"Industrial Automation: A Comprehensive Review of Innovations, Trends, and Challenges"

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Abstract: The use of various control systems to run machinery, manufacturing processes, boilers, heat-treating ovens, telephone network switching, ship and airplane steering and stabilization, and other applications with little to no human intervention is known as automation or automatic control. The main advantage of automation is that it increases quality, accuracy, and precision while consuming less labour, energy, and material. Industrial automation is one area that commonly uses wireless communication technologies. Both vertical and horizontal mold fastening are possible with injection moulding machines. Actuators, smart sensors, and wireless communication offer pathways for the long-term development of automation technology. To find out more about industrial automation, 15 research publications published between 2000 and 2013 were screened using a two-stage process. Four primary issues were identified following a thorough evaluation process: "Controlling method of injection molding machine for new technologies, new trends in industrial automation, energy storage in co-generation power plant & wireless data transmission." These issues mostly require improvements in industrial automation components in order to have a better solution approach. The review yielded a number of conclusions that were categorized under different major topics. The findings included a discussion of the advantages and disadvantages of the algorithms and techniques employed to address specific research problems, as well as the potential for further study in the field.

Key words: **Co-generation power plant, Data Transmission, VDF**

I. Introduction

The drive system and electronic controller comprise the control system for the plastic injection moulding machine. The three categories of electronic controllers are microcomputer controllers, PLC controllers, and conventional relay controllers. Classic relay controllers are currently used less often because of their complex circuitry, poor precision, and difficulty in maintaining and changing them. The PLC controller is expensive even though it offers several benefits, such as strong anti-interference capabilities, high dependability, ease of programming, and ease of maintenance. ZigBee is the only standards-based wireless technology designed specifically to satisfy the needs of low-cost, low-power wireless sensors. The best thing about IEEE standard 1588 is that it speeds up control methods by removing process delays. The power plant can store energy more easily by using modern energy storage technology. A capacitor bank can be easily expanded whenever its value has to be increased.

II. Review Process Adopted

To learn about the study topic and what issues have been resolved or need to be resolved in the future, a literature review is essential. To make the procedure easy to understand and flexible, this review process approach was broken down into five parts, which were as follows:

Stage 0: Get a “feel”

When starting a literature review with a more thorough domain and classifying them according to the requirements, this stage provides the information that needs to be confirmed.

Stage 1: Get the “big picture”

Groups of research papers are formed according to application subfields and common challenges. To find out the answers to some of the questions, you must read the title, abstract, introduction, conclusion, and titles of the sections and subsections.

Stage 2: Get the “details”

Stage two involves a thorough analysis of each research paper to understand the methodology employed to support the problem, the novelty and relevance of the solution approach, the particular topic treated, the main contribution, the scope, and the limitations of the work provided.

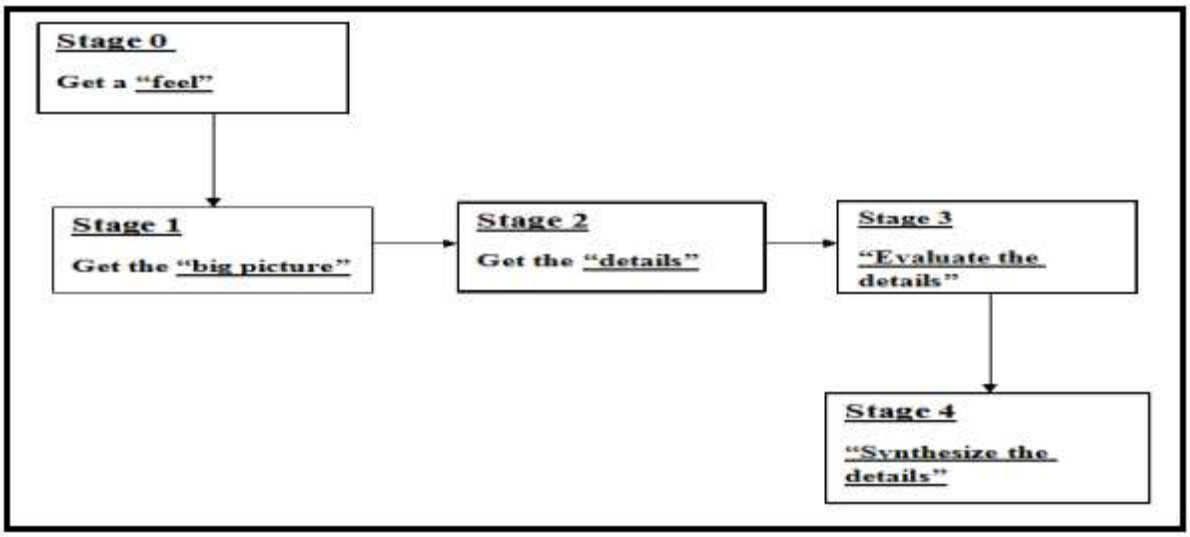

Fig: 2.1 Review Process Adopted

Stage 3: "Evaluate the details"

This step assesses the specifics in light of the problem's importance, its novelty, its solution, its strategy, the veracity of its claims, etc.

Stage 3+: "Synthesize the detail"

Evaluation of the information provided and some generalization are the topics of stage 3+. The synthesis of the writers' data, concepts, and findings is the focus of this step.

III. Various Issues In The Area

The following concerns need to be addressed throughout the design and implementation of the injection moulding machine, according to our assessment of 15 research papers on controlling injection moulding machine parameters:

1) Managing the injection moulding machine's operation for emerging technologies
2) New developments in industrial automation
3) Cogeneration power plant energy storage
4) Data Transmission via Wireless

IV. Issue Wise Discussion
Issue 1:- Controlling method of injection moulding machine for new technologies

One of the problems with new technologies is controlling injection moulding machines. Some solutions have been developed to address this problem, such as using relay logic to control the injection moulding machine's process, which is very difficult. Instead, embedded system logic is used to control the injection moulding machine; this method is superior to relay logic and offers a simple and efficient way to control the hydraulic system. A new framework architecture is required to design automation control systems due to the growing complexity of automation applications. The best method to lessen the growing complexity of automation is to use automation components such as component-oriented design, reusability, and image structure. Because the component can be tested using its internal test capability, this method saves important development time. The creation of a distributed control system for PLC-based applications is improved by the use of hardware structure, system software architecture, and experimental plate form. PLC-based technologies and applications are a very practical and efficient way to increase the quantity and quality of products.

Issue 2:- New trends in industrial Automation

The second problem is new trends in industrial automation. To solve this problem, a simulation method for induction motor speed control utilizing Lab View software was employed. One of the most important pieces of software is LabVIEW. Today's industries rely solely on remote processes for control applications. The user typically sits in a secure location away from the workplace and controls the plant while ensuring that the system parameters are optimized. In this case, simulation software is essential to the Industrial Monitoring and Control system. The primary challenge in the field of design is that most issues arise when a big number of control circuits are used, as this results in an unnecessary number of wires. In order to reduce the number of hardwired circuits and make it easier to visualize things moving or happening graphically, we can use simulation software to implement

these circuits on a simulation level. Even designing control of remote systems is impossible since it would require enormous, hard-wired circuits. However, simulation programs have made engineering design simple and use less material. It asserts that selecting Lab View as the human-machine interface for implementation is the right choice because it offers a variety of applications and features that are simple to comprehend and utilize. Secondly, this method is more cost-effective because the goals and system flaws can be found without the circuit being implemented. This paper specifically focuses on using LAB VIEW to control an induction motor and its variables, such as speed and direction. However, there is another issue with the simulation software, which is insufficient because it is unable to produce the desired result and only has three multilevel references in the VDF when controlling speed. Therefore, this needs to be improved for better controlling and simulation.

Issue 3:- Energy Storage in co-generation power plant

The third issue is energy storage in cogeneration power plants. To address this, two technologies for electrical power storage were compared. One is a traditional approach, while the other is a contemporary methodology. Battery storage is used in conventional power storage methods, whereas capacitor banks are used in newer methods for electrical storage. It is insufficient due to the numerous challenges and intricate connections involved in the new installation of capacitor bank storage. attempted to provide a better option for electrical storage in an attempt to address the issue of traditional power storage. Even though this is just a recommended approach for electrical power storage, the limitations of the provided alternative are very comparable to those of the standard method. This will be a superior option for electrical storage in solar plants due to its simpler circuitry and lower cost of investment.

Issue 4:- Wireless Data Transmission

Engineering Approach for Secure and Safe Wireless Sensor and Actuator Networks for Industrial Automation Systems, which incorporates the security concept in the context of industrial automation, is one method that has been utilized to address the fourth issue, transmission. It introduces an approach to automation networks that is both comprehensive and simple to deploy. The problem is justified using comprehensive methods, such as security protocols, and VEST (Virginia Embedded Systems Toolkit) projects that concentrate on creating efficient composition. However, a security solution must make sure that an attacker's potential cost to breach the system is greater than the expense of doing so. An engineering technique was used to obtain a solution approach for handling security concerns in the context of industrial automation. The three steps of the solution—the development flow, the selection process inputs, and the mapping from requirements to workable solutions—collected and analyzed data. A trustworthy objective engineering of appropriate system solutions is promised by the suggested development path. A comprehensive goal definition and an iterative composition method that naturally utilizes and expands on prior knowledge are two of the flow's key ideas. This holistic method is dependable, secure, and safe. Utilizing ZigBee to Apply Short-Range Wireless Technologies to Industrial Automation. For short-range communications, four widely used wireless technologies are Bluetooth, ultra-wideband (UWB), ZigBee, and Wi-Fi. In particular, the ZigBee network is a new technology that focuses on device-level communication to enable wireless sensor networks. It is made for low-cost, low-power, and low-rate wireless personal area networks. ZIGBEE creates wireless networks that should be inexpensive and low power users. As a result, it has been utilized extensively in a variety of applications, including wireless sensor networks, location and position, industrial control, home automation, and telecommunication.

V. Issue Wise Solution Approaches Used

Table 6.1 to 6.4, which also contains other details like hardware, software, and variables/parameters employed, as well as the outcomes obtained, display the solution approaches under the various issues. The comparative analysis of different solution approaches is also described in the same table.

VI. Issue Wise Discussion On Results

Issue 1:- Controlling method of injection molding machine for new technologies

S. No.	Solution Approach	Results
1	Injection Speed Controlling Algorithm	Product quantity increases
2	Numerical Control of Machine Tools	Reduce dangerous ,boring & difficult jobs in manufacturing plant
3	Class 1 PC programming software , Class 2 PC monitoring software	Flexibility , Scalability increase
4	Direct Teaching Algorithm	Automation operation easy for not trainer worker
5	Use new Automation components i.e Mechatronical components	Reduce valuable development time

Table 6.1 Issue wise Solution Approaches & Result

Issue 2:- New trends in industrial Automation

S. No.	Solution Approach	Results
6	LAB VIEW is suggested to be good simulation software with easy understanding and simple functions.	It is easy to integrate with other devices. It has less no. of Voltage divider frequency. It is better software in comparison to other.
7	IEEE 1588 algorithm which is actually a time based control algorithm which is more better over traditional control techniques like scan- based and many other	It is a faster approach. Removes delay of the process. It is hard to migrate control devices particularly I/O to the 1588 standard.
8	R-Field bus which is a radio based physical layer based on the existing and available radio technologies in the LAN.	R-Field bus is a radio based physical layer. This meet the entire user requirement & industrial environment hurdles
9	The proposed solution relies on a series of simple concept of new architecture with different layers.	Author defends the solution with new architecture approach.
10	Simulation software Lab View, Lab view virtual instrument development platform is a graphical programming language.	This approach reduces the development time. DP provides the needed flexibility & scalability in control plants design.

Table 6.2 Issue wise Solution Approaches & Result

Issue 3:- Energy Storage in co-generation power plant

S. No.	Solution Approach	Results
11	Alternative of energy storing system	Alternatives for energy storage system proves better storage system compare to conventional one
12	Cogeneration heating of working fluid in plant	Fluid heating can be done in much economical way by using given method in the paper
13	Two stage thermal energy storage system	Plant can be operated in two stages it will reduce the cogeneration problems

Table 6.3 Issue wise Solution Approaches & Result

Issue 4:- Wireless Data Transmission

S. No.	Solution Approach	Results
14	ZIGBEE Technology	Developing a wireless network which should be low Power consumptive with low cost & in reduction of wiring cost, labour cost & Maintenance cost.
15	FRS,TRS Technology	Provides multi-platform solutions for testing

Table 6.4 Issue wise Solution Approaches & Result

VII. Common Findings

Issue 1:- Controlling method of injection molding machine for new technologies

- PLC-based technology and applications are a very practical and efficient way to increase product quality and quantity, among other things.
- An efficient and simple method of controlling the injection molding machine's sequence is to use an embedded system based on a hydraulic circuit and microcontroller.
- Relay logic makes process control extremely difficult, hence injection molding machines use embedded systems to control processes.

Issue 2:- New trends in industrial Automation

- Selecting Lab Considering the human-machine interface for implementation is a wise choice because it offers a variety of applications and functions that are simple to comprehend and utilize. Secondly, this method is more cost-effective because the goals and flaws in the system can be found without the circuit being implemented.
- Instead of employing conventional control methods, the research focuses on the trend in manufacturing toward faster and more precise part production through the use of IEEE 1588, or time-based control systems.
- Based on the current and accessible radio technologies in the LAN and WAN domains, R-Field bus is a radio-based physical layer.

Issue 3:- Energy Storage in co-generation power plant

- Given the current circumstances, solar energy storage systems ought to be swapped out with more contemporary ones, as the former are less reliable than the latter.
- To verify the disparate performances of the two-stage thermal energy storage system, an analysis of the solar power tower plant was carried out.

Issue 4:- Wireless Data Transmission

- The invention of multiple hop topologies is the foundation of ZIGBEE technology, despite the fact that algorithmic research is not its foundation.
- When it comes to cost and power consumption, Zigbee can help with data transfer and continuous physical parameter monitoring in mobile networks.
- When it comes to cost and power consumption, Zigbee can help with data transfer and continuous physical parameter monitoring in mobile networks. The modulation method used in Zigbee networks, known as Direct Sequence Spread Spectrum (DSSS), effectively blocks electrical interference. The solution approach was obtained using ZIGBEE technology and an XBEE trans receiver.

VIII. Work Scope in the Area

- One of the key challenges facing the automation industry is information security management.
- The primary cause of the problem is the introduction of new ICT technologies into the field. There is a noticeable trend of convergence in the field's solutions toward common ICT solutions, especially IP-based communication and de-facto operating systems.
- The Autonomic Network concept can increase the productivity of intelligent applications in intelligent surroundings. Look at the most recent strategies to improve automation security management.

IX. Conclusion

An assessment of fifteen research articles in the subject of industrial automation has been carried out in order to ascertain the present problems and scope of the topic. After the review, we identified several issues that must be appropriately addressed when security is enhanced, including the control of injection moulding machines for new technologies, new developments in industrial automation, and wireless data transmission and energy storage in cogeneration power plants. An overview of several security issues and the regulatory work done in the integrity field is given in these articles. These ideas aim to improve system reliability and reduce security risks.

Today, simulation software has made a name for itself in the rapidly changing field of industrial automation. We can see how the plants react long before they are initiated. Time is also important; IEEE standard 1588 uses a rapid time-based control method to improve system delays. Findings about the topic of industrial automation and the scope of the research project for the first semester of the M. Tech degree may eventually be extracted from the comprehensive review.

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