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DESIGN AND ANALYSIS OF PLC BASED INDUSTRIAL CONTROL SYSTEM

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ABSTRACT

The best quality production and the safety of human beings is the result of moderate and required conditions which are one of the most important industrial parameters. PLC is effective, fast responsive, and has a wide bandwidth. In this paper, we propose a technique of controlling different parameters of the industry through PLC based system by connecting the temperature, pressure, and level sensors with 2A4RTD. In any case of emergency, these sensors will detect the problem and making it easy to control and monitor the situation. 2A4RTD is a combo module that is used for taking analog and resistive inputs from the source, delivering them to the PLC 20-MAR board. PLC accepts the two analog inputs with the help of the 2A4RTD module, which has reduced the additional cost. After getting the information of the input signals, we can get the ranges of temperature, pressure, and oil levels. With the help of ranges, we can estimate the solutions to control their worst levels. Some components like the cooling fan, buzzer, and air conditioner will be connected with the relay or simply connected to the PLC board, to get the issues under control. Data will be collected and monitored through HMI.

Keywords: PLC, HMI, Temperature Sensor, Pressure Sensor

Introduction:

The moderate and required conditions are one of the most important industrial parameters for the best quality production and the safety of human beings. In the fields of scientific research and product manufacturing, controlling or monitoring pressure, liquid level, and temperature is very necessary especially in the case of atomic, metallurgy, fabrics, synthetic, fossil fuel, food, machinery, and building materials industries. To increase the efficiency of PLC logic code and reusing the code for multiple or different PLC categories, new technology is proposed. The ontology-based semantic model was developed. IEC 61131-3 cannot be used again., not just in terms of the file exchange format (syntactic), but also in the field of semantics. We offer an implementation of the auto-translation of XML schema and the PLC project into the ontology-

based knowledge model. PLC also provides security from cybercrime or cyber-attacks NNP environment using black chain technology [1-2].

For the effectiveness of heat control of different heat resources, a new method called dynamic matrix controller was introduced. It was dependent on the incorporation of nonlinearities. PLC was used as the main functioning block. DMC provides an equal balance between the performance control and PLC's memory load. It had used FOPDT approximations to perform operations on nonlinearities [3].

Developed a data collection and management system with an automatic lifting device, known as the data acquisition system. The micro-controller sends a motion control signal to the PLC, in accordance with the data to be processed. The PLC automatically develops the necessary speed and delay, operating curves, by the shift key. To get accurate speed control, motor control fuzzy PID approximation and the digital IIR filter method were used [4].

To improve the efficiency of thin-assessment, different NBI and IN properties, as well as a comparison of sparse recovery algorithms, have been tested to be able to exploit them, and the operational principle of IoT technology, the operational principle of RFID technology, and the operating mode of the PLC are to be considered as well. The creation of an automatic control system must be based on the status quo, development, general planning, and phased implementation by the school's real demands. The construction of a platform for the automatic settlement platform for the client's management subsystem, library monitoring subsystems, and access control subsystems must be addressed [5-6].

To investigate the responsiveness and voltage dip of different PLCs, several laboratory tests and mechanistic inspections were performed. It had shown that the rated voltage is affecting the responsiveness of the PLC. The voltage dip tolerance was dependent on the relationship of PS and DI modules in terms of AC-type PLCs. Whereas for DC-type, PLC's sensitivity didn't depend on the relationship of PS and DI modules [7].

To reduce the impact of linearity error of intelligent temperature transducer (ITT) operating characteristics and its offset and gain errors, experiments and simulations were done. Results had certified the exactness of functioning of the new auto-calibration procedure. It was elaborated that the resistor, power supply, and amplifier in the bridge were not necessary to implement. 4^{th}-degree polynomial presents the operating characteristic of the ITT measurement channel [8].

It was proposed that a small and low-loss PLC-based mode be used. The WFM technique was used to design a mode rotator with a curved trench construction. When compared to a typical straight-groove design, the suggested rotator mode, 45 percent of the overall volume (1.0 mm), and reduced loss (1/5) furthermore, the suggested mode rotator can be realized using low-mode interference. The suggested low-loss and small mode rotator device would be beneficial for the integration of PLC-based devices in multi-mode multiplexers [9-10].

A method is used to allow a designer to change the values, taken from SCT into a PLC application program, systematically corresponding to the international standard which states the main rules of PLC and Programming. The consequent program applies SCA which focuses on some problem that emerges in PLC-based control implementation, practically modeled as a DES. Using this method, one can reuse previous hardware and designed software for sequential controlling of subsystem [11].

Based on WFM optimization, a broadband PLC-based 2-mode MUX / DEMUX is suggested. Theoretical studies show that low-loss (0.3dB) and low-crosstalk (-13dB) losses can occur over a wide range of wavelengths ranging from 1400 to 1700 nm [12].

Using the system simulation process, the efficiency of the FFC design is improved under limited conditions. A lower 32bits valued is used in PLC to increase efficiency using a LU decomposition with pivoting, and a correction of operational sequences is developed. The main idea is to check whether the problem has been observed, which is compatible with the simulation of the behavior or not. The control signal is the data that is stored in the memory of a PLC that is used for this procedure [13-14].

Designed and integrated using a MUX/DEMUX mode, for LP01, LP11, A, LP11, B, and LP21 modes, all of which are operating in the C band, and with the help of silicon oxide, based on the PLC, with a uniform altitude of the LP11 mode controller. Our built-in PLC-based MUX/DEMUX mode, on a single chip, and for the first time, reached a multi-or the multiplexing of the four modes of operation. Developed two new "smart" electronic devices, which make the communication between the DSO and the communication bridge. Developed under CEI 0-21 standard measurement and safety requirements. In addition, most of the commercial, IP addresses, integrates the communication protocol and interface for communicating with both the DSOs (via PLC) and the inverters of DGs [15-16].

A new method of synchronizing time is based on IEC 61131-3 and model construction. The concept of extending the existing OPC level is also being developed. Suggested a standardized method for performing automated testing of complex structures (e.g., CTL, LTL) in PLC systems. This method is based on the Intermediate Model (IM), which seeks to transform PLC programs written in various standard languages (ST, SFC, and so on) into a range of modeling tools for verification tools [17].

Smart HEMS is designed to track, consumption, and performance. In the case of energy consumption, EMCUs are put in shops and lights to measure the energy consumption of household products, and the lamps using ZigBee, the data obtained is then transferred to the home section. The home server uses this software to determine the pattern of power usage in the house. PLC modems are put on each solar panel to check its status during electricity generation. The REG gathers status data for PLC solar panels as well as production data from RS-485 inverters and sends it to the home server. This PLC monitoring device can also keep track of each solar panel for maintenance purposes [18].

A new method for the transmission of the data was obtained during real-time monitoring of photovoltaic systems has been proposed. The voltage, current, and temperature of the PV panel are measured with the help of low-cost, intelligent monitoring, and the communication module and transmitted to the central control system is based on communication, materials, technology, power lines, the existing DC lines, thus avoiding the additional installation cost [19].

The quality of service (QoS) of wireless sensor networks (WSN) was primarily influenced due to the sensor node's failure. The percentage of sensor node failure was increasing because of the addition of the number of sensors. To tackle the problem, a method was presented, in which defective sensor node was marked up by calculating the RTD time of discrete round trip paths and comparing the calculated values with outset values [20].

To meet different industrial requirements, the temperature controlling and monitoring systems available on the market or in research laboratories vary in sensor and controlling channels configuration. Multiple AI-Meters were used to maintain communication between different channels. Without the check of bandwidth, number of bits for information frame, starting bit, number of terminating bits, odd or even parity, and digits that were transmitted between two communication sites because communication had been created in the operation of debugging [21].

Identified four key issues with the OPC interface: jitter, time delay, race status, and sluggish sample, and also proposed two solutions: A software-based solution is based on IEC 61131-3, as well as a new standard OPC solution [22].

Introducing the Web accessibility lab. For this, a PLC-based framework is developed to control the system. To monitor and manage the system, SCADA is installed in the test setup [23].

Two PLCs operate in the "master-slave" mode. In the first case, the master unit is being done, while the slave unit is in standby mode. The expansion module may be damaged, but with a lower failure rate than that of lead. During the operation, the final details of the master device and are, still to be sent to the slave [24].

The PLC regulates the operating parameters on the velocity required by the user, as well as the system's functioning in normal operating mode and shut down situations. Tests of an induction motor system driven by an inverter and controlled by a PLC demonstrate superior speed control precision when compared to a typical SI-control system. With the PLC control, efficiency may be enhanced to up to 95% of the synchronous speed. As a result, the PLC has earned a reputation as a flexible and effective instrument for use in industrial applications. They run in a synchronous, cyclic manner with a high degree of predictability. A response time of 1 m/s or even less, requires a very careful hardware selection. If a deterministic response time of less than 0.5 m/s is required, the PLC does not seem to be appropriate [25-26].

To perform Natural Language Processing (NLP) on sandhi language had used tokenization process. For the processing of tokenization different tools were deployed. In this process input language was converted into sentences, operations performed on IRT, sentences were broken into words, tokens in words and numbers were generated [27].

For face detection, a new method was introduced which works on the principle of MTCNN and enhanced the accuracy of the proposed network. This model was designed using python and cascades. Research had shown that HAAR is faster and MTCNN is better in the case of accuracy [28].

Proposed a method that described the resume ranking scheme for ranking the candidate’s CVs according to job requirements. For this, vector and word embedding mechanisms were deployed. Research had shown that word embedding was better than document vector [29].

The remaining part of this paper is structured as follows: describes the methodology and flowchart of the project. After that, it elaborates the experimental results of the project and gives the complete analysis that is available in the tabular format. Finally gives the conclusion and future work.

Methodology

Results and their description are illustrated below;

Block diagram

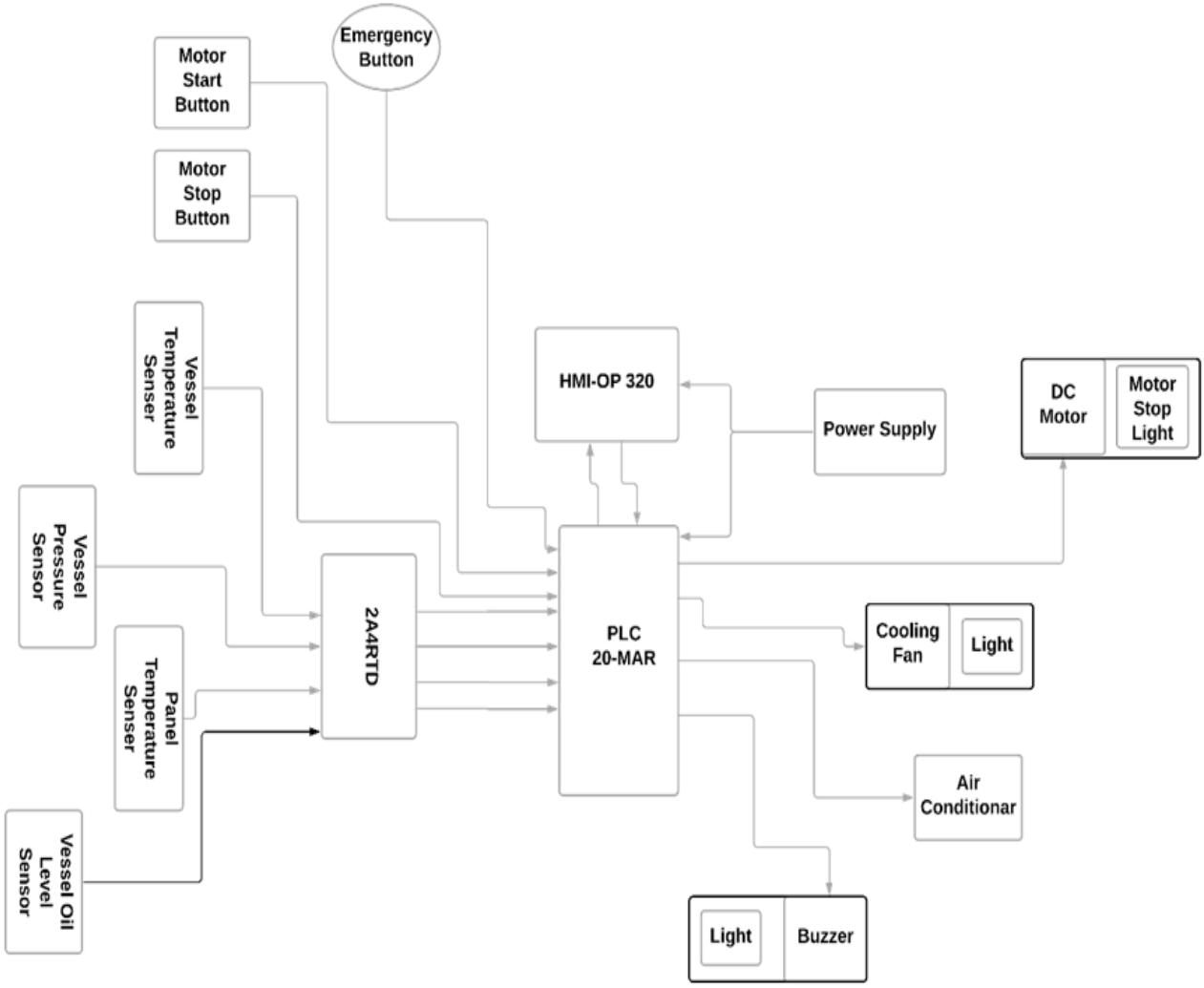

Fig. 1: Block Diagram of System

Description

The sensors after detecting the ambient conditions generate analog signals ranging between 0-10 Volts and transfer them towards the 2A4RTD combo card. After performing some operations on analog signals, the 2A4RTD module will transfer the signals toward the PLC 20 MAR. The PLC board performs the required actions according to the given conditions. Like, if the temperature is high or Oil level is low or it's crossing the limit and then the machinery temperature is high to a dangerous level according to the provided condition, PLC would start the fan, motor, air conditioner, and buzzer. At the same time, the data will be displayed on HMI.

Flow Chart

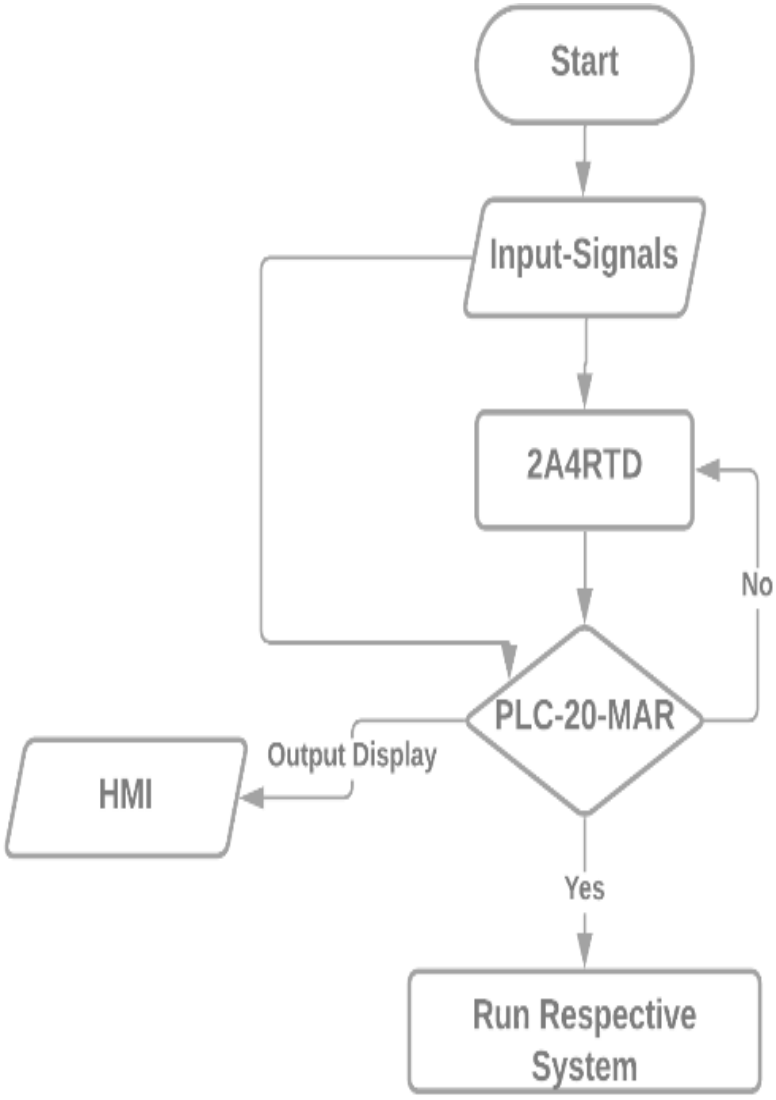

Figure. 2: Flow Chart of the System

Description

First, some of the input signals are sent to the 2A4RTD card and some of the signals are sent to PLC directly. Then these input signals are compared with thrash hold points at the comparator of PLC. And respective actions will be performed until the normal state is achieved. Its output, at the same time, will be displayed at HMI. The comparator with its logic will compare the input signals continuously.

Results and Discussion

Three sensors are used to control the vessel. A temperature sensor is used to monitor the internal temperature of the vessel. If the vessel temperature increases from the threshold condition, then the cooling fan turns ON to maintain the temperature level of oil. Whereas a pressure sensor is used to monitor the internal pressure of the vessel. If the oil pressure increases, then the buzzer started to alarm so that the control room can take safety actions. The oil level sensor will measure the level of oil in the vessel if the level is increasing or decreasing from the normal level then the motor will start or stop. There is another temperature sensor that is used to monitor the control room temperature. And if the temperature increases from a threshold value, then the air conditioner (AC) system of the room turns ON to balance the environment. Simultaneously, HMI is displaying the running state information.

Fig. 3: System Prototype

Vessel Temperature Monitoring

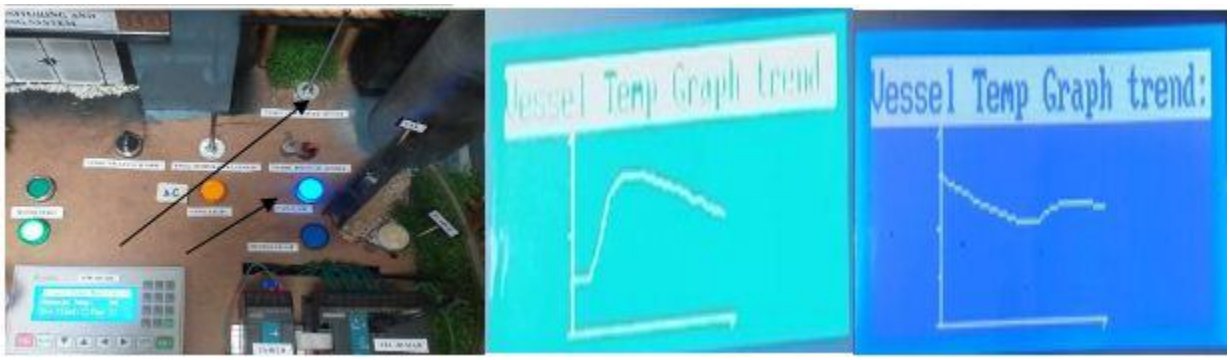

Fig. 4: Vessel Temperature Monitoring

Description

The vessel temperature sensor is measuring the temperature of the vessel and taking protective actions. Simultaneously, HMI is showing the temperature trend graph. On the y-axis, there are temperature (Celsius) values whereas on the x-axis there is time (seconds).

Pressure Monitoring

The vessel pressure sensor is measuring the pressure of the vessel and taking the defending actions. Simultaneously, HMI is displaying the running conditions like ambient pressure level and the moderate condition.

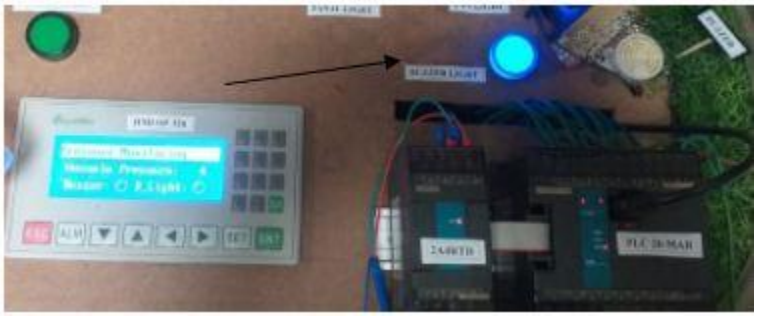

Fig. 5: Pressure Monitoring

Level Monitoring

The vessel level sensor is measuring the oil level of the vessel and taking the shielding actions. While simultaneously, HMI is displaying the running conditions like ambient oil level and the moderate level.

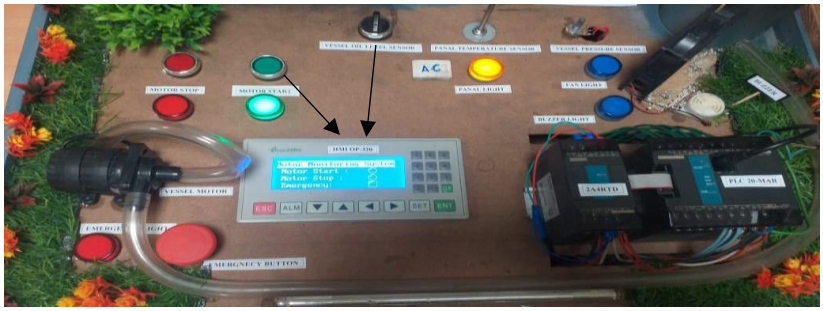

Fig. 6: Level Monitoring

Panel Temperature Monitoring

The panel temperature sensor is measuring the temperature of a control room and taking protective actions. Simultaneously, HMI is showing the temperature trend graph. On the y-axis, there are temperature (Celsius) values whereas on the x-axis there is time (seconds).

Fig. 7: Panel Temperature Monitoring

Conclusion

We have demonstrated a way to prevent, especially the industry from deadlier accidents that can lead any country toward economical and human lives crisis by the idea of system automation using PLC. We have used PLC FATEK-Fbs 20-MAR to control the industrial environment. To save cost, a 24ARTD combo module is deployed with PLC. It provides the compatibility of transferring the analog signal to PLC without the use of an A/D convertor. RTD PT-100 is used to sense the temperature. It is highly sensitive. It provides temperature ranges from 0° - 600° C. HMI (OP-320) has been connected to the control station for monitoring the running processes in the industry. It has some limitations like PLC, sensors, and other components that are of high cost. Sensors are highly fragile that they can break with a minimum hit. Data transfers rate is slow as compared to Nano controller. In the future, we are aimed to transmit data through Wi-Fi on the internet, so that we can monitor and control industrial systems through the online system. At the same time collected data will be monitored or controlled through HMI and sent to an open cloud source, any web page, or mobile application with the help of a Wi-Fi module. It will be helpful for industries as the information can be assessed easily through Wi-Fi no matter what is the location.

The results are concluded here in the following Table I.

Table I: Results

No. of Observations	Parameters	Normal Condition	Threshold Condition	Graphical Ranges	Graphical Time Span
1	Vessel Temperature	0° C ~ 34° C	35° C <=	33° C~ 89° C,	0s~90s
2	Vessel Pressure	0 ~ 3 Psi	4 Psi<=	-	-
3	Vessel Oil Level	150m ~ 200m	200m <	-	-
4	Panel Temperature	0° C ~ 39° C	40° C<=	24° C ~ 69° C	3s ~ 70s

Author's Contribution: H. S., and A. S., gave the idea; H. S., Designed the simulated work, and A. S., had collected or purchased the required data or components. H. S., A. S., and S. A. K., have integrated the system. Grammatical edits or Critical revision were done by H. S.

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