AUTOMATED PRODUCT QUALITY TESTING USING IOT

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***Abstract*—Our objective is to provide an automated quality testing method of various fluids, especially oils, based on standard parameters which are remotely controlled by Industrial IOT application.**

Keywords— Automation; Quality testing; PLC; IIOT; Cloud; AI; Neural Network.

1. Introduction

A Programmable Logic Controller is simply a computer device used for industrial control systems. Amongst the various advantages of the PLC, the ease of programming and robust structure stands out and meets the rightful needs of the vastly growing industries. Also, a number of sensors and actuators are compatible with the PLC for performing several processes.

With the advent of IIOT and Industry 4.0, automated manufacturing and testing has become even more efficient. The project includes IIOT to allow the user to choose between the products that are to be tested remotely. Thereby reducing on-site involvement of any human element. The IIOT combined with the PLC will be used to test the quality of a particular product. Therefore, with the help IIOT, we can seamlessly transfer data and give commands without the use of wires in various places.

2. Ease Of Use

(i) Programmable Logic Circuit

There are various ways to program a PLC, like- the ladder logic, function block diagram, sequential flow chart, structured text and instruction list. All the mentioned programming languages are easy and user friendly which makes it easy for any person to set it up and debug an issue reducing the time spent. The PLC itself is a replacement for the relay logic, which helped in the simplification. Sensors of various kinds can be calibrated easily as per the industrial needs.

(ii) Industrial Internet of Things

With the vastly growing industries around us, time is an essential aspect to consider. Automation over the internet is a time reducing approach to our delegated task. Digitization has significantly increased the accuracy over the years making us bent towards the reduction of human interface in the production and assembly line. The usage of cloud to get the inputs from the sensors instead of the traditional data transfer cables is a reduction to the clutter around the workspace. With the increase in the number of machines used at the industries, it is risky for the engineers to go all the way to the machines in order to give a desired command every time. A voice command over the IIOT, from an isolated command room will significantly reduce the risk, increase the ease of operation and also eliminates the time wasted in order to get to the machine

3.Components

(i) BOSCH PLC:

This project has been implemented using the **BOSCH REXROTH L20DP PLC.The IndraControl L20 is a modular and scalable control.** It combines the benefits of a compact small control with a standardized I/O system on the basis of terminal technology. It is a hardware platform that can be used for PLC applications. It provides onboard interfaces, e. g. high-speed inputs and outputs (8 each) and communication interfaces, such as Ethernet, PROFIBUS and RS232. The locally available I/O units can be extended by the Rexroth Inline I/O system, just by simply mounting the components side by side. Application programs, incl. runtime, are completely stored to an easily accessible standardized Compact Flash medium.

(ii) LOAD CELL:

A load cell is a device that measures the weight of a product. The basic principle of a load cell is it converts physical quantities such as compression, pressure, force into electrical signals, hence measuring the weight of the object. The particular load cell used is a **strain gauge load cell**. This load cell is the most commonly used load cell because of its profound accuracy, versatility and cost-efficiency.

(iii) IR PROXIMITY SENSOR:

The IR proximity sensor is a simple fool proof sensor that works on a basic transmission and reception principle of infrared light. The sensor consists of an electromagnetic transmitter and a receiver which measures the distance of the object from the source based on the distance travelled by the ray.

(iv) TRANSMITTERS AND RECEIVERS:

Due to the inclusion of IoT in the project, the transmission and reception of information from the sensors to the PLC need to happen over the air. Therefore, the sensors have a transmitter which transmits the input signal to a designated receiver connected to the PLC through the cloud.

(v) BARCODE/PRODUCT SCANNER:

In order to differentiate the products to initialize the entire operation, we make use of a barcode scanner which specifies the type of products in the selection palette.

(vi) PNEUMATIC ACTUATORS:

The motion of the pick and place robot entirely takes place because of these actuators. These actuators convert the electrical signals from the PLC into mechanical action with the use of pneumatics. This pneumatic pressure exerted moves the robot up, down, back and forth.

(vii) INDRAWORKS SOFTWARE:

Indraworks is a tool offered by **REXROTH BOSCH** in which we can create our desired PLC logic to dump. We benefit from quick and transparent access to all the functions and system data of the automation components. IndraWorks offers continuous operation based on current Windows technologies and extensive wizards for the project planning of controls, drives, and peripherals.

4. WORKING

Objective:

- To identify and select the product
- To take input parametric value
- To implement IOT gateway
- To test the products according to standards
- To take remote monitoring and controlling actions.

Quality testing is an integral part of any industrial manufacturing process. The testing process is a rigorous task, where the products are tested for hundred percent quality, post production. In our project, we intend to test the quality (weight/level and brand wrapping) of a product containing liquid quantity. With the inclusion of IIOT, we can regulate the initial product selection over the internet with a unique voice command. The following (fig 1) is the basic block diagram of the automated quality testing process.

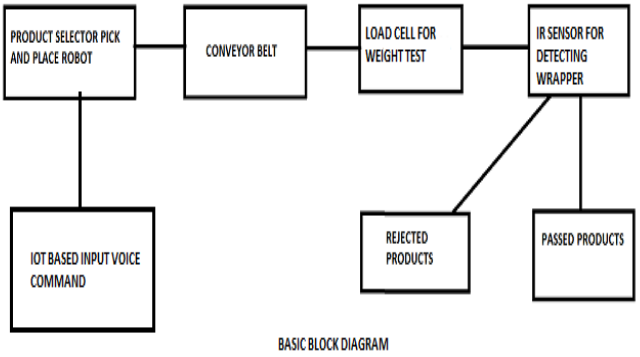

Fig. 1: BASIC BLOCK DIAGRAM

The second part of the process contains the mechanical parts such as the pick and place robot and conveyor belt. The pick and place robot receives the coordinates to pick the product from the plc. The place action places the specified product onto the conveyor belt which acts as a transfer line which takes the product towards the quality control section where the sensors check for quality according to predetermined set points.

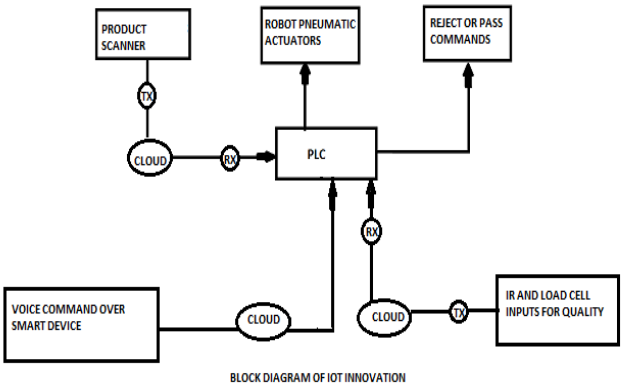

Fig. 2: IIOT INNOVATION

In the block diagram mentioned below (fig 2), the IIOT inclusion in the process is briefly specified. The Programmable Logic Circuit is fed with data from the sensors over the internet with the help of cloud data transfer. The IIOT inclusion starts from the control room where the voice command is initiated for the product selection. Based on the selection, the product scanner will send the information of the particular selected product to the PLC, which will in turn actuate the process with the help of a pick and place robot and transfer the product from the crate, on to the conveyor belt for further testing. At the

testing section, first, the load cell will weigh the product making sure the liquid inside is at the desired level. Up next, the IR sensor will check if the brand wrapper is present on the bottle. Both these information (weight and wrapper check) are sent to the Programmable Logic Circuit over the internet with the help of cloud data transmission. Based on these inputs, the Programmable Logic Circuit will actuate a gate action which will either reject or pass a product completing the quality testing process of a production line. These passed products are further secured and ready to dispatch.

A **database** containing the obtained data regarding the input and output parameters for testing is created. This is then stored in a **cloud** accessible on a server. Therefore the data can be monitored and controlled from a control room away from the testing site as well. The cloud used in our project is service based cloud from azure or aws.The database can be manipulated by using dbms or query languages as well. Hence the overall inclusion of cloud allows us to not only safeguard our information but also efficiently manipulate it.

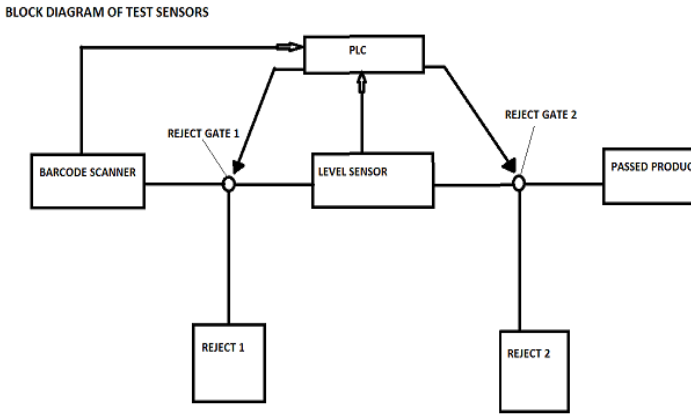

Fig.3:MECHANICAL SETUP

The final block diagram shows us the mechanical setup of the project.Which includes the pick and place robot and the conveyor belt.The choice of the robot and belt is decided depending upon the types of products that are to be handled. The passed products can either move to further testing or be packed for shipping.The conveyor belt action and speed are controlled by the inputs from the PLC.Timers and counters are used to decide the delay and runtime of the belt depending upon the type of product to be tested. The pick and place robot needs accurate input of the coordinates to work efficiently. This can be done only if we know the location of the product precisely. Although we are moving toward a more electronics era , electro-mechanical systems still play a major part in the manufacturing and testing industry.

5. Advantages

- Completely automated (safety).

Increased automation leads to reduced labour recruitment on site. This reduces the probability of accidents as the entire process is remotely operated.

- Inclusion of IOT for efficient data transfer and process control.

IOT enables us to handle and monitor data transfer on a real time basis. Real time monitoring increases the efficiency and allows for flexibility in setting the parameters.

- Efficient means of quality testing using several sensors.

Use of several sensors increases the stability of the automated system.

6. Limitations

- High initial cost.

The inclusion of parts like PLC and IOT gateway make the initial setup relatively expensive .

- Maintenance of conveyor belt and pick and place robot required.

The automated system contains mechanical parts such as the belt and the robot which require regular oiling and maintenance for efficient functioning.

- Multiple setups required for testing multiple products simultaneously.

To test two are more different products at a time, we require as many setups of the conveyor belts and sensors.

7.APPLICATIONS

As the title suggests the project finds its applications in product testing.The setup is such that it allows us to select among several different products and test them for quality.The primary application is in testing of fluid based products in bottles of different sizes for level and wrapper. But the application can be extended to packed carton box products and any other solid packing products. They can be tested for physical parameters such as level/weight , wrapper, standard size of packing etc.

The project can be implemented without the IOT applications too in small scale industries where cost is a factor. Therefore the application of the projects are highly broad and can be applied to various industries from mineral water bottle manufacturing to car manufacturing assembly lines.

8. Scope For Improvement

The inclusion of **AI and neural networking** in the scanning process will be a boon for this prototype. The image recognition can take place in two places- **the pick and place robot** and **brand wrapper test**.

The pick and place robot can use image recognition in order to segregate the product by itself, replacing the additional scanners placed in the products' crate.

The IR sensor can be replaced with image recognition, allowing it to recognize other details on the wrapper, like the barcode, size of sticker ,expiry date, printing quality, etc.

Increasing the number of parameters for testing such as product standard size and other physical and chemical parameters will enable us to expand the scope .

The same idea can be applied to a manufacturing process such as an automated iot based bottle filling machine to fill the bottle with different liquids which can be selected using IOT command.

With such advanced technology, we can further improve the efficiency and the scope of the project.

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