voltage lowers in the region of 2.46 to 2.54 V, the voltage input to the ATDC sensor from the controller is set as a voltage reference. When the control is switched to T/C recovery mode, the Sub Hopper Toner Replenishing Motor is activated to replenish the Development Unit's toner supply. If T/C is not restored to 13% or higher (2.50 V or less) within a particular time frame, empty toner is produced. With the following run times: 35-cpm photocopier = 150 s; 25/20-cpm photocopier = approximately 209 s; 20-cpm photocopier [13].

1.5 Toner Controller Refilling

The ATDC sensor detects the developer's toner-to-carrier (T/C) ratio in the Devel-operating mixing chamber. The LED emits infrared light onto the toner. There is a phototransistor that converts the intensity of the light reflected from the toner to a suitable voltage value and outputs. The T/C is determined based on the value of output voltage. The ATDC sensor auto adjustment to the reference value for the ATDC sensor that is automatically adjusted, which is described below using the ATDC sensor auto adjustment mode. Install a new I/C can puts the photocopier into ATDC sensor auto-adjustment mode. However, the I/C motor rotates, the ATDC T/C sensor samples. According to the read of photocopier provides the controls: T/C (%), more than 19, 14 to 19, 13 to 14, 12 to 13, 10 to 12, 7 to 10, less than 7, toner filling represents sub hopper toner replenishing motor operation [13].

1.6 Main Toner Hopper Refilling Mechanism

Hopper Main Discharge Charge Booster provides a boost to supply toner from Toner Bottle to Sub Hopper. Toner is refilled whenever the Sub Hopper Toner Empty Switch (S4) provided in the Sub Hopper is moved and deactivated [13].

1.6 Refilling Mechanism of Sub Hopper Toner

The sub hopper toner replenishing motor feeds toner from the sub hopper to the developer mixing chamber. The toner refill time is determined according to the T/C reading.

1.7 The Hopper Detection as Empty

If the T/C is not found at a level of 13% or higher within a certain period of time after the photocopier has entered T/C recovery mode, an empty toner state is detected. With run time: 35-cpm photocopier = 150 s; 25/20-cpm photocopier = approx. 209 S. If, the T/C drops below 7% as a result of making additional copies after the toner is empty, Dition has been detected from the Sub Hopper, a faulty ATDC Sensor results and the photocopier displays a corresponding fault code. Magnetic carriers and toner are utilized to develop the electrostatic latent image created on the photoreceptor to generate the image in conventional electrophotographic image production device. When utilizing a dual component developer, just the toner in it is utilized during image formation, reducing the developer's toner density. Toner density must be detected in electrophotographic image-forming apparatus in order to provide toner if the observed toner density is less than a specified reference value [13],[14].

1.8 Photo Interrupter

An opto-interrupter also known as a photo interrupter is a transmission-type photo sensor that integrates an optical receiver and a transmission element in a device package. The components consist of a molded plastic housing with an IR LED facing the phototransistor in the slot. Any object in the gap will interfere with the IR beam and consequently switch the phototransistor on and off. This device is very fast and ideal for calculating, timing, or sensing. It is widely used in optical switches, ATM machines, vending machines, edge and position detection, and office automation equipment [12].

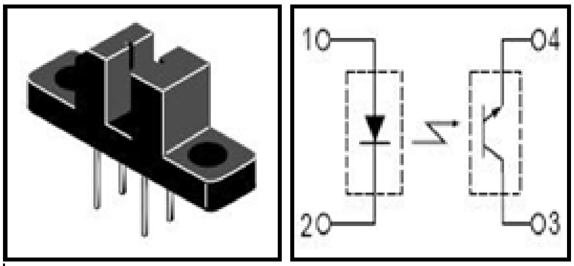

Figure 5: Photo-interrupter

The photo-interrupter has a working principle that is almost the same as the optocoupler [8]. However, the photo-interrupter can be used to detect whether there are obstacles between the transmitter and receiver. Photo-interrupter works with the following logic: when there are no obstacles, the infrared light emitted by the IR LED (transmitter) can be received by the phototransistor (receiver). So that the output of

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the photo-interrupter will be HIGH logic, "1" When there is an obstacle, the infrared light emitted by the IR LED (transmitter) cannot be received by the phototransistor (receiver). So that the output of the photo-interrupter will be logic LOW, "0".

1.9 Use of ATDC Sensor to Determine the Toner Density in the Hoper

The ATDC sensor can be used to detect the supply of the amount of toner in image formation equipment with high accuracy of the toner density in the developer device. The image formation apparatus includes, according to this aspect of the invention [1], a first development device incorporating a first developer whose spectral reflectance of the toner and magnetic carrier is unanalogous, and a second developing device incorporating a second developer whose spectral reflectance of the toner and magnetic carrier is unanalogous. Parameters that change as the toner density of the first and second development devices varies are observed. As a result, the relationship between the detected parameters and the real toner levels or toner supply quantities can be identified. It is believed that the first and second developers differ over time yet are almost identical in the same setting.

The second kit's toner supply quantity is determined from the relationship between the actual toner supply density or quantity and the detected parameters of the first development kit. The toner is supplied to the second development device according to the specified amount of toner supply, so that the toner can be properly supplied. Toner density can be maintained precisely. The image forming apparatus forms electrostatic latent images at the photoreceptor according to digital image signals, and includes a number of enhancements for developing electrostatic latent images using a dual component developer consisting of toner and a magnetic carrier.

The image forming apparatus contains the first development apparatus, which incorporates the first developer and has an unanalogous spectral reflectance of the toner and magnetic carrier. A second development device incorporates a second development for which the spectral reflectance of the toner and magnetic carrier is similar, and the total toner consumption of the first and second developers is estimated based on the information density included in the digital image signal.

The optical ATDC supplied toner to the earliest development devices. Hence, a relationship may be discovered between the quantity of toner consumption estimated from the digital image signal and the actual supply of toner to the first developer. For the first and second developing solvents, it is assumed that the connection between the estimated toner consumption quantity and the actual toner supply quantity is practically same. Based on this assumption, the second developer's toner supply quantity can be estimated by applying the second developer's toner estimate to the relationship between toner consumption and toner supply. Toner density in the second development device can be correctly maintained by feeding toner to the second development device in accordance with the calculated amount of toner supply [1].

2.0 RESEARCH METHOD

The focus of this research is based on error code C032, namely research on the toner control assembly module, and testing on the photocopier directly. This method is carried out to ensure that the modifications to be made can actually be applied to a real photocopier.

The photocopier has one main part, namely the developer part. The developer section consists of a toner bottle drive section using a stepper motor, photo interrupter sensor and ATDC sensor. This part is shown in the Figure 6.

Figure 6: photo interrupter sensor and ATDC sensor

2.1 Hardware and Software Design

The research design included the type of Pretest-Posttest Single Group (The One Group Pretest-Posttest). Namely, the experimental design carried out on modifications to the placement of the opto-interrupter sensor which is installed on the outside of the Minolta 421 copy machine developer section. Before modifications are made, an initial test (pretest) is carried out on what causes the opto-interrupter sensor to interfere with work then after modification and measurement (posttest).

The data is obtained on whether there is an effect on the error signal shown on the monitor display so that the experimental results can be known. The placement of the photo interrupter sensor is installed close to the toner tube on a photocopier, which often experiences interruptions or errors. The toner tube control research design with Arduino uno using an opto-interrupter sensor is shown in Figure 7.

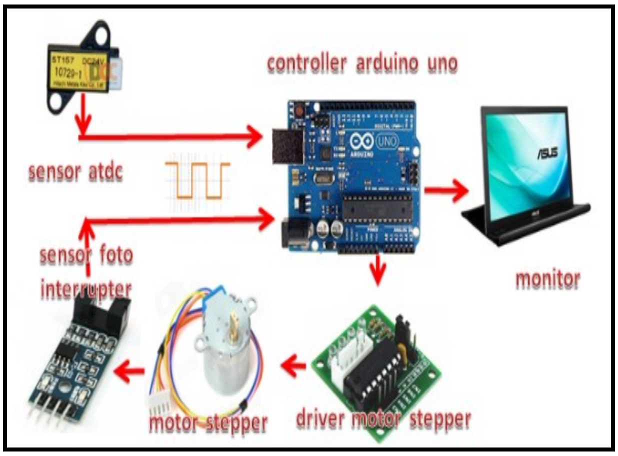

Figure 7: The toner tube control research design with Arduino uno using an opto-interrupter sensor

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2.2 Design of a Toner Tube Drive Using a Stepper Motor

Moving the toner tube with the Arduino controller module is carried out in several stages; the first is assembling the stepper motor driver circuit with Arduino, the second is loading the code on Arduino, doing the testing, namely setting the stepper motor rotation speed. Stepper motor is a type of dc motor controlled by digital pulses. The working principle of the motor stepper is changing electrical pulses into a discrete mechanical movement where the motor the stepper moves based on the given pulse sequence to the stepper motor [15].

The stepper motor in this research was the dc motors, whose motor movement was driven by digital pulses. These digital pulses were then converted into mechanical movement. The movement is based on the sequence of pulses given to the stepper motor. The components required are Arduino Uno [16-17], stepper motors, and ULN2003 drivers.

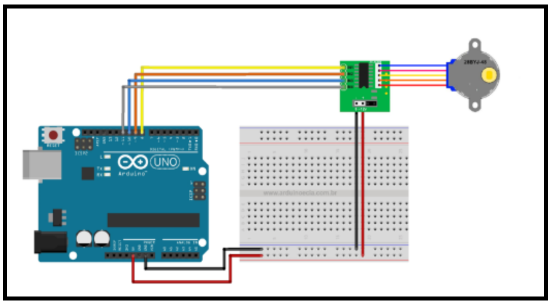

Figure 8: Toner tube drive circuit using Arduino

Design of a stepper motor drive circuit with Arduino. Connecting the driver to Arduino is +ULN2003 to 5V Arduino, – to GND, IN1 to Pin 8, IN2 to Pin 9, IN3 to Pin 10, IN4 to PIN 11. In the Arduino IDE itself, the example code is available, File >> examples >> stepper [13]. There are several code examples including motor knob (rotation is regulated by a potentiometer), one revolution (turns 1 full rotation in alternating directions), one step at a time (rotates 1 step at a time), speed-control (adjusts the rotational speed of the motor). Set the number of rotations of the motor and immediately stop. Because in the example there is no code to stop the rotation of the motor, in this code, tested setting the number of times the motor rotates and will stop until the desired condition. The result of the code is to test that the motor will rotate two full rotations and will stop when it reaches certain conditions.

2.3 Detect the Number of Revolutions of the Toner Bottle

To detect the number of rotations of the toner bottle, the following steps are carried out, namely; Assemble the interrupter photosensor interface circuit, load the code on Arduino; Do the test, namely reading the rotation of the toner bottle. The 28-BYJ48 type stepper motor has a Gear ratio of 64, and a Stride Angle of 5,625 ° so this motor has 4,096 Steps. Calculating the number of steps or steps is done in the following way; Steps = Number of steps in One Revolution * Gear ratio. steps = (360 ° / 5.625 °) * 64 "Gear ratio" = 64 * 64 = 4096. This value will be used in the Arduino Sketch with the command "int steps left = 4095; "Connection of sensor relationships with Arduino, namely; VCC: Module power supply from 3.3V to 12V, GND: Ground, D0: Digital signal of the output pulse, A0: Analog signal of the output pulse. Output signal in real-time. (Usually not used).

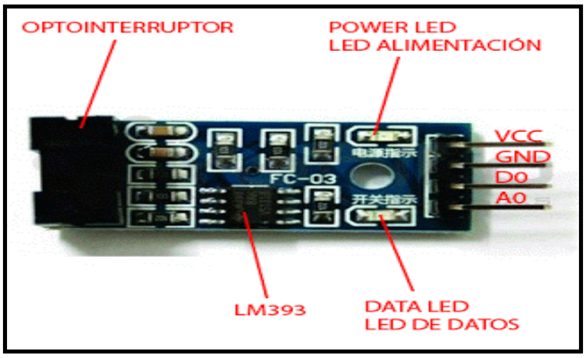

Figure 9: the main part of the encoder

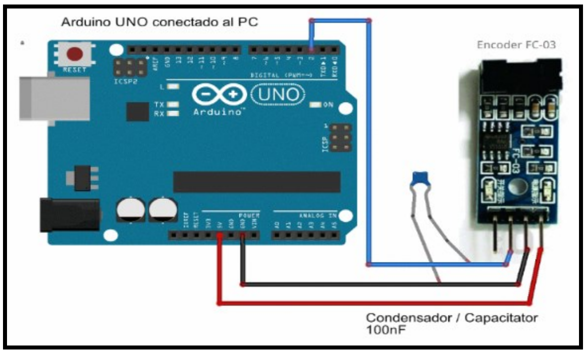

Figure 10: Toner tube rotation detection circuit with Arduino

In Figure 10 shows how to use the FC-03 encoder or FZ0888 encoder (infrared speed sensor module with LM393 comparator) or opto-switch. The process of calculating the rotational speed of a wheel by placing a rotating ring gear onto the wheel. The basic operation of this sensor is as follows; If anything passes between the sensor slots it will create a digital pulse on the D0 pin. Pulses range from 0V to 5V and are digital TTL signals. Then with Arduino read the pulses.

2.4. Toner Bottle Speed Test Circuit with Arduino

A photo interrupter specially designed to connect with Arduino is already available in the form of a module shown in Figure 10.

2.5. Reading Toner Tube Rotate with Interrupter Photo Sensor

Program to digitally read the sensor value since it is a digital sensor output. The output is 0's and 1's. When there is a constraint between the interrupter modules, then the output will be 1 otherwise it is 0. For example, take a piece of paper and insert it between the slots. You will see that the value changes from low to high i.e. 0 to 1.

2.6 Interface Arduino Uno to Relay

A relay is a switch that is operated electrically and is an electromechanical component that consists of 2 main parts namely electromagnet (coil) and mechanical (a set of switch contacts) [10]. Relays use electromagnetic principles to drive switch contacts, so that the small electric current (low power) can conduct electricity with a higher voltage. When the Arduino provides a 5 V voltage to the relay, the relay will activate the dc motor which will rotate the toner.

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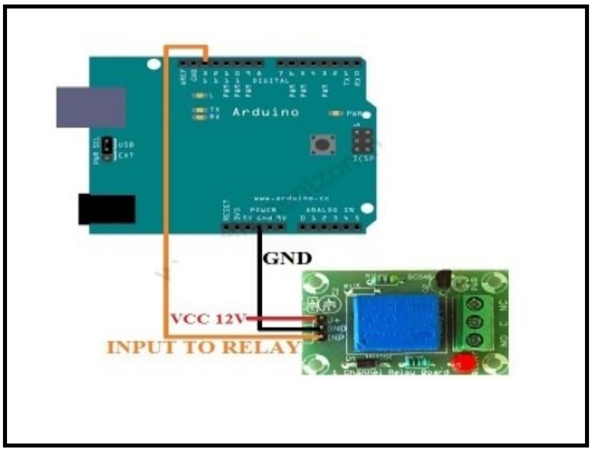

Figure 11: The relay is connected to the Arduino

2.7 Interface Arduino Uno to DC Motor

DC Electric Motor or DC Motor is a device that converts electrical energy into kinetic energy or motion. These DC motors can also be called Direct Current Motors. As the name suggests, DC Motor has two terminals and requires direct current or DC (Direct Current) voltage to be able to move it.

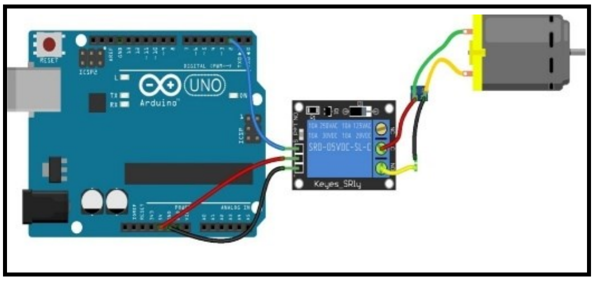
Figure 12: DC motor connected to Arduino

2.6 Interface Arduino to Sim 800L

The SIM800L GSM/GPRS is the part that functions to communicate between the main monitor and the cellphone. SIM800L GSM/GPRS is controlled via AT commands, AT-AT Command commands are commands that can be given by a GSM or CDMA modem to send and receive GSM/GPRS-based data, or send and receive SMS.

Image of SIM 800L connected to Arduino. Sim800L functions to send SMS when the toner rotation reaches 80%. Arduino sends an AT command to the SIM 800L with the syntax "CMGS" to send an SMS to the destination SIM card number. When the rotation reaches 99% of the set point, Arduino will send a signal to the relay to turn off the relay and stop the rotation of the toner tube. At the same time, Arduino also sends the AT command to the SIM 800 L with the syntax "ATD" to send the phone to the destination SIM card number.

3.0 RESULT AND DISCUSSION

Tests and measurements are carried out to prove whether the system that has been made works according to the company's standard specifications. In testing, measurements are carried out which will later be used to analyze the supporting hardware and software.

3.1 Modification of hardware devices for function testing

3.1.1 Opto-coupler Sensor Modification

The materials for detecting the number of toner rotations are designed with the sensor components and the perforated disc shown in Figure 13.

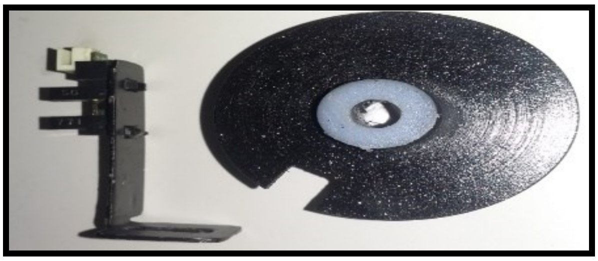
Figure 13: Sensor and disc

3.1.2 Placement Modification of the Sensor

In Figure 14 shows the placement modification of the sensor. It can be seen that the sensor is placed on the outside, by placing the perforated disk on the axis of the inner shaft which is in line. This is to prevent the sensor from leaking dust or toner ink when refilling or replacing the toner.

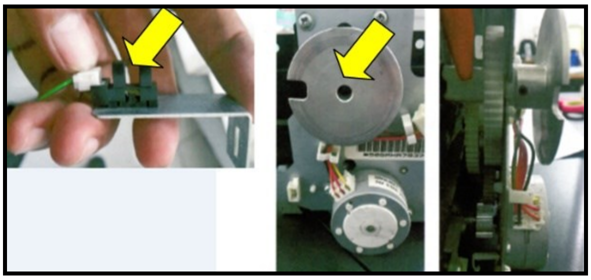
Figure 14: Sensor Location

3.2 Modification of the Developer Module

Preliminary testing before modifying the placement of the optocoupler sensor is tested first on specially assembled modules so that tests on photocopiers have full confidence that this can be done. The circuit or module is shown in Figure 15.

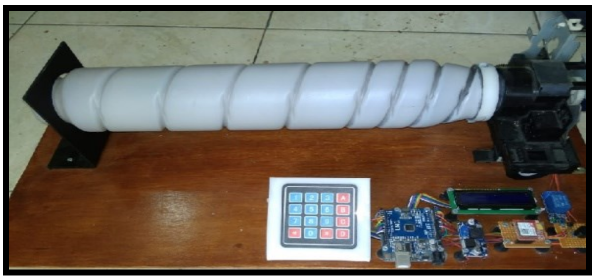
Figure 15: Circuit module

3.2.1 System Testing

After the design is done, testing is needed to ensure that the system that has been designed can run as planned. The parts to be tested are the toner rotation counter (which consists of 3 components, namely the relay, motor and photo interrupter sensor), output and indicator. Below is a picture of the system design.

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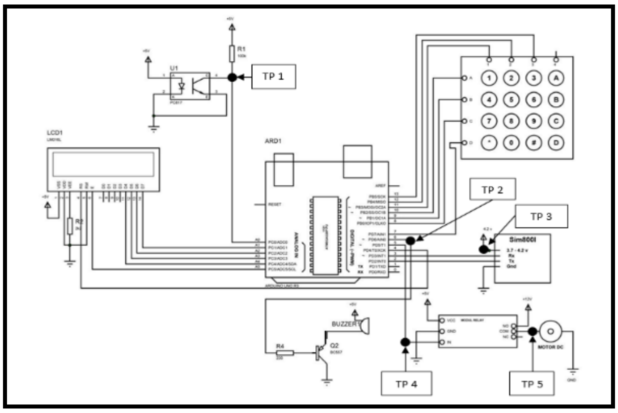

Figure 16: Toner process control system suite

3.2.2 Toner Cycle Counter

To find out whether the process of calculating the toner rotation is going well, tests and measurements are carried out on the 3 main components, namely: the relay, the motor and the photo interrupter sensor. Measurements on the relay are carried out at test point 4, namely pin 5 Arduino uno, measurements on the motor are carried out at test point 5, namely COM relay, and measurements on the photo interrupter sensor are carried out at test point 1, namely pin A0 Arduino UNO. The test and measurement results can be seen in the Table 1.

Table 1: Relay testing and measurement

Condition	Voltage	Logic
on	88.31 mV	0
standby	5.009 V	1

Table 2: DC motor testing and measurement

Condition	Voltage	Logic
Rotating	12.05 V	1
Non-Rotating	0.43 mV	0

Table 3: Testing and measurement of photo interrupter sensor

Condition	Voltage	Logic
With Resistance	4.7 V	1
Without Resistance	2.881 V	0

In testing and measuring relays, the voltage obtained when the condition is "ON" is lower than when the condition is "OFF". This is because the relay is actively working low. The reason why the relay is actively low is because the relay module works on the same principle as a PNP transistor where when the base leg is given a logic "0", the collector and emitter of the transistor will be connected, causing a switch. In testing and measuring the photo interrupter sensor, the results are obtained in Table 3. The measurement results show the voltage value in 2 different conditions.

The photo interrupter sensor will actually experience a change in resistance when conditions are blocked and unobstructed. Where when the sensor conditions are blocked, the light from the IR (transmitter) will not reach the phototransistor (receiver) and causes a high resistance value and the resistance value of the phototransistor (receiver) from the sensor is inversely proportional to the received light intensity. However, Arduino does not recognize resistance in reading data, so a voltage divider circuit is used to convert the resistance generated by the sensor into a voltage that can be read by Arduino as a controller. When the sensor produces a resistance of 135.96 kΩ, Arduino will read a voltage of 2.881 V which has logic "0" and does counting 1 and this continues until the rotation reaches the number of set points.

3.2.3 Outputs

The output of this system is SMS and miss calls sent by SIM 800L to the destination number. Measurements were made at test point 3 and after measurements were made on the SIM 800L to ensure that the module was working properly, the results were 3,997 V. However, the Arduino UNO only provides 3.3V and 5V output. Then an additional regulator is used to regulate the amount of voltage from the Arduino so that it can reach the working voltage of the 800L SIM, which is 3.7V – 4.2V.


Figure 17: Motor testing rotating and non-rotating condition


Figure 18: Image of relay testing "ON" and "OFF" conditions

Figure 19: SMS to cell phone

Trial SIM 800L in sending SMS and miscall can be seen in Table 4. It was conducted 10 times of test. From the experimental results in Table 4, it can be seen that the percentage of SIM 800L success in sending SMS is 98% and in making miss calls is 98%.

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Journal of Ocean, Mechanical and Aerospace
-Science and Engineering-
30th July 2023. Vol.67 No.2

Table 4: Trial SIM 800L in sending SMS and Miscall

No	Refill ink test	SMS	Miscall
1	Refill ink 1	Sent	Succeed
2	Refill ink 2	Sent	Succeed
3	Refill ink 3	Sent	Succeed
4	Refill ink 1	Sent	Succeed
5	Refill ink 5	Sent	Succeed
6	Refill ink 6	Sent	Succeed
7	Refill ink 7	Sent	Succeed
8	Refill ink 8	Sent	Succeed
9	Refill ink 9	Sent	Succeed
10	Refill ink 10	Sent	Succeed

3.2.4 Indicators

When the rotation of the toner tube has reached 99% of the total set point, Arduino will give an order to SIM 800L to make a miss call and turn on the buzzer and stop the motor rotation. To ensure that the buzzer works properly, tests and measurements are carried out. Measurements are made at test point 2, namely pin 6 Arduino. The following are the results of tests and measurements on the buzzer.

3.3 Test Results Directly on the Photocopier

Modification of the Minolta Bizhub 421 photocopier that focuses on the photo interrupter sensor. Before being modified, the photo interrupter sensor was located on the inside of the photocopier, which could detect the rotation of the toner tube. But sometimes the photo interrupter sensor could not detect the rotation of the toner tube because it was covered in dust or leaked toner and caused error C032 and then stopped the photocopier. Therefore, a modification was made by moving the photo interrupter sensor out of the photocopier which aims to minimize the occurrence of the C032 error and make it easier to clean. After that, Arduino Uno was added to this tool as a microcontroller so that the motor rotation can be calculated and the set point set to be notified that the toner ink is running out by sending an SMS and miscall according to the settings and when the ink has run out the buzzer will sound. Direct testing on the photocopier after the modification of the sensor placement is successfully recharged for an average number of 12 recharges without information. The value of the test results can be seen in Table 5.

Table 5: The test results immediately refill the toner sample tube

Sample Test	Machine Type	Serial number	Number of successful refills
1	Bz 361	AOR 7O2 1004 567	12
2	Bz 361	AOR 6O2 1005 264	14
3	Bz 361	AOR 6W2 1001 493	10
4	Bz 361	AOR6W2 1001 624	13
5	Bz 361	AOR 6O2 1003 672	12
6	Bz 361	AOR 6O4 1000 625	15
7	Bz 361	AOR 6O2 1002 358	8
8	Bz 361	AOR 6W2 1001 396	10
9	Bz 361	AOR 6O2 1003 664	12
10	Bz 361	AOR 6O2 1006 162	14

4.0 CONCLUSION

The placement of the toner sensor, which was originally located at the bottom of the toner was moved to the outside so that the possibility of the sensor being closed due to toner powder can be avoided. By designing this tool, the possibility of the C032 error can be minimized. With an indicator that the toner rotation has reached the set point, users of the Minolta Bizhub 421 photocopier can more easily monitor the toner tube. The success of SIM 800L in sending SMS and miss call notifications to users reaches 98% and the percentage of failures reaches 2%. With this modification, the photocopier does not take too much time to service and reduces costs for service.

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