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INDUSTRIAL SCRAP SEGREGATION SYSTEM BASED SENSORS USING PROGRAMMABLE LOGIC CONTROLLER

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Abstract:
There is no indication that waste generation will slow down, and this increase is the result of a number of causes including urbanisation, population expansion, economic growth, and changing consumer behaviour. The problem of garbage recycling and reuse must be resolved with the best solution. However, manual segregation is difficult and takes more time, money, and labour. Describe the automation concept 100% accurately, more efficiently, and automatically isolated the trash. With the aid of hydraulic cylinders and a proximity sensor, the system is designed to separate five different sensors that can each identify an object that is travelling along a conveyor belt in order to separate the various waste products. The primary element in this automation process is a PLC (programmable logic circuit), which can be implemented with the aid of a ladder logic diagram.
Key words: Sensors, conveyor belts, hydraulic cylinders, DC motor, PLC

1. INTRODUCTION

Each year, India generates two million tonnes of garbage, of which 43 million are collected, 12 million are kept for future use, and 31 million are dumped in landfills. Because of these landfills, the majority of the sites are full to capacity and not a significant concern. The Swachh Bharat mission's sanitation survey conducted by the minister of urban development revealed that 50% of Indians have trouble with inappropriate garbage collection and handling. PID, AI, DCS, PLC, and other controller algorithms could be used to address this issue. PLC is the one of these systems that is most frequently utilised. Because of its versatile properties, which include an accuracy, toughness, and eligibility. PLC (programmable logic controller) is used in industries to separate metal and non-metal trash. Automation with minimal cabling and a low error rate are two advantages of PLC.

2. LITERATURE SURVEY

The waste segregation method is advantageous, preserves the environment, and also lowers the number of poisons entering the atmosphere to protect the animals and plants, according to Bhoomika's suggestions [1]. According to Yoshika Chaudhary, automatic waste segregation utilising PLC will reduce hand-wiring and eliminate the need to update system architecture in the event of system changes [2]. Ajay V. P. asserted that automatic waste management is the best choice for safe management and is also less expensive [3]. According to Lakhmi P, waste segregation can be automated to save time, money on labour, and maintain a clean atmosphere [4]. Manikandan R asserted that the use of automatic waste segregation in our society will lessen disease and pollution, and that in the future we will also use Bluetooth or other wireless technology [5]. According to Nurul Nazihah Ahamad, the fully automated system is anticipated to have negative effects on both the environment and the people that are directly involved in the garbage sorting [6]. The Bhagyashri proposed that PLC be utilised as an automation device since it is cost effective, incredibly flexible, reduces complexity, is environmentally friendly, and requires less effort [7]. According to M. Deepak, automatic waste segregation would decrease the amount of labour required, eliminate risks, boost accuracy, and hasten

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waste management [8]. In order to reduce the risk to the general public and environment, Alena V.J. proposed that the segregation, transport, handling, and disposal of waste be managed appropriately [9]. Rashmi M. Kittali asserted that the adoption of PLC has other benefits, including a decrease in labour costs, increased waste management accuracy and speed, and a reduction in the risk of working around potentially hazardous materials [10]. According to Pushpa M.S., the term "municipal solid waste" refers to a category of waste that comprises items that are discarded by members of the public, causing environmental damage and a decrease in the value of property. This has an impact on our environment and health, but it is simply fixable with current technology [11]. Subhasini Dwivedi opined that this approach decreased human intervention and increased process control flexibility [12]. Adil Bashir stated that the primary goal is to protect the environment and eradicate society's solid waste through the development of technology that will entirely autonomously separate garbage [13]. According to Krishna Veni G, the movement and disposal of waste are disorderly and unscientific. Unchecked rubbish disposal on the edges of towns and cities has led to overflowing landfills and health risks for the local population. The garbage is divided, separated, and recycled using numerous devices in ways like incineration. Bag pickers, however, are crucial to the recycling of urban solid trash when it comes to domestic waste. In addition to a high prevalence of bites from rodents, dogs, and other animals, rag pickers and conservancy employees have increased morbidity owing to infections of the skin, respiratory, gastrointestinal, and multisystem allergic disorders [14]. According to Bankole I Oladapo, the material handling systems might be as simple as pallet rack and shelving projects or as complicated as automated storage and retrieval systems, overhead conveyor systems, and automated storage systems. Sorting and picking are additional aspects of material handling. Sorting has a variety of uses, from the production of agricultural goods to the fabrication of consumer goods [15]. The effective management of garbage, according to Archana Babu, is one of the main issues facing the modern world. To reduce environmental danger, trash generation, dependence, and management must be done effectively. The old method of manually sorting the waste involves more labour, expense, and time [16]. According to Minal Patil, the reason for this is that waste would be collectively thrown in open spaces, leading to numerous types of health problems and disease-causing bacteria and viruses. In order to prevent dangerous health concerns, industrial issues, and to protect our environment, waste management and segregation are crucial steps [17]. Ankitakharade suggested using an automatic trash segregator to increase output and do it economically, as well as for worker health and safety [18]. According to Ashwin D's suggestion, this paper offers a method for automatically detecting, identifying, and classifying waste materials into biodegradable and non-biodegradable categories. In this study, embedded Raspberry Pi applications, image processing, and machine learning techniques are integrated. The item is placed on a revolving flap joined to the two compartments by the robotic arm. To determine the waste item's category, machine learning is applied. The suggested solution is based on artificial intelligence-trained hardware and does not employ any sensors [19]. According to Michael Foster, it demonstrates how academic PLCs can complement the usual focus on continuous-based control, which is often covered in a control system engineering course. Foster also noted that it indicates how academic PLCs might be used in teaching. The natural integration of continuous and non-continuous control theory can be made possible by this course for mechanical engineering students [20].

3. RESEARCH GAP FROM LITERATURE SURVEY

AUTHORS	WORK DONE	WORK NOT DONE
[1].Bhoomika S	The garbage is separated using air classifiers and eddy current separators with sensor-based sorting methods.	It is not used any software to modify the system.
[2]. Yashika Chaudhary	Sort the waste with the aid of a PLC utilising an inductive proximity sensor and a capacitive sensor.	Not all material types will be identified, only plastic and metal.

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[3]. Ajay V P	Using a smart trash can, waste is separated into metallic and non-metallic materials.	It can only use this technology for domestic uses; not for business.
[4]. Lakshmi P	With the aid of automation, the metallic, dry, and wet waste may be separated.	The garbage is separated using the restricted sensor.
[5]. Manikandan R	Waste is separated using a robot (recycle bot), ultrasonic sensor, image processing, Zigbee, and human-machine interaction.	This process needed to be improved for fully automatic operation.
[6]. Nurul Nazihah Ahamad	For residential use, resistance value and moisture content were found.	No usage of bulk waste segregation technologies.
[7]. Bhagyashri	This essay suggests separating garbage made of metal and nonmetal.	The pick-and-place system was not designed for quick segregation.
[8]. Dr. M. Deepak	Remove the wiring based on PLC programming and keep the system design.	Avoid using robotic arms for better performance.
[9]. Alena V. J	Metal, biological materials, plastic, and ultrasonic sensors are employed to separate the garbage.	Ultrasonic sensors, metallic, organic, and plastic are used to segregate the waste
[10]. Rashmi M. Kittali	The purpose of the novel is to segregate the different types of waste with the help of PLC.	Monitoring the waste cannot be done in addition to system performance monitoring.
[11]. M K Pushpa	used to regulate timing and movement with an 8051 microcontroller.	PLC is better efficiency as compared to the microcontroller.
[12]. Adil Bashir	Smart vehicle system, local base station, smart waste system, and smart monitoring and control hut technologies are used in this procedure.	SCADA software and PLC-based programming are not to be utilised for monitoring reasons.
[13]. G.Krishna Veni	To separate the waste and tell metal from nonmetal, use the IR sensor principle.	Automation technologies not be used.
[14]. Bankole I	This essential method of simulating automated production systems.	Monitoring purposes need some software but not used types of software.
[15]. Archana babu	It was made to sort the garbage into dry waste, moist waste, metallic waste, and other categories.	For greater performance, a dc motor is replaced by a servo motor.
[16]. Minal Patil	Pneumatic compactor that separates garbage into various components.	There is no robotics and monitoring system available.
[18]. Ankitakharade	A zonal area around the roadside garbage container is created using the load sensor concept	There isn't a probiotic arm utilised for pick-and-place operations or high sensitivity monitoring.
[19]. Ashwini D. Awale	The robotic arm is used to PLC and position the object while machine learning is utilised to recognise the photographs.	Monitoring is required to track the effectiveness of the system.

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[20]. Michael Foster	background in conventional programming languages like C++. identifying the industry's use of the control theory.	Author is unable to provide a genuine application along with an explanation.

4. DETAILS DESCRIPTION OF PLC SYSTEM

The automation system's mind is controlled by a PLC. It was utilized in a wide range of settings, including residences, businesses, and factories. Because a PLC costs more than an Arduino or other device, it is employed for industrial automation applications. A production line as a whole or a particular process can be automated by a programmable logic controller. The block diagram of the PLC system is shown in Fig. 1 below.

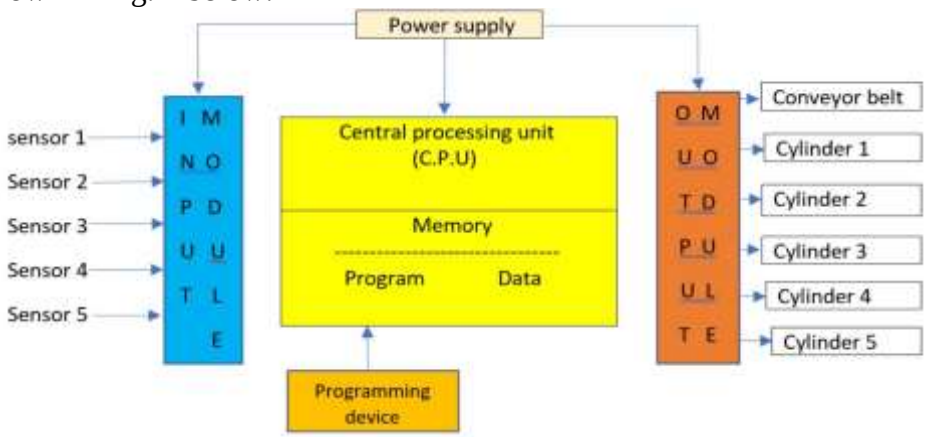

Fig.1.Block diagram of the PLC

Following the processing of the data and the triggering of outputs based on pre-programmed parameters, the PLC receives data from the input devices. A PLC can monitor and record run-time data, such as machinery productivity or data from any form of sensor, and can also automatically start and stop processes depending on the inputs and outputs. A versatile and reliable control solution, programmable logic controllers can be applied to practically any application.

4.1 Details Specification

1. Supply voltage: DC input of 12-24V
2. input: 5 Digital inputs and 6 outputs are used
3. PLC: Allen Bradley PLC

4.2 Detail input components

Sensors

A. IR Sensor:
The infrared sensor operates in a rather straightforward manner. IR sensors operate on the fundamental idea of light reflection. Once the object makes contact with the IR light from the IR transmitter, the light bounces back off of it and the sensor sends a signal to the PLC, which then determines there is an object in front of it and activates the conveyor belt.

B. Moisture Sensor:
The dry and organic trash are separated using a moisture sensor. It was put in front of the plastic sensor and behind the IR sensor. When waste is placed directly on sensors, it is recognised and sorted into it.

C. Plastic Sensor:
Use the plastic sensors following the moisture sensor. Water bottles, containers, plastic cups, and other items made of plastic are separated using this sensor.

D. Metal Sensor:
The metal sensor detects metallic components, with the exception of non-metallic materials, by operating on the inductance of a coil and the power losses in the coil principles.

E. Glass Sensor and paper sensor:
Capacitive proximity sensors are another name for glass sensors. When something close to the sensor surface enters the electrodes' electrostatic field and modifies the capacitance of an

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oscillator circuit, the device is said to be in operation. The oscillator starts to pulsate. The oscillator amplitude is read by the trigger circuits, and the output state of the sensor can be modified when it reaches a particular level. The paper sensor sensed the paper material and separated it after all the scribe was to be separated.

4.3 Detail output components

A. DC Motor:

Over the past few years, industrial use of DC motors has increased significantly. It was producing mechanical force anytime a conductor carrying current was placed in a magnetic field. Based on the Flemings left-hand rule, DC motors operate. DC motor and conveyor belt connected in series.

B. Conveyor Belt:

The waste material is moved from one site to another using a conveyor belt. A conveyor belt is continuously moving, and PLC is being used to regulate the speed of the conveyor belt. The conveyor belt may travel in any direction because it was designed using programming using ladder logic.

C. Hydraulic Cylinders:

The material conveyor belt is moved into the bin cylinder using hydraulic cylinders. Due to the intense pressure placed on the fluid during both the extension and retraction processes, the cylinder is only under pressure on one side internally.

5. FLOW CHAT DETAILS DESCRIPTION

Using flow chat, the entire scrap segregation process will be explained. The garbage is gathered and poured onto a conveyor belt to begin the scrab sorting process. When the motor bush button was depressed, an IR sensor detected scrap on the conveyor belt, which caused the conveyor belt to begin moving. All of the detector sensors, including the paper, glass, metal, plastic, and moisture sensors, are independently coupled at various locations. With the aid of a sensor detector, any scrap that is found is reported to the hydraulic cylinder, which is subsequently pushed to a container where the junk can be kept. It is shown in figure 2.

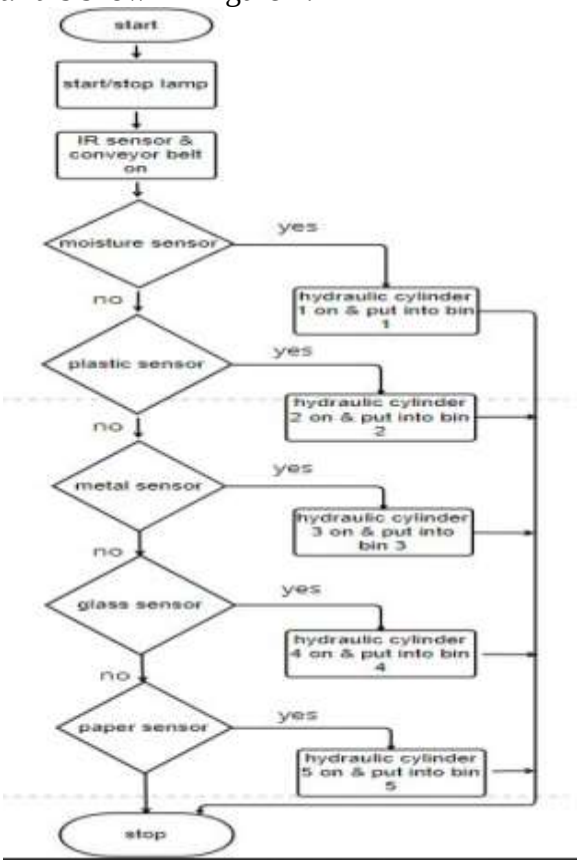

Fig.2. Flow chart

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6. RESULTS AND DISCUSSIONS

Allen-Bradley industrial software PLC programming with RS Logix MICRO Starter Lite 8.30eng for PLC programming (Ladder Logic). Allen-Bradly addresses inputs and outputs in a particular way. Input begins with an I and a pair of dots, just like IO. O and the same as the output, which begins with the letter (Q) and has spaces between each letter to form Q0.0. All of the input parameters and the output parameters associated with the motor contactor are stated in terms of I and Q in the table below. It is shown in table 1.

Table 1. All input and output parameters are used in the program

Stop push button	I:0.16	Cylinder_1	O:0.32
Start push button	I:0.1	Cylinder_2	O:0.2
Motor contactor	O:0.0	Cylinder_3	O:0.3
Conveyor belt relay	O:0.16	Cylinder_4	O:0.4
IR sensor	I:0.1	Cylinder_5	O:0.5
Moisture sensor	I:0.2	Start lamp	O:0.6
Plastic sensor	I:0.3	Stop lamp	O:0.7
Paper sensor	I:0.4	TON and TOFF timer	T4:1, T4:3, T4:5, T4:7, T4:9 and T4:0, T4:2, T4:4, T4:6, T4:8

A timer has also been employed here; there are two kinds of timers. A turn-on (TON) timer is shown in figure 3, and a turn-off (TOFF) timer is shown in Figure 4. The off-delay timer is generally operational once the system has been running, but it will only begin to calculate the set time if the power is turned off to the system. When the current delivers to the TON delay timer, it will begin computing the specified time. The ladder logic programming is shown in figure 5.

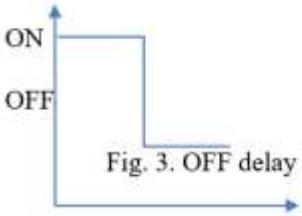

Fig. 3. OFF delay timer

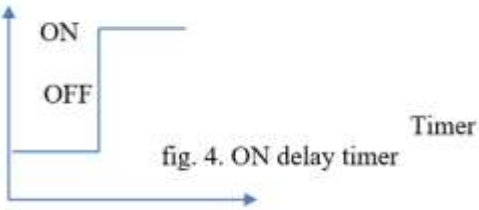

fig. 4. ON delay timer

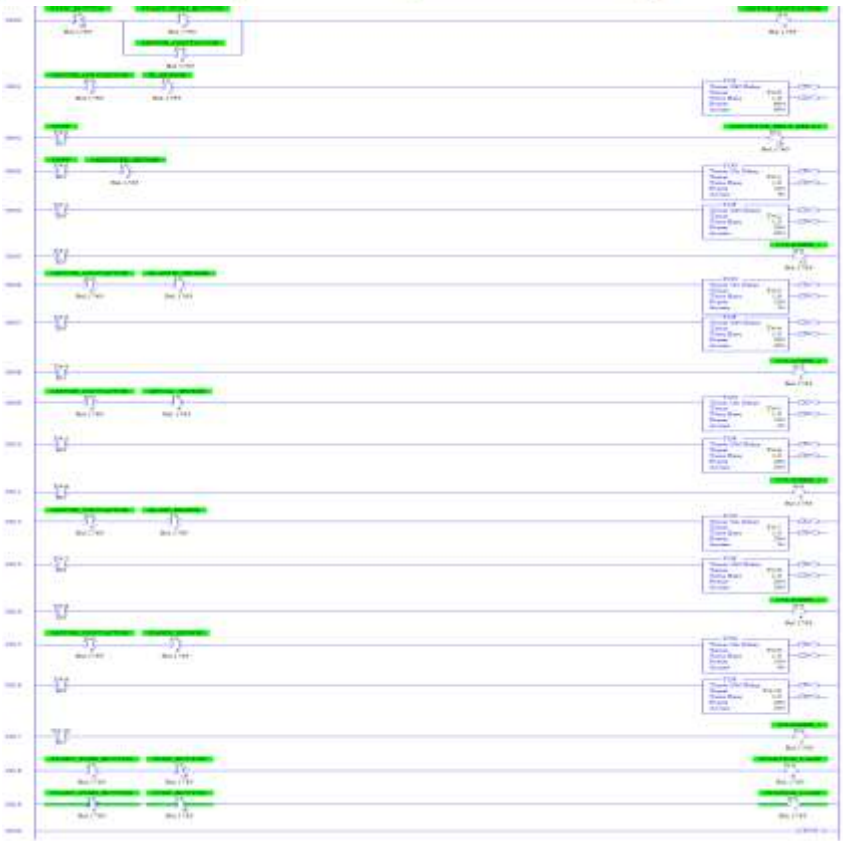

Fig. 5. ladder logic programming

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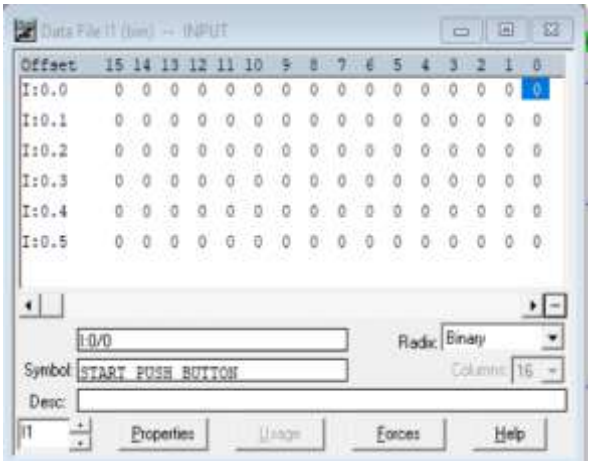

Fig. 6. Input status

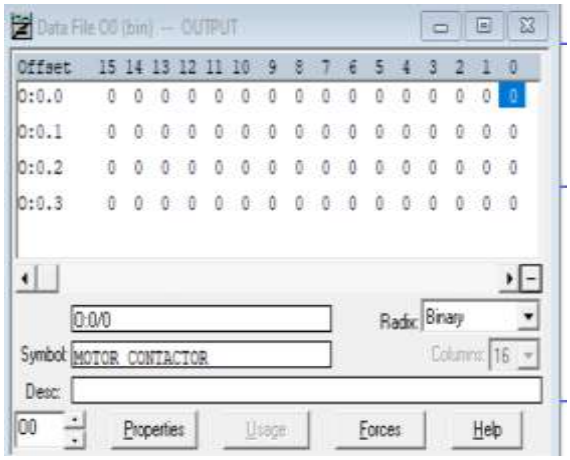

Fig. 7. Output status

The input and output statuses must be zero prior to execution. It has been used to represent ordinarily open (N.O.) and normally closed (N.C.) contactors in the ladder logic diagram. A flip-flop device, or latch operation, is what a motor contactor is used for. Nineteen parallel networks make up the PLC programme, starting with the motor coil. The coil turns on when the push button is pressed, with the exception of when the switch is off, as illustrated in figures 6 and 7.

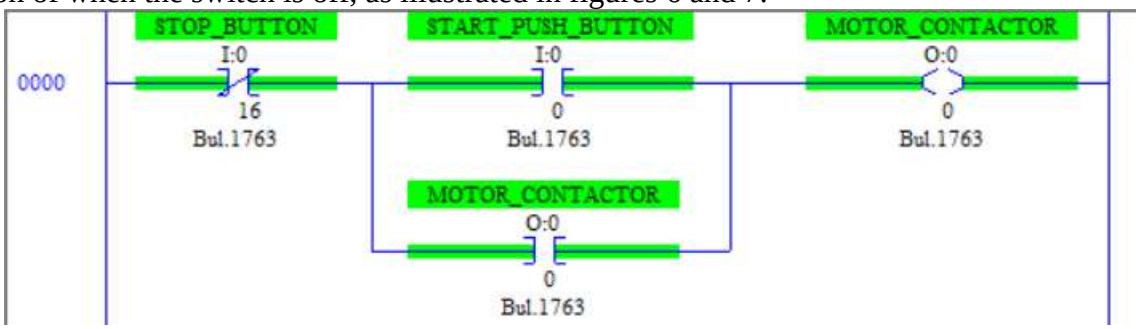

Fig. 8. Start and stop the motor with the latch

If the switch is abruptly turned off, the conveyor belt will halt after a brief period of time (about 60 seconds) due to the off-delay timer that is in the second network. It is shown in figure 8. The conveyor belt starts moving after the motor contactor turns on and the IR sensor detects any material will be present. The material is forced to the appropriate bin locations by the off-delay timer. Below is a diagram of the conveyor belt programming using a delay timer. It is shown in figure 9.

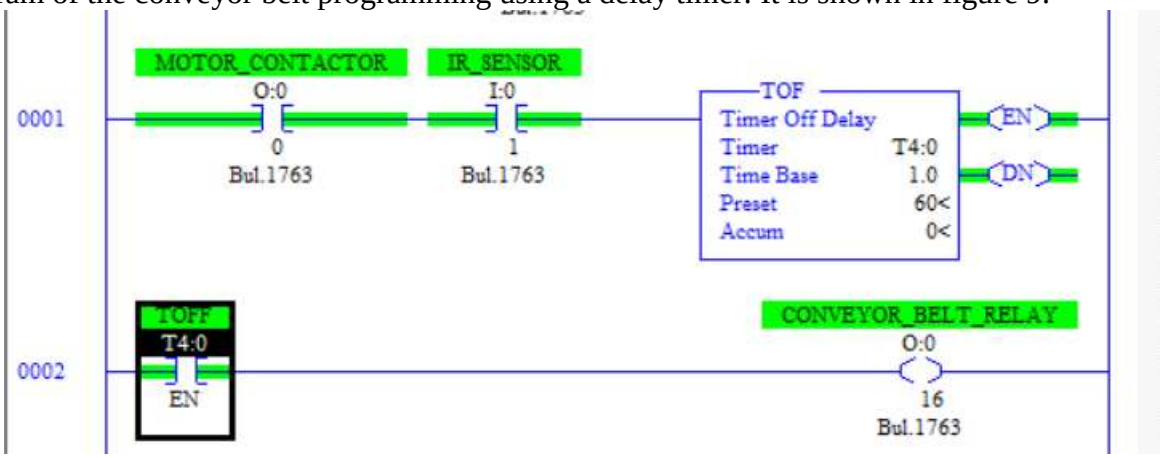

Fig. 9. Turn on the conveyor belt operation

Every sensor detects a certain type of material and sends a signal to the corresponding cylinder to open and bin into the opposite bin container once the conveyor belt relay belt has moved on after detecting the material. The hydraulic cylinder opens the bin and pushes the material into it if the sensor detects moist material. The on-delay timer begins counting after this. It is shown in figure 10.

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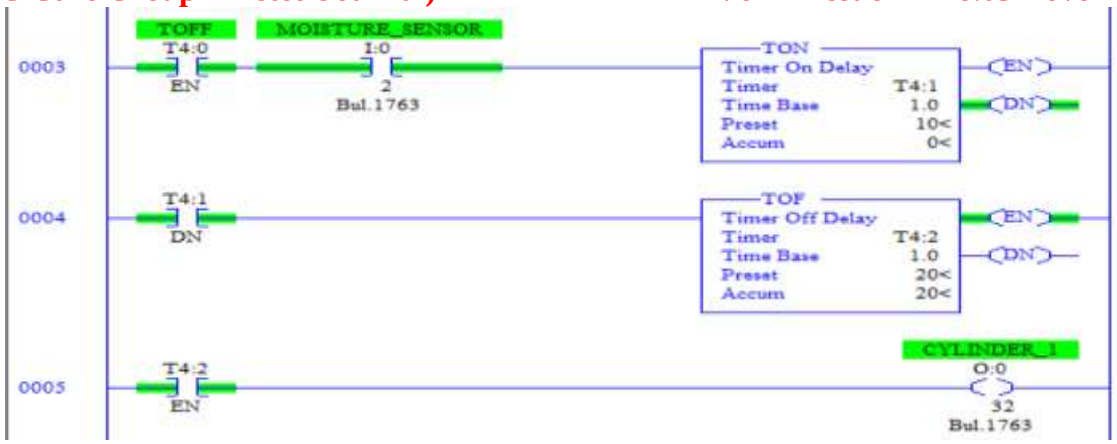

Fig. 10. Activating the moisture sensor

The bin cylinder is stopped to open and the material is to be passed to the next plastic sensor once there is no longer any wet material on the conveyor belt. The plastic sensor will stop operating when it cannot detect any plastic material and the TOFF timer was working at 5ms periods, as shown below. If the substance is plastic, it will be tested by (I:0.3) and cylinder two will be on once one delay timer completes its time. Then it ceased counting and moved on to the subsequent procedure. It is shown in figure 11.

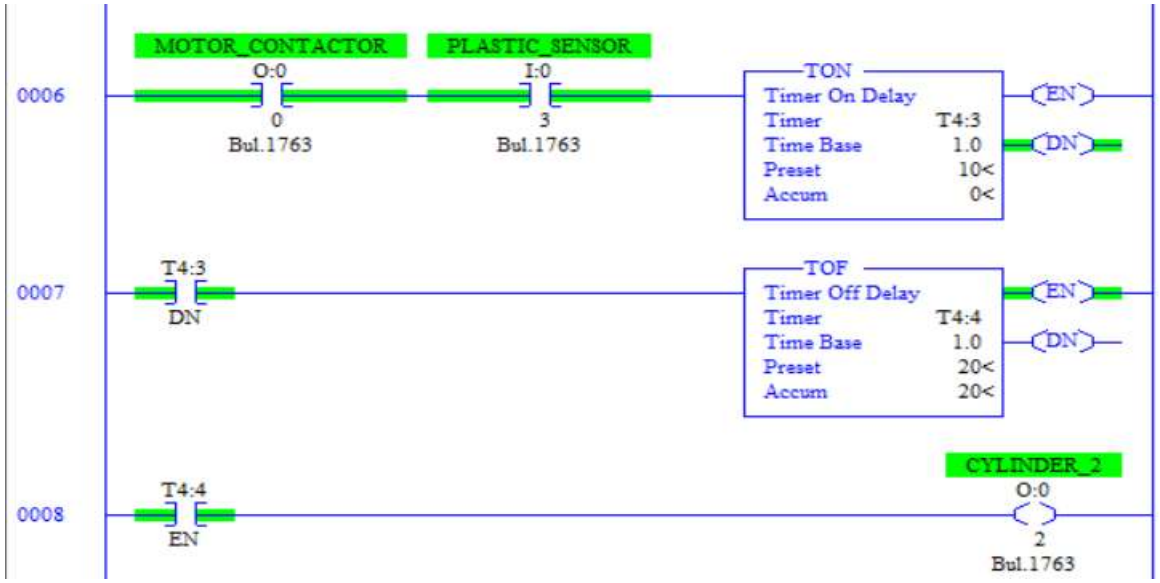

Fig. 11. plastic sensor turns on and turns off the programming

For the other sort of materials, the procedure is done in the exact same order. It has outlined the PLC programming for various sensors activating using on-delay timer programming in shown the figure 12 below.

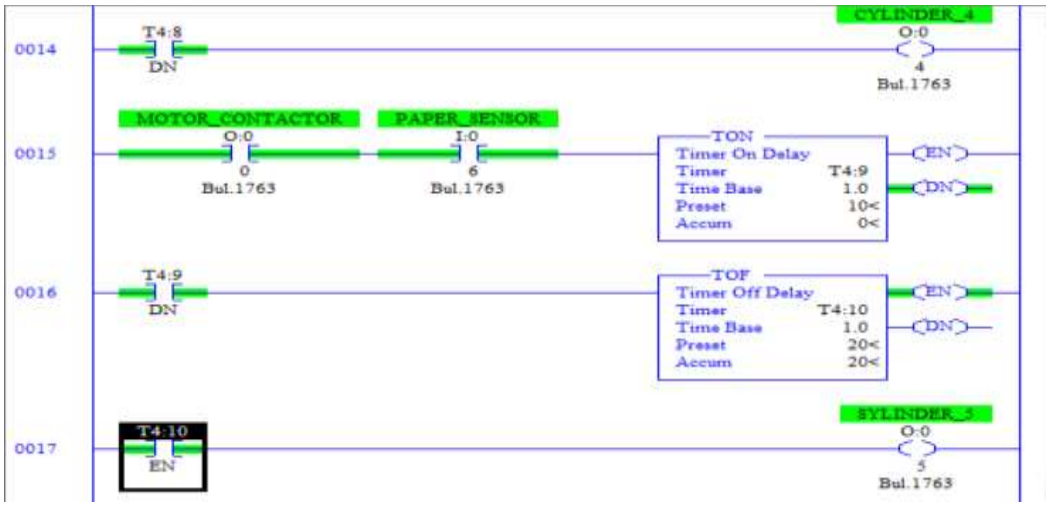

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Fig. 12. Remaining all sensors activated

The stop indicator/stop bulb (O:0.6) is lit before the push button is activated or is ordinarily open. The start lamp (O:0.7) turns on after the push button is activated, signalling that the motor contactor has turned on. Because stop or start bulbs cannot glow continuously, it has connected an alternate start and stop lamp. It is shown in figure 13.

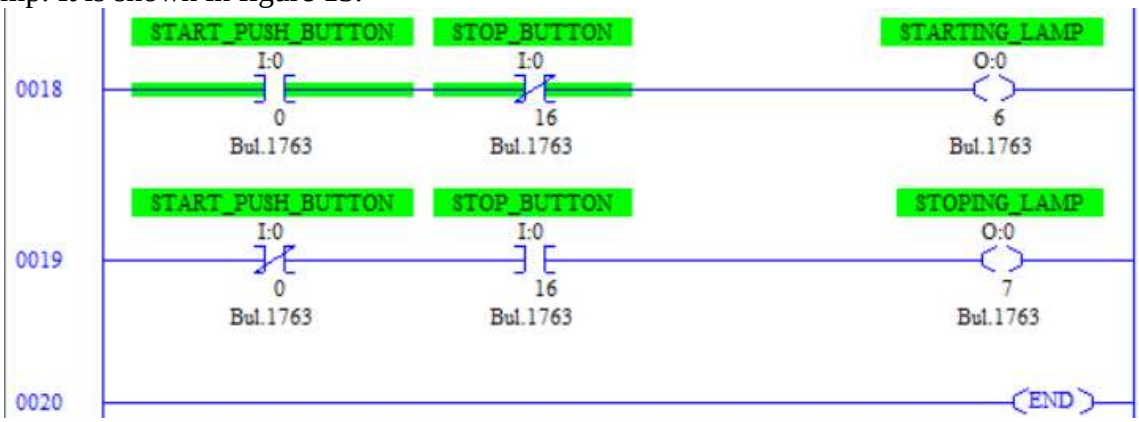

Fig. 13. Start/stop lamp activating

7. COMPUTER CONFIGURATION

*Easy programmes that just need one level of logic and don't demand that users create projects or add custom fields and text elements. A software package called RS Logix Micro Starter Lite is made for PLC programmers who are just starting out. It has numerous features that are simple to use and comprehend.

*To make the process of system design simpler, this software has a schematic editor, I/O mapping tools, and a device programming interface. The specifications for the system

*The following software is included: Microsoft Windows XP, Vista, 7, 8, and 10. (32-bit or 64-bit). 1 GB of memory 800x600 resolution

8. ADVANTAGES AND DISADVANTAGES

1. keep the environment clean and fresh
2. saves the earth and conserves energy
3. reduces environmental pollution
4. waste management will help to earn money
5. create employment
6. reduce the land occupation

9. DISADVANTAGES

1. The process is not always cost-effective
2. the resultant product has a short life
3. the sites are often dangerous

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4. the practices are not done uniformly
5. waste management cause more problem

10. CONCLUSION

Government attention is needed for the critical issue of waste management. Different sorts of garbage will be automatically separated and collected in separate containers utilizing PLC technology. With the use of this technique, waste management was able to enhance in efficiency, accuracy, and speed while minimizing dangers. Time and money are saved by this automated solution. Low-investment industries can use this system. The proposed approach saves time, money, and the environment (waste management and segregation is not only the removal, processing, and disposal of materials). The System's purpose is to produce money while assisting with garbage segregation. In contrast to other systems now in place, this approach can be applied to all recycling industries. By separating garbage from other types of waste, this technique aids in waste management. This technique aids in the preservation of wildlife that may be endangered by eating discarded plastic. because poisons in the atmosphere are increased by waste products. The number of pollutants in the air is decreased by this technique. In this approach, both people and the environment are protected. Finally, this technique lowers air pollution and maintains a fresh, clean environment.

FUTURE SCOPE

In the future, recycling will be collected with a robotic arm. When they are full, use the sensors at the top of each dust-collect ing bin to quickly unload them. In the future, we will be able to place an analogue sensor into a camera sensor, which will then be able to detect all input signals and transmit them to the plc programming. Additionally, we can use cloud-based technologies and monitor from anywhere at any time, eliminating the need to travel to the location where the setup was installed.

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