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Automatic Warp and Weft Stop System in Manual Loom

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Abstract
In the textile industry, the loom serves as one of the most critical machines for fabric production. The manual loom, in particular, has been a significant part of the weaving process for centuries. However, one of the major challenges in operating manual looms is the issue of thread breakage, particularly with the warp and weft threads. When either of these threads breaks, the loom continues operating without realizing the fault, which results in defective or incomplete fabric. This leads to wastage of materials, time, and labor. Moreover, manual intervention is required to fix the breakage, causing production delays. As the textile industry shifts towards automation and more efficient production methods, the need for an automated solution to handle warp and weft thread breakages has become more pressing. The Automatic Warp and Weft Stop System is an innovative solution designed to address this problem by automatically detecting thread breaks and halting the loom's operation. The introduction of such a system enhances the productivity of looms by reducing downtime caused by thread breakages, improving the quality of the fabric produced, and minimizing human intervention. This system is composed of sensors, controllers, and actuators integrated into the loom to monitor the threads during the weaving process. The sensors are responsible for detecting when either the warp or weft thread breaks, and they immediately send signals to the control unit. Once the breakage is detected, the control system activates the actuator to stop the loom. This automatic stopping process prevents further damage to the loom and fabric and ensures that the break is addressed before continuing the weaving process.
Keywords: *Raspberry pi 3 model B, Warp pin sensor, IR sensor, Relay, LCD Display.*

1. Introduction
The Automatic Warp and Weft Thread Stop System is designed to improve productivity and efficiency of weaving operations through technology integration. It eliminates lost machine hours because the system controls the startup and shutdown of the weaving machine in cases when warp or weft threads are misplaced or gets broken. With conventional textiles weaving processes, one broken thread spells a ripped fabric, an excruciatingly expensive time sink, and additional effort required to Patch Things Up. The sensor-based automatic thread stop system utilizes real-time monitoring to quickly resolve issues, providing effective automation. This helps alleviate the adverse impacts of defective fabric production and assists productive endeavor consolidation.

The sophistication of this cutting-edge fabric weaving system makes it possible to install it on different machines and use any type of yarn from all ranges regardless of the type of textile manufacturing unit. The application of this system results in substantial savings on materials and at the same time, improves operational efficiency and quality of fabric.

2. Existing Problem
Existing methods in warp and weft stop systems typically involve mechanical sensors or manually-operated devices to detect thread breakage. These systems often rely on the operator's intervention to stop the machine when an issue is detected, leading to potential delays and human error.

3. Proposed Method
IR sensors are used in conjunction with drop pin sensors to identify the breaking of warp threads and drop pin threads. The drop pin sensor responds when the warp thread is split. The IR sensor responds to

weft thread breakages by emitting infrared light. Both devices, after detecting the thread breakage, stop the machine to eliminate fabric defects and minimize downtime.

4. Literature Survey

[1] Afriyie, A.O., Howard, E.K., Asinyo, B.K., Badoe, W., Seidu, R.K., and Apau, E. (2021) focuses on an electronic warp-break detection system for manual looms. This system is designed to automatically detect warp thread breakages, which traditionally require manual intervention. The researchers created a mechanism that halts the loom as soon as a thread breaks, reducing fabric defects and downtime. By automating this process, the system improves efficiency and ensures higher-quality fabric production. The study demonstrates that this electronic system enhances productivity in manual loom operations. The authors conclude that it provides a significant advantage in maintaining consistent fabric quality. [2] Kabir, R.B. (2017) explores advancements in warp and weft stop motion systems, from traditional methods to modern electronic systems. The paper highlights how these technological improvements have enhanced the efficiency and reliability of textile weaving machines. Kabir emphasizes the role of electronic systems in reducing human intervention and fabric defects, leading to better production quality. The study also discusses the integration of automated sensors and control systems that provide real-time monitoring and faster response times. This evolution has contributed to the overall optimization of weaving processes in the textile industry. [3] Lee, J. H., Seyam, A. M., Hodge, G., Oxenham, W., & Grant, E. (2007) this attempt to build a MEMS-based system that detects warp breaks in Jacquard weaving. The system is capable of Micro-Electro-Mechanical Systems (MEMS) technology that enables accurate cut detection during the weft insertion in the weaving process. The research illustrates the integration of MEMS sensors into the control system of weaving machines which will enable automatic monitoring of fabric production quality and improvement of such a parameter as the number of warp breaks, which are automatically detected and eliminated. [4] Tiwari, V., Garg, S., Bhat, S., Kumar, S., Manikandan, J., Mathiazhagan, P., Bhat, P., Tamilselvan, M., and Periyasamy, S. (2023) present the design of a real-time warp and weft measurement system for fabric analysis in textile testing using machine learning. The authors explore the integration of machine learning algorithms to accurately measure and analyze the warp and weft properties of fabrics, improving the precision of textile testing. The paper highlights the system's ability to provide real-time data, enhancing quality control and process optimization in textile production. Additionally, the study demonstrates how this system can reduce human error and manual labor, increasing the overall efficiency and reliability of textile testing processes. The innovative approach holds potential for advancing automated inspection systems in the textile industry. [5] Raguvaran, K. and Thiyagarajan, J. (2015) showcase a system that uses Raspberry Pi to keep an eye on global industrial processes through wireless communication and relay modules. This setup lets users watch and manage industrial processes from afar, which helps to run operations more . Adding relays to the mix means devices can be controlled based on up-to-the-minute data making things more flexible and automated. By pairing Raspberry Pi with wireless communication and relay control, the system offers a budget-friendly and expandable way to monitor industrial processes. [6] Riley, H.B., and Celenk, M. (2017), titled "IR sensing embedded system development for prototype mobile platform for autonomous convoy," discusses the development of an infrared (IR) sensing embedded system aimed at supporting a mobile platform used in autonomous convoy operations. The authors focus on creating a prototype system that uses IR sensing to enhance the vehicle's ability to navigate and communicate with other vehicles in the convoy autonomously. This research is part of efforts to improve convoy automation, which has applications in military and logistics contexts. The system's development is evaluated through its integration into a mobile platform, with performance and capabilities assessed during testing. [7] Mohammad, T. (2009), in "Using Ultrasonic and Infrared Sensors for Distance Measurement," looks at how ultrasonic and

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infrared sensors can measure distances with precision. The study compares how these two types of sensors perform in different uses pointing out what they're good at and where they fall short. Ultrasonic sensors work well to measure longer distances, while infrared sensors are better for short ranges. The paper explains the science behind each sensor type how to figure out distances with them, and where they come in handy in areas like robotics, automation, and finding your way around. [8] Lammasniemi, J. and Hyvärinen, T. (1993) examine how industries use infrared (IR) sensing technology to measure things, with a focus on checking temperature without touching. The paper looks into the basic ideas ways to calibrate, and how people apply IR sensors in industrial processes. They point out the benefits of using IR sensing to keep an eye on very hot environments and to make processes more effective. The research shows how IR sensing helps with quality control and making processes better. [9] Ghael, H.D., Solanki, L., and Sahu, G. (2020) provide a review of the Raspberry Pi and its various applications in their paper. The authors discuss the capabilities of Raspberry Pi as a low-cost, versatile computing platform used in areas such as automation, robotics, and IoT. They explore its hardware, software, and connectivity features, highlighting its role in educational and industrial applications. The paper emphasizes the growing use of Raspberry Pi in innovative engineering and management solutions.
[10] N Patil, S Ambatkar, S Kakde proposed the topic 'IoT based Smart Surveillance Security System using Raspberry Pi' in 2017 and is about designing a low-power security alert system using the IoT framework that monitors gestures or motion and sends captured images to a cloud server. This IoT-based system enables remote observation and alerts activity detection. When a cloud server is inaccessible, images are stored locally in a Raspberry Pi, a small-sized computer. The Raspberry Pi equipped with OpenCV Software to process images created alerts via email with the use of a normal webcam with a Wi-Fi module. This setup demonstrates an efficient and cost-effective way to realize IoT-based security systems using readily used hardware and software components.

5. Hardware And Description

The figure depicted showcases an automated warp and weft stop system. It illustrates the block diagram of these advancements.

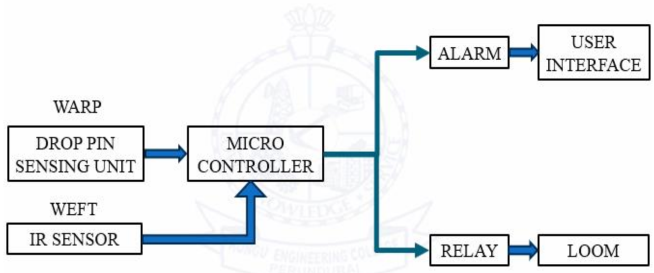

Figure 1 Block Diagram of Automatic Warp and Weft Stop System

In Figure 1 the system follows the glass cleaning process starts with the glass collector, which holds and positions the tea glasses in front of the IR sensor. When the glass is recognized, the IR sensor generates the control signal for the STM32 processor to start the cleanup procedure. The controller then turns on the first relay and the water cleaning solution sprayer pump is energized. This pump ensures that a precise amount of cleaning solution is sprayed onto the glass, ensuring that the surface of the glass is adequately covered and cleaned. Once the cleaning solution has been applied, the STM32 controller initiates the second stage by activating the second relay, which starts the pump connected to the hot water sprayer. The hot water, maintained at a temperature of 45°C, is sprayed onto the glass to thoroughly rinse off the cleaning solution and sterilize the glass. This two-stage process ensures that the glasses are both cleaned of residues and sterilized for hygienic use. The STM32 controller serves as the central unit, synchronizing the timing of the cleaning solution and hot water sprays, ensuring that each stage of the cleaning process is conducted with precision. Additionally, the controller monitors the signals from the IR sensor and adjusts the operation based on the detection of new glasses, thus optimizing the cleaning cycle. The power is provided by a single power supply that ensures consistent operation across

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all electrical components, including the pumps, relays, and microcontroller. This ensures that the system operates efficiently and without interruptions, providing a reliable automated cleaning solution for high-traffic tea shops. This system offers significant advantages over manual cleaning methods, including enhanced hygiene due to controlled cleaning and rinsing temperatures, consistent cleaning cycles due to automation, and the ability to process multiple glasses in quick succession. The use of an STM32 microcontroller enables precision control, while the integration of sensors, relays, and pumps ensures that the system can operate autonomously with minimal human intervention. [11]

5.1 Drop Pin

The drop pin sensor is a small, durable component typically made of stainless steel. It is highly sensitive to changes in thread tension, triggering a fall when a warp thread breaks. The sensor's response time is quick, ensuring minimal delay in stopping the machine. It is designed for long-term durability, withstanding high-speed weaving conditions. The drop pin sensor is compatible with various weaving machines, providing a reliable solution for automatic thread breakage detection. [12]

5.2 AC Single Phase Motor

A Single-phase AC motors operate from either 120 V or 230 V single-phase AC supply mains. Electric energy is converted into mechanical energy by kinetic energy that interacts with the rotating field. They range from less than one-tenth to about 2 horsepower (0.06-2 HP). One horsepower sometimes is the lowest regarded rating, while five horsepower is usually accepted as the maximum rating. The reason is that a single-phase supply cannot produce a rotating magnetic field, hence they require some sort of starting mechanism, usually one of two types: capacitors or split-phase windings. Single-phase motors are used in fans, refrigerators, and washing machines. Their suitability for low-cost, dependable methods of controlling motors in low-power applications has generally led to their widespread use.

5.3 Relay Module

Essentially, a relay module is a switch that can be controlled via an electrical signal. The relay module works on the principle of controlling a high-voltage device using a low-voltage signal. Relay modules operate under very general voltages of 5V or 12V DC, responsible for much higher and more effective switch ability at more high currents, approximately up to 10A at 250V AC. Relays provide electrical isolation between the control circuits and the high-power components; hence, sensitive devices are protected. They can switch quite rapidly with an approximate response time of 5 to 10 milliseconds or so. Relay modules are built quite ruggedly and can handle tens of thousands of switching cycles before finally failing. [13]

5.4 IR Sensor

IR (Infrared) sensor detects changes in light or thread movements by emitting infrared light and measuring its reflection from the surface or object (e.g. weft threads). In an automatic warp and weft stop system it detects weft thread breakages or misalignments by detecting the absence or disruption of the infrared light. It operates at 5V DC and has a detection range of several cm to meters. Response time is usually under 10ms for real time detection. IR sensors are very reliable, robust and can be integrated with various weaving machines.

5.5 Raspberry PI Model B

The Raspberry Pi 3 Model B is another micro sized single board PC with a 1.2GHz quad core ARM Cortex-A53 CPU, 1GB RAM, on board Wi-Fi and Bluetooth. Additional ports bring that to 4 USBs, Ethernet port, HDMI output and a 40 pin GPIO header for hardware attachment. It uses microSD storage and will run a variety of operating systems. Popular uses include basic computing, IoT, home automation, media centers, robotics, education and lightweight servers. It's a great entry point for both beginners and advanced into electronics and programming projects.

5.6 16x2 LCD Display

A 16x2 LCD display is a screen that is capable of showing lessons with two rows and 16 columns, providing space for up to 32 characters. It is operated through a microcontroller, raspberry pi, and usually used to display information such as alphanumeric text, sensor data, or system status updates. Users can

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send commands to control features such as cursor positioning, screen clearing and backlight adjustment. This type of display is widely used in embedded systems to create a direct user interface.

5.7 Prototype

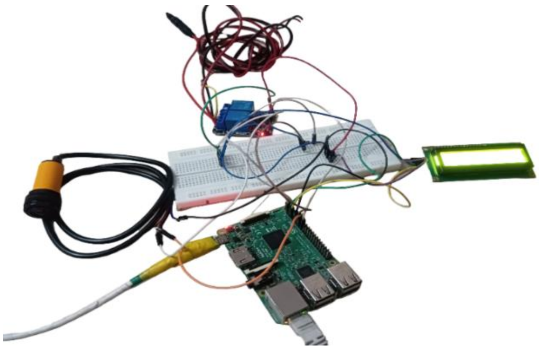

Figure 2 Electronic Setup for Automatic Warp and Weft Stop System

The Warp and Weft Stop System uses a Raspberry Pi in order to improve the productivity of looms by detecting and stopping the loom in case of thread breaks, thereby preventing the production of defective fabric. The warp stop consists of a drop pin, which is normally held in place by the tension in the warp threads; if any warp thread is broken and refers to the fallen pin, then it creates the signal for Raspberry Pi, stopping the loom at once. The weft stop uses an IR sensor; the presence of a weft thread is detected if it reflects infrared light from the IR lamp and reaches the sensor. If the IR sensor detects any broken weft thread or a weft thread that is absent, then it signals the Pi to stop the loom. The Raspberry Pi is the main controller, allowing the processing of signals from the drop pin and IR sensor through its GPIO pins. After detecting such kind of thread breakage, the Raspberry Pi will not only stop the loom but will also update the LCD that shows the ongoing status of the entire system, proper error notifications, and an indication of what the operators need to do to reset it. The loom stop is controlled by means of relays or motor controllers for effective response time features. This automated process reduces amount of manual attention, wasted raw materials, increases in production with respect to textile manufacturers. Figure 2 shows Electronic Setup for Automatic Warp and Weft Stop System Figure 3 shows Prototype of Automatic Warp and Weft Stop System

Figure 3 Prototype of Automatic Warp and Weft Stop System

6. Results

The automatic warp and the weft stop system in the manual loop effectively detects and stops the loom when a taunt or scattered breaks. This automatic process ends the need for constant human supervision, reduces cloth defects and machine downtime. This ensures a smooth and rapid production process, enhancing the quality of the fabric. By reducing dependence on manual labor, system reduces labor costs, improving efficiency. Overall, the system streamlines operations, enhances competition, and adopts the loom to meet the demands of the modern textile industry. Table 7.1 shows the time required to complete the cleaning process in both existing and proposed methods. From this data the time taken to complete the cleaning with proper hygiene is less in the proposed method than in the existing method. Figure 4 shows Warp and Weft Stop System Result

Figure 4 Warp and Weft Stop System Result

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Figure 5 **Loom Running in LCD Display**

Figure 6 **Weft Error in LCD Display**

Figure 7 **Warp Error in LCD Display**

Conclusion

The implementation of an automated warp and the weft stop system in the manual loom provides significant improvement in the efficiency and reliability of the weaving process. By reducing the need for continuous human intervention, this system reduces cloth defects and machine downtime, which increases the quality of production and increases the output. In addition, it provides a more consistent and accurate response to issues such as fabric breakdown or waft obstruction, which ensures smooth operation. Integration of automated systems not only improves the overall functionality of manual tax, but also paves the way to adopt the future of future, more autonomous textile manufacturing systems. It plays an important role in modernizing the textile industry while maintaining cost-affect and reducing manual labor. Additionally, it contributes to better resource management, low production costs, and better stability in textile manufacturing processes. Continuous development of such technologies will undoubtedly run further innovation in the textile sector. Figure 5 shows Loom Running in LCD Display, Figure 6 shows Weft Error in LCD Display, Figure 7 shows Warp Error in LCD Display

Future Scope

The newer technology applied in textile manufacturing maximizes productivity and elevates the quality of textiles. High precisions sensors such as optical and ultrasonic detection facilitate very early in-production defect detection, which helps in waste and error minimization. AI and machine learning can foresee disruptions in operation, optimize weaving processes, and transition between different loom settings with little human intervention. IoT-enabled remote monitoring manipulation affords opportunities to adjust both processes and performances in real time without compromising productivity of the entire system. Customization for various types of loom enables it to be easily integrated into automated production lines. Energy-efficient solutions will thus be cheaper and greener. The overall aim is to have automation systems to reduce human intervention and achieve higher productivity with unparalleled quality of fabric to enable manufacturers to stay in competition as the textile landscape evolves.

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