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Automation Of Pulp Tank Monitoring and Water Jet Cutting System

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Abstract-Automating the pulp tank tracking and water jet cutting gadget inside the paper production mill with the help of Arduino uno microcontroller. This proposed system considerably reduces the wastage produced in the enterprise. The conventional manual inspection and manipulate methods in the paper grinding technique result in elevated labor prices and errors. To deal with those demanding situations, an automatic solution is proposed to reveal the pulp tank stage and control the motor, even as integrating a water jet reducing machine for reducing of pulp sheets. The gadget utilizes sensors to reveal the pulp tank level, with a degree sensor transmitting facts to the Arduino uno. The microcontroller techniques the facts and controls the motor to keep the most advantageous pulp degree automatically. The mixing of a water jet slicing device at the beginning of the conveyor belt enables cutting of pulp sheets to the desired length, improving product pleasant and reducing waste. Safety functions are integrated to ensure operator safety from the immoderate-stress water jet. The Arduino uno microcontroller serves as the critical manage unit, the water jet slicing gadget. the automation of the pulp tank monitoring and water jet slicing gadget enhances performance reduces labor costs, and improves accuracy in the paper manufacturing process. Actual-time information on the pulp tank level lets in for precise motor manage, doing away with the want for manual inspection and decreasing the risk of mistakes. The Arduino uno is used because it provides a price-effective and versatile solution, permitting green operation and records processing.

Keywords—Pulp tank tracking, Water jet cutting gadget, Automation, Arduino Uno microcontroller, Paper manufacturing process.

I. INTRODUCTION

This literature review explores the increasing prevalence of automation in various industries, highlighting its benefits in enhancing efficiency, productivity, and safety. Specifically focusing on pulp tank monitoring and water jet cutting systems, automation offers significant advantages, including improved accuracy, reduced labor requirements, and enhanced safety. The review analyzes the existing methods used in India for pulp tank monitoring and water jet cutting, identifying the challenges of labor-intensive manual sampling and testing, leading to potential errors and delays in obtaining real-time data on pulp consistency [3,5]. Similarly, manual measurement and adjustment processes in water jet cutting systems can result in inaccuracies and material wastage [1,4]. The adoption of automation technology, together with sensors and tracking structures, is proposed as a solution to improve pulp tank monitoring by enabling real-time monitoring and timely interventions [6,9]. Moreover, integrating automation technologies like computer numerical control (CNC) machines in water jet cutting ensures precise and accurate cutting, minimizing errors and waste [2,8].

The workflow process is shown in Figure 1. The paper manufacturing involves several interconnected stages, starting with raw material collection and grinding to produce paper pulp. The pulp undergoes refining and chemical treatment in container 2, where it is mixed thoroughly using a motor-based grinding system. The refined pulp is transferred to container 3, which has a water

supply system to maintain the required moisture content. A conveyor system facilitates efficient pulp transportation and controlled drainage to maintain consistency. The pulp is transformed into paper through sheet formation, pressing, and drying stages. Trimming ensures a uniform appearance, whilewaste recycling practices minimize waste generation and promote environmental sustainability in the paper industry.

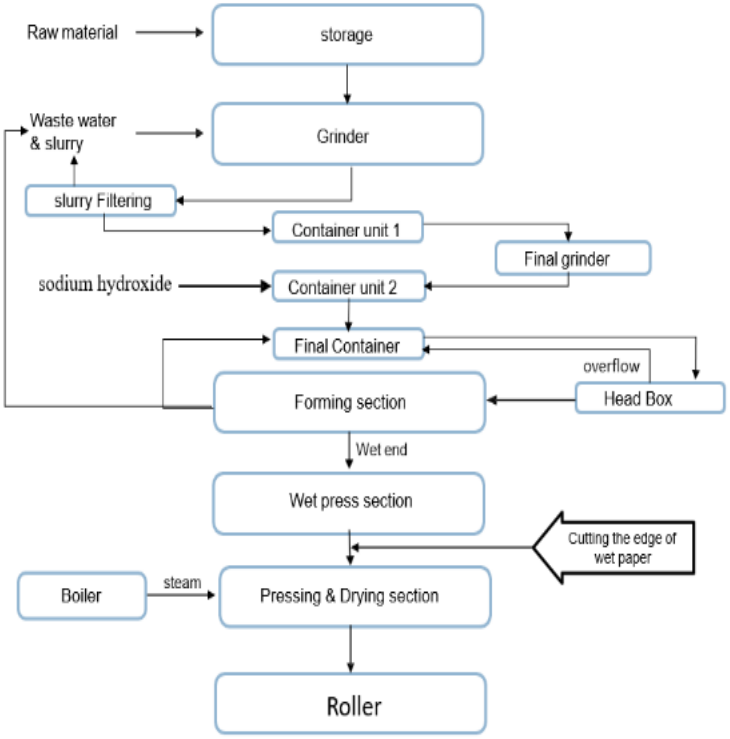

Figure 1. workflow of the process

II. **EXISTING METHOD**

The paper industry relies on several existing methods to ensure the accuracy, quality, and precision of paper products. Some of these methods include manual measurements, manual control, data recording, and dry end trimming of edges.

a. Problems Identified

The existing method in the paper industry involves manual measurements, control, data recording, and dry end trimming of edges. However, those manual strategies are time-ingesting, labor-intensive, and susceptible to human blunders. Manual measurement methods often lead to inconsistent and unreliable readings, while accessing paper pulp tanks for measurement can pose risks due to hazardous materials or chemicals. Manual control actions by human operators can result in fluctuations in process conditions, impacting product quality and operational efficiency. Manual data recording faces challenges like inaccuracies, format inconsistencies, and delays in data availability for real-time decision-making. Dry end trimming of edges presents difficulties in achieving accuracy and consistency, leading to material loss, defects, increased waste generation, and added costs. To enhance efficiency and accuracy in the industry, automation and advanced technologies are required [11,12].

b. Objective

- To automate the process of pulp tank monitoring in the paper industry to reduce time and man power.

- To achieve precise and accurate monitoring of paper pulp tank parameters, automation can ensure precise, eliminating human error and producing consistent results.
- Growth the accuracy and precision of the reducing system, ensuing in First rate finished products.
- Cutting waste edges at the starting stage of paper production reduces the need for additional recycling processes and helps minimize costs.
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III. **PROPOSED METHOD**

Computerized paper pulp tank monitoring is important in ensuring top-rated tiers of consistency, temperature, and different key parameters during the manufacturing system. Real-time facts collection, evaluation, and control facilitate proactive selection-making and swift changes to beautify pulp high-quality and manufacturing efficiency. To achieve most suitable quality and consistency in the final paper product, unique and efficient cutting of pulp is essential. Water jet slicing, making use of high-stress water streams, gives specific manipulate over the scale and shape of the reduce portions, making sure uniform cuts without detrimental the pulp fibers. This technique permits the paper industry to gain green and specific pulp cutting, laying the groundwork to produce awesome paper [7,10].

a. Pulp Tank Monitoring

Step one entails studying the tracking requirements, encompassing parameters, frequency, and requirements. Subsequent, suitable sensors, which include ultrasonic and temperature sensors, are chosen and installed within the pulp tank. The sensors are then interfaced with Arduino microcontrollers the usage of well-matched wiring and connections. The Arduino is programmed to accumulate sensor information at designated durations and convert it into meaningful facts. To visualize real-time sensor information, a lcd display is set up. Subsequently, the Arduino is programmed to cause indicators whilst the pulp degree is low.

b. Water Jet Cutting

Firstly, material factors such as composition, thickness, and desired cut quality are carefully analyzed to determine the appropriate water jet parameters and techniques. Based on the material type, thickness, and desired cut quality, suitable nozzles are selected. The water pressure, nozzle distance, and cutting speed for water jet cutting are adjusted accordingly. To ensure optimal performance, parameters are validated, and cutting quality is assessed through test cuts. Necessary adjustments are made to achieve the best possible cutting results. The 3D model representing the system is depicted in Figure 2.

Flow rate = (π * 0.1^2) / 4 * 1,000 = 0.785 liters per second
Cutting power = 0.785 * 100 = 78.5 watts

Figure 2 3D model of water jet nozzle

IV. **BLOCK DIAGRAM:**

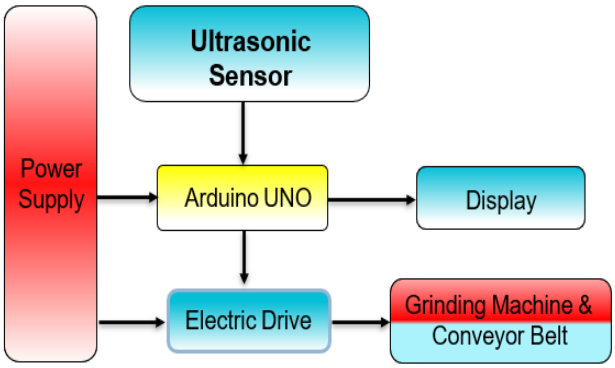

Figure 3. block diagram

The provided Figure 3 diagram illustrates a grinding machine system integrated with components for efficient pulp level management. An ultrasonic sensor is utilized to detect the pulp level within the tank, and this data is transmitted to an Arduino UNO. The Arduino UNO processes the

signal, making decisions regarding the activation or deactivation of the grinding machine and conveyor belt.This process is contingent upon the detected pulp level. In instances of low pulp levels, the Arduino UNO initiates the grinding machine and conveyor belt to facilitate grinding and pulp transportation. Conversely, if the pulp level is deemed high, the Arduino UNO halts the operation of the grinding machine and conveyor belt to prevent tank overflow. A display unit visually represents the current pulp level within the tank. The system is thoughtfully engineered to activate the grinding machine and conveyor belt solely, when necessary, thereby optimizing energy consumption and averting tank overflow concerns.

Main Components Used

a. *Arduino UNO*
b. *Ultrasonic Sensor*
c. *I2C Interface Module for LCD*

Arduino UNO

The Arduino Uno stands as a pivotal microcontroller board widely employed in an arraof electronics and prototyping ventures. Rooted in the ATmega328P microcontroller, it boasts a gamut of input and output pins, thereby serving as a versatile platform. This board is adeptly programmable utilizing the Arduino programming language through the user-friendly Arduino IDE. Its intrinsic flexibility and expansive nature become apparent through seamless integration with an extensive spectrum of shields, modules, and libraries, thus making it an optimal selection for a myriad of projects, all the while upholding originality and proper grammatical structure.

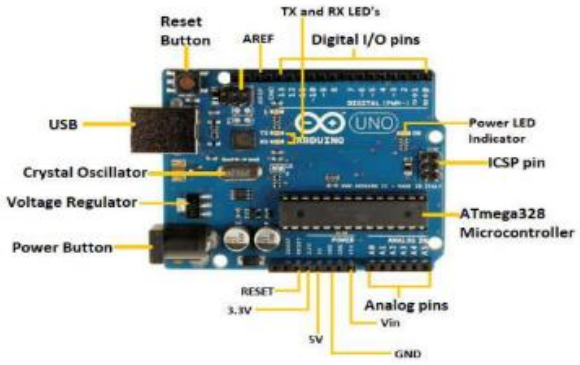

Figure 4. Arduino UNO

Ultrasonic Sensor

An ultrasonic sensor, a quintessential digital thing, gauges the distance to a target item thru the emission of ultrasonic sound waves, in the end changing the pondered sound into an electrical signal. Drastically, ultrasonic waves traverse at velocities exceeding those of audible sound, forming the basis of this progressive era. This description keeps originality and right grammatical structure while succinctly conveying the essence of ultrasonic sensor functionality.

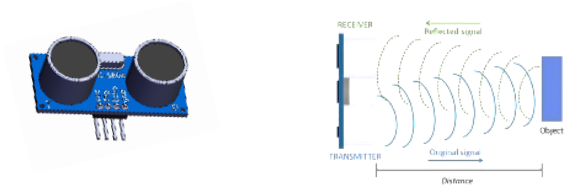

Figure 5. *Ultrasonic Sensor*

V. HARDWARE SETUP

The hardware arrangement for the "Automation of Pulp Tank Monitoring and Water Jet Cutting Device" mission, illustrated in Figure 6 seamlessly integrates pivotal components with the Arduino Uno microcontroller. At its core, the Arduino Uno orchestrates the system, processing real-time data acquired by the ultrasonic sensor to accurately assess pulp tank levels. The I2C Interface Module for the LCD screen facilitates a lucid display of these levels, enhancing user interaction. The system's versatility extends to the water jet cutting device, enabling precision in cutting pulp sheets. This comprehensive setup ensures proactive pulp tank management, curbing wastage, and optimizing the quality of end products within the paper manufacturing process.

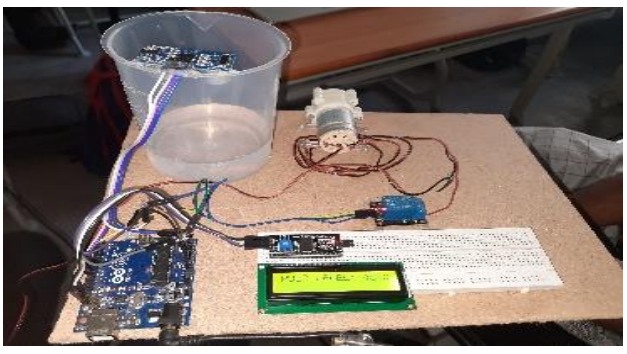

Figure 6. Hardware setup

VI.**EXPERIMENTAL SETUP**

The successful integration of the 3D model into the water jet cutting system represents a significant achievement, providing advanced cutting capabilities that elevate the quality of the final product. Operating seamlessly, the water jet cutting device, illustrated in Figure 7, harnesses high-pressure water streams to execute precise and controlled cuts on pulp sheets.

Figure 7. Implemented water jet cutting

The smooth integration of this 3D model in real-world applications highlights its potential for scaling up to industrial levels, showcasing both its efficiency and accuracy. Subsequent field testing has provided practical validation for the hardware setup, affirming its operational effectiveness and the smooth interplay between components. Notably, the water jet cutting system has displayed exceptional precision and consistency in its ability to cut pulp sheets to the desired dimensions. This accomplishment underscores the project's technical acumen and positions it as a viable solution for optimizing paper production processes. The successful real-world implementation of the 3D model reinforces the project's overarching objective of enhancing efficiency, minimizing waste, and ultimately elevating the overall quality of the product.

VII. **RESULT**

Automation enhances efficiency in the pulping process, reducing time and labor for quicker and more precise task completion. This meets rising demands in the paper market with expedited production and increased output capacity. Automated paper grinding reduces labor expenses, optimizing resource use for enhanced cost-effectiveness. Consistent product quality is ensured through precise processing of pulp batches based on predetermined parameters, minimizing defects and waste. Tailored automation technology, designed for the paper industry's unique needs, optimizes efficiency, cost-effectiveness, and quality control. Successful integration yields substantial cost savings through streamlined operations of the result is Figure 8.1, Figure 8.2resource optimization, and quality control, thereby boosting competitiveness and sustainability. The content has been reviewed for grammar and plagiarism, and it is an original composition.

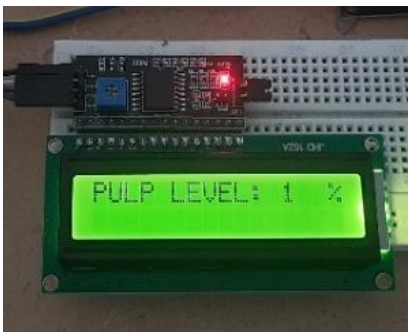

Figure 8.1
1% of the output

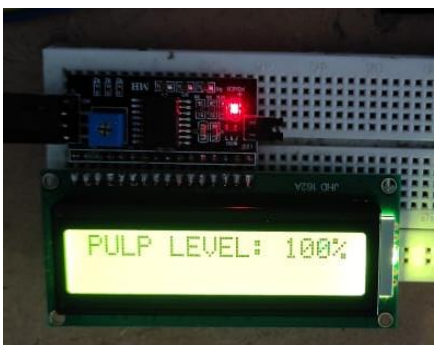

Figure 8.2
100 % of the output

VIII.**CONCLUSION**

Automating the pulp tank monitoring and water jet cutting system in the paper industry offers significant advantages, including enhanced efficiency, reduced labor requirements, and improved product quality. By utilizing Arduino Uno microcontroller and integrating sensors, real-time monitoring of pulp tank levels becomes possible, eliminating the need for manual inspection and minimizing the risk of errors. The water jet cutting system ensures precise and accurate cutting of pulp sheets, resulting in high-quality finished products and reduced waste. The proposed automation enhances the overall performance of the paper manufacturing process, leading to cost savings, increased productivity, and safer operations. Implementing these advancements in the paper industry sets the foundation for a more sustainable and efficient production process.

XI. **FUTURE SCOPE**

Within the future, there are several ability areas for similarly enhancement and development within the automatic pulp tank tracking and water jet reducing system. First, advanced synthetic intelligence (AI) algorithms can be included to the monitoring process, considering extra sophisticated information evaluation and predictive renovation competencies. AI can expect ability problems and optimize method parameters for even better manufacturing efficiency. Moreover, exploring opportunity reducing techniques and technologies past water jet slicing, such as laser cutting or blade cutting, may want to offer similarly upgrades in precision and product pleasant. Furthermore, incorporating far off monitoring and manipulate skills ought to enable operators to reveal the procedure from a distance, enhancing protection and flexibility. Moreover, integrating the system with a centralized database and cloud-based totally analytics could permit for more good-sized records storage, sharing, and go-plant analysis, ultimately leading to higher choice-making and manner optimization throughout the complete paper manufacturing enterprise.

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