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Real Time Monitoring and Control for Industrial Automation using PLC

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Abstract: Automation in the industrial workplace provides the advantage of improving productivity and quality while reducing errors and waste, increasing safety and adding flexibility to the manufacturing process. In the end, industrial automation yields increased safety, reliability and profitability. Thus this paper aims to replace the manual ineffective counting system in industry, with a system that efficiently utilizes the available resources and introduces the accuracy, precision, reliability and efficiency of the automatic counting mechanism. The main idea of our project is to automate the counting system of bags with the help of sensors and Programmable logic controller. The project also aims to control the industrial process locally and to monitor, gather and process real time data using SCADA. The system will also provide the efficient database management system that will store, organize and manage a large amount of data.
Keywords: Programmable Logic controller (PLC), SCADA, Database, Industrial Automation.

I. INTRODUCTION

PLCs are evolving and continue to be the best option for a variety of industrial automation applications. Greater programming flexibility and ease, scalability, more memory, smaller sizes, very high-speed (Gigabit) Ethernet, and built-in wireless are among evolving programmable logic controller features. The PLC's hardened embedded processor, running a real-time proprietary operating system, has proven to be a mainstay of the industrial automation world, fighting off all challengers to its supremacy. Microsoft Windows-based open systems have made inroads but lag behind PLCs, a trend expected to continue as the PLC with its purpose-built hardware, specially designed software, and one supplier support model remains a solid choice for many industrial control applications. The IEC 61131-3 standard introduced other programming languages for industrial controllers, but ladder diagram responded with advancements of its own and has shown surprising staying power. There are applications where sequential function chart is better, particularly for process control. Structured text works well for data manipulation, and other IEC languages have their strong points. But ladder diagram forges on, and remains the leader by a wide margin in terms of PLC programming languages. Supervisory control and data acquisition (SCADA) systems are commonplace in industrial processes all over the world. Renowned for their process monitoring capabilities, these systems are ubiquitous in industrial enterprises. SCADA systems are at the crux of industrial processes today, as they help organisations manage modern demands. Automation in the industrial workplace provides the advantages of improving productivity and quality while reducing errors and waste, increasing safety, and adding flexibility to the manufacturing process. In the end, industrial automation yields increased safety, reliability, and profitability. Various industries in India are still largely dependent on manual operations like counting, data management, bagging, etc. Little or no use of emerging technology is made. Efficiency of manual counting is hampered by various factors which do not ensure optimum and accurate results also, human errors make them unreliable. Thus our project aims to automate the existing conventional counting using sensor, PLC, SCADA, etc which will provide a user-friendly experience for monitoring and controlling the system in the industry. The objective is to automate the existing conventional counting system to be robust, flexible and to provide a user friendly experience using the latest technologies available for monitoring and controlling system in Industry. While such system's are already in existence, the project aims to develop a cost effective system with minimum probability of failure.[7]

II. LITERATURE REVIEW

Y. Aruna et al. [1] presents a paper on Automatic Conveyor System With In-Process Sorting Mechanism Using PLC And HMI System. The paper put forth efficient methodology to automate the process of sorting the material moving on the conveyer belt according to their sizes. Programmable Logic Controller was used for machinery packaging material handling automatic assembly. Sensors were kept at different places to sense and detect the job pieces of different sizes which get sorted based on the program running in the PLC. HMI system was used as an interface between the man(operator) and the process (machine).Which performed tasks like process visualization, displaying alarms, process values, and alarm logging and process and machine parameter management.

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System was found to be efficient using PLC as it controls multiple inputs and outputs along with sensors installed throughout and also increased production quality and capacity but decreased the total manufacturing cost and provided ease of analysis. H. Kumar et al. [2] presents a model using PLC to automate material handling process in industries. The packages were sorted out with the help of scanners and stamped if the package was correct and then stacked. The whole process was carried out in five steps that were filling, sorting , packaging, stamping, and loading. A PLC ladder logic was built for the above process using tags, counters and other features provided by the PLC software. The SCADA system was also developed to control and monitor the performance of the designed system. Alhade A. Mustafa S. et al. [3] presents a project to design and fabricate small and simple conveyer belt system and automate for packaging small cubic pieces of wood into a small paper box. Inductive sensors and Photoelectric sensors were used to provide the information to the controller. Electrical DC motors were used as output actuators for the system to move the conveyor belt when it gets the order from the controller. Programmable Logic Controller was used to control and automate the system by ladder logic diagram software in which the operation passes through two stages, carrying empty boxes to the desired location and packaging the samples into the boxes. K. Manhas et al. [4] designed and implemented bottle filling autonomous system for food processing industries using PLC. The primary job was to start and stop the conveyer system using the motor. The secondary task was to fill the bottles in a particular period(in seconds) and speed to attain the same quantity of liquid in all bottles.The system was controlled by ladder programming . A sensor was used to sense a bottle placed under the tank which was in turn placed over the conveyor.

III. PROPOSED METHODOLOGY

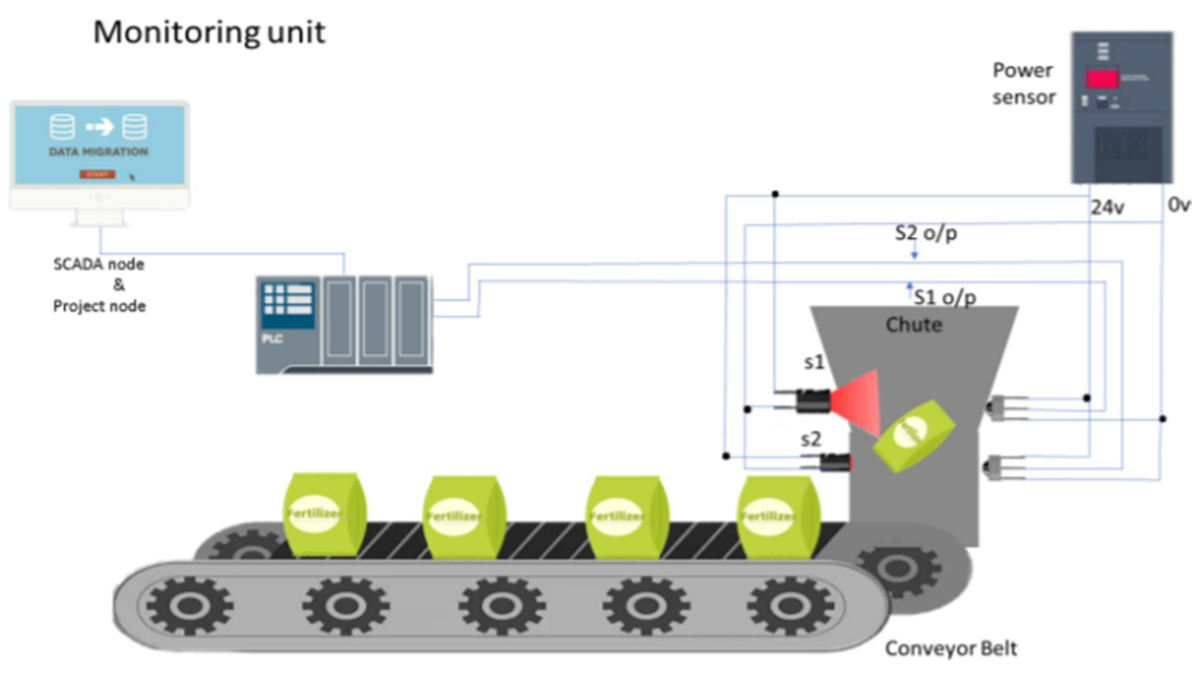

Figure 1: Overview

The above figure shows the basic monitoring and controlling unit of proposed system. It has a photoelectric through beam sensor, whose output directly connected to the PLC. The sensor notifies the PLC when the bag is detected and counting process will be initiated. If there is any fault such as false sensing, bag stucked in between the conveyor belt, wire breakage of sensor, the red light will glow indicating the fault. Transmitter and Receiver blocks of sensor were mounted on two ends of the conveyer belt so that bag was detected after it was passed through its transmitter and receiver end. Run indication of the downstream belt was connected to the PLC and If belt has been stopped during a long pulse, it is to be considered as a single bag. Physical counter which will provide a real time count for workers in the bagging area. To control and monitor the entire process in a remote location such as control room. Data was sent to the control room through an optical fiber cable by MODBUS over TCP/IP. The data received was stored in microsoft SQL server database which led to the generation of reports for the shift/day/type of product using INTOUCH SCADA.

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A. Components Used in Implemented Design:

1) *Programmable Logic Controller (DVPSE11R):* A programmable logic controller (PLC) or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as manufacturing process, or any activity that requires high reliability control and ease of programming and process fault diagnosis. DVP-SE is the most complete network type slim PLC in the industry that provides 8 digital inputs and 4 digital outputs with built-in mini USB, Ethernet and 2 RS-485 ports. This PLC is a slim type yet has all the features which make the user to get the maximum out of it.

2) *Photoelectric Sensor (Transmitter Receiver):* It is a through beam type sensor which is reliable for detection. Can range upto 12 meters and also immune to dust and dirt. For our application we are using normally close type sensor.

3) *Pulse Counter:* DIN 72 x 36-mm Total Counter/Time Counter with Easy-to-read Displays and Water and Oil Resistance. It has compact (66 mm) body which supports both external resetting and manual resetting.

B. Software Studied

1) *WPLSOFT:* PLC programming software Delta is written by Delta Electronics and used to create a program for active Delta PLC, unlike other PLC firms, PLC Delta has copyright software provided free of charge, creating economic benefits for users and giving customers good economic conditions easily accessible.[16] WPLSoft V2.47 software is the latest version used to specialize in programming DVP-Series.
2) *Wonderware "In Touch":* Wonderware InTouch can act as a SuiteLink client to get data from a SuiteLink Server. SuiteLink protocol was developed by Wonderware and uses a TCP/IP based communication protocol. SuiteLink places a time stamp and quality indicator on all data values delivered to VTQ-aware peers, such as KEPServerEX. KEPServerEX was configured as a SuiteLink server, providing data to one or more InTouch instances.
3) Microsoft SQL Server: The database was created using microsoft sql server. We designed a database to store a limited number of tag values from InTouch. Begin by noting the tagnames in InTouch application that hold the values which we wish to store and their data types such as string, integer, etc. Parameters which we stored in the table is given the table.

C. Implementation

1) Internal Circuitry

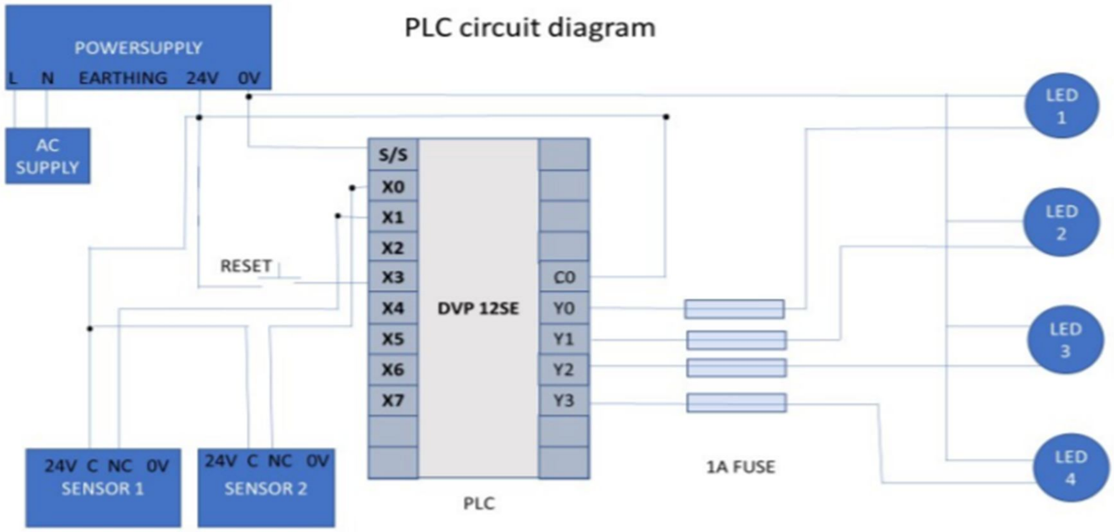

Figure 2: Circuit Diagram

Photoelectric sensors and LED's through fuse are connected to PLC which is powered by 24v power supply.

2) *Flowcharts Of PLC:* Two photoelectric sensors are placed at a fixed distance of 0.5m on a conveyor belt. These sensors provide the data to the controller. A counter in PLC keeps the track of all the bags detected by the sensors, on the following basis.

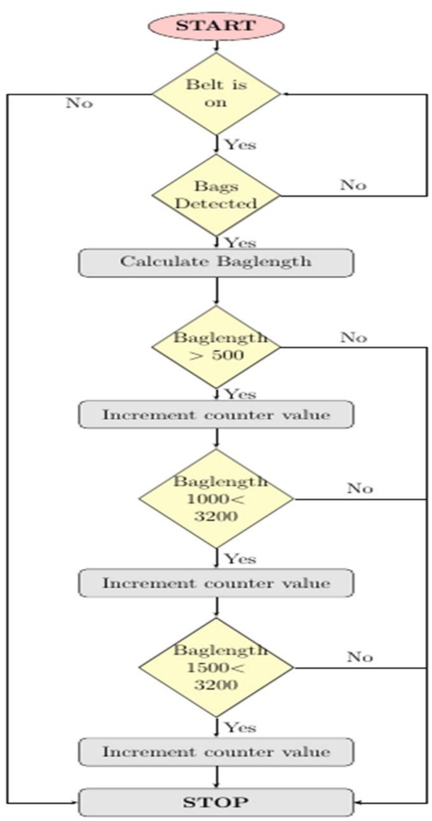

Figure 3: Counting Process

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When bag is detected by a sensor, the time period of sensor being ON is stored in a timer for each passing bag. This timer value is used in the speed equation to calculate the baglength. The calculated baglength is continuously compared with the predefined length for single bag, double bag and triple bag and the counter value is incremented accordingly.

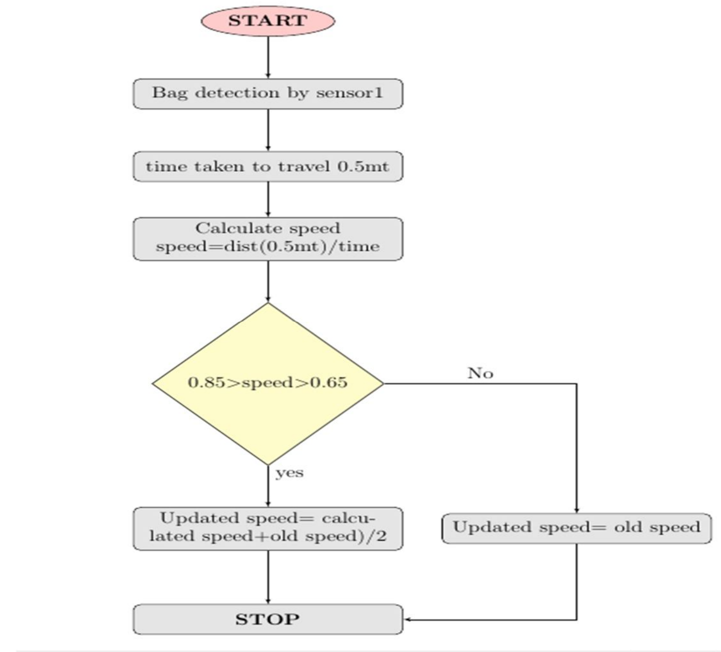

Figure 4: Speed Detection

To control and track the speed of conveyor belt. The time taken by the bag to pass from sensor 1 to 2 is divided by the fixed distance between them. If this calculated speed is between 65m/s to 85m/s (that is the minimum and maximum limit respectively), then speed is updated by using the equation
Updated speed=(calc speed +old speed)/2
Else old speed is retained in the updated speed.

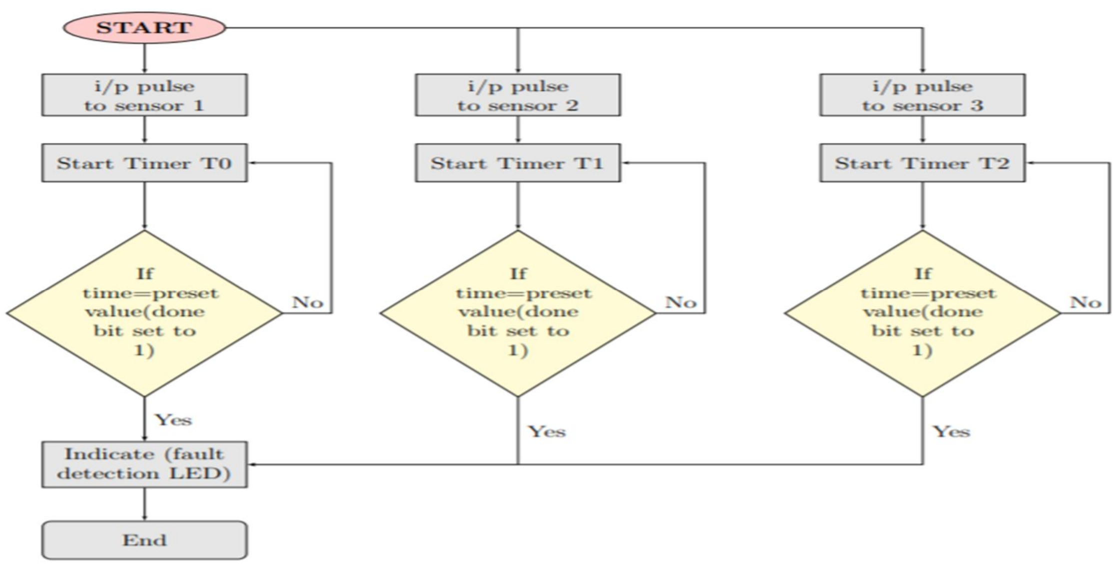

Figure 5: Fault Detection

Fault detection: with input pulse to each sensor, 3 timers T0, T1 & T2 (for sensor 1, 2 &3 respectively) will also start. If the timer value exceeds 3seconds (which corresponds to false baglength) then user is alerted by a red LED, else continuous monitoring of the system is done.

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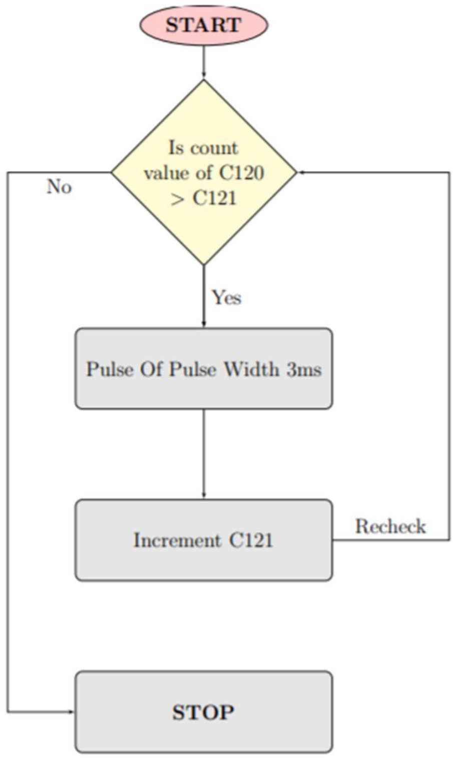

Figure 6: Pulse Counter

External pulse counter for easy visual display of count is also provided. Short pulse of 24v given to the counter will increment its value by 1. This value is continuously compared with the PLC counter. If it is not equal then the value is incremented until both the counters has same count. Timer interlocking is used to generate complete and accurate short pulse.

D. Prototype

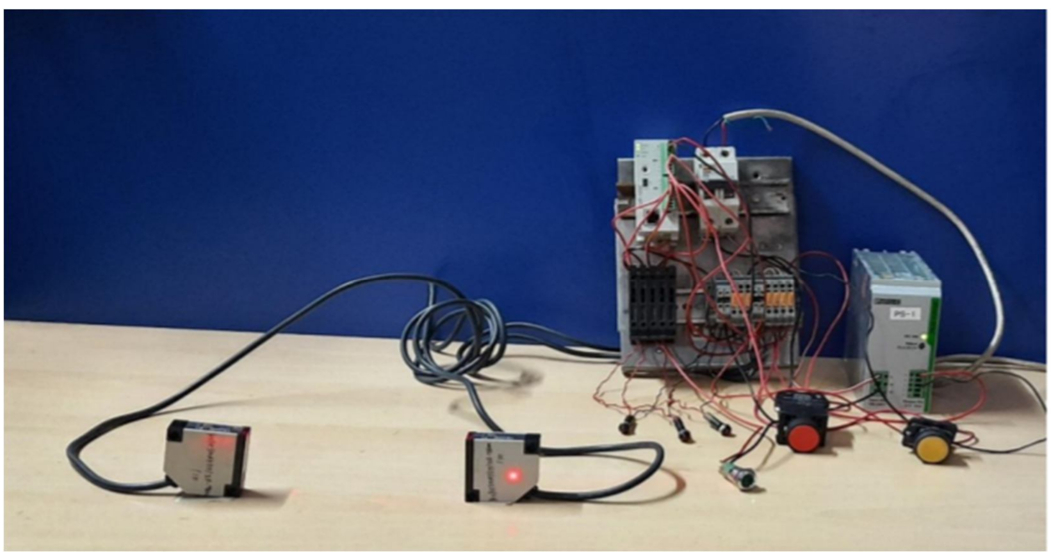

Figure 7: Prototype Model

After designing the model of the prototype, it was successfully implemented. The circuit is protected from short-circuit and overloading cases by using MCB (Miniature circuit Breaker). Terminal blocks are used to organize and safely connect two or more wires together.

IV. RESULT

While testing the above process data was successfully read by scada and displayed on the screen.

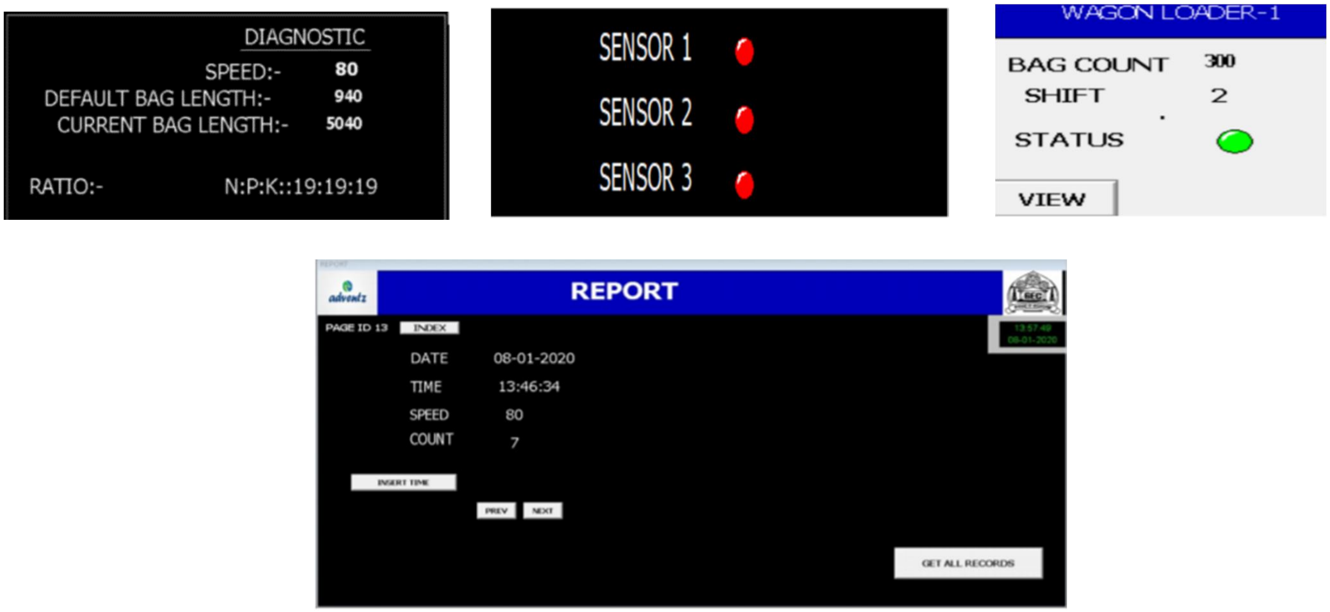

Figure 8: SCADA Screens

After the first shift at 2o'clock total count of bags are stored in the "First shift" tag and counting was continued from the "Second shift" tag. We could display the speed of the bags on the conveyor belt. System was indicating if the bagging process was healthy or faulty. Calculated Bag length of every bag was displayed on the screen. Report could be generated as an when the user wanted the data. system could notify if the sensors are working fine using indicators.

	DATE	TIME	SPEED	BAGLENG...	TOTALCOU...	FIRSTSHIFTCOU...	SECONDSHIFTCOU...
1	08-01-2020	13:41:00	0	0	1	1	0
2	08-01-2020	13:42:00	80	1040	5	5	0
3	08-01-2020	13:43:00	80	1040	5	5	0
4	08-01-2020	13:44:00	80	1040	5	5	0
5	08-01-2020	13:45:41	80	1040	5	5	0
6	08-01-2020	13:45:42	80	1040	5	5	0
7	08-01-2020	13:45:43	80	1040	5	5	0
8	08-01-2020	13:45:44	80	1040	5	5	0
9	08-01-2020	13:45:45	80	1040	5	5	0
10	08-01-2020	13:45:46	80	1040	5	5	0
11	08-01-2020	13:45:47	80	1040	5	5	0
12	08-01-2020	13:45:48	80	1040	5	5	0
13	08-01-2020	13:45:49	80	1040	5	5	0
14	08-01-2020	13:45:50	80	1040	5	5	0
15	08-01-2020	13:45:51	80	1040	5	5	0

Figure 9: Database Entries

From figure 9 we can observe PLC counter values are stored into database with proper date and time. Baglength of each bag is also stored into database as counting proceeds. Since data is recorded into the database is during first shift so count values are only present in first shift column.

V. CONCLUSION

Technology in industry is a use of control system. Hence, project makes an effort to introduce innovations in the industrial automation field. The proposed system was designed and developed to automate and monitor the counting process at urea plant at fertilizer industry using PLC and SCADA. Nevertheless, this system can be adopted at various plant as well as changing certain parameters in the software. Efficiency was increased by introducing belt stop condition. We thus hope to introduce the precision and reliability of technology in Industries and make conventional industrial practice free of human errors.

VI. FUTURE SCOPE

A. Here in our project we have worked with WPL software and delta PLC series. It can be done using various other PLC's and its softwares.

B. Data stored in database can be used to do industry analysis which will help them with opportunities and threats coming their way.

C. Some improvements can be made in SCADA to enable communication between several different machines/system having high accuracy.

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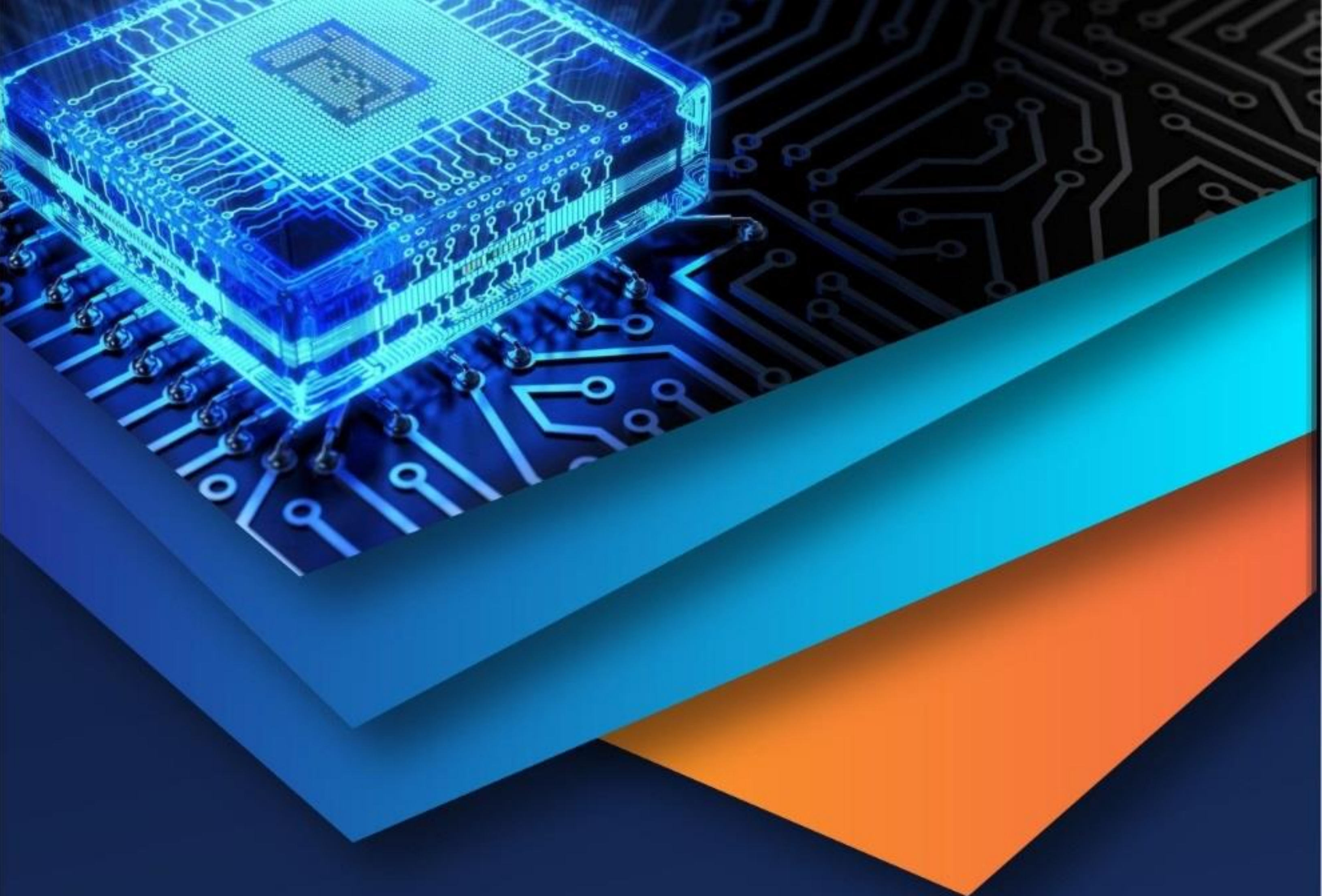

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