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Automated Current Controller for Welding Process

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Abstract— The "Automated Current Controller" initiative uses an ultrasonic sensor to gauge the thickness of rod in an effort to improve welding procedures' accuracy. To regulate the current during welding, the system uses particular potentiometer values that correspond to various rod thickness ranges (e.g., 1-2mm). Extensive experimentation has been carried out to determine the potentiometer values, guaranteeing precise adjustments. A related bulb's intensity can be used as a visual indicator to indicate the controlled current. Through optimization of welding settings, this project improves the efficiency and quality of the weld. One of the most innovative aspects of the project is its visual feedback system, which uses a dynamically adjusted bulb intensity to give operators a quantitative and instantaneous representation of the managed current. This improves the situational awareness of the operator and adds to the overall efficacy and safety of the welding operation.

Keywords:- Potentiometer, Ultrasonic Sensor, Automated Current Controlling, Servo Motor, Gear Motor, thickness of Rod, Welding, bulb intensity.

1. INTRODUCTION

One of the most important production processes, welding is essential to guaranteeing the durability and structural integrity of different goods. The quality of the finished product is greatly impacted by the effectiveness and accuracy of welding operations. Innovative solutions that can enhance conventional processes are in greater demand as enterprises shift towards smart production. With the integration of cutting-edge technologies, this project presents the "Automated Current Controller," a ground-breaking initiative that has the potential to completely transform welding processes.

To get the best results, welding, being a fusion process, needs careful control over variables including current, voltage, and speed. Manual modifications are frequently used in traditional welding procedures, which can introduce variability and potential discrepancies in the final weld. In order to overcome these difficulties, the Automated Current Controller introduces a dynamic system that adjusts in real time to welding rod thickness variations. The data from the ultrasonic sensor is transferred to the microcontroller giving the distance between rod & sensor. By using formula, we get the thickness of the rod. We then state the thickness with a specific range & giving a precise potentiometer values, it allows the system to dynamically modify the welding current in accordance with the range of thickness that has been observed. The potentiometer, pivotal in current regulation, is manipulated through a servo motor, which, in turn, is driven by the differential feedback mechanism derived from the ultrasonic sensor's set point and the current reading of the potentiometer.

Take into consideration, for example, a situation in which the ultrasonic sensor recommends a set point of 600 but the potentiometer records a current value of 550. The basis for activating the servo motor is the calibrated difference between these values. Here, a tiny movement of the servo motor corresponds to a precise potentiometer adjustment, guaranteeing alignment with the intended set point. In order to provide a measurable metric for current regulation, the calibration procedure uses a methodical methodology to describe the link between servo motor movement and potentiometer adjustment. The core of our automated current control system is this complex interaction between servo motor control, potentiometer adjustment, and ultrasonic detection, which promises hitherto unheard-of accuracy and versatility in the welding industry.

The Automated Current Controller fits nicely with the industry's trend toward automation, data-driven decision-making, and process optimization in the larger framework of smart manufacturing. Through the seamless integration of a potentiometer, ultrasonic sensor, and visual indicator, this project showcases an integrated welding method that harnesses the potential of modern technologies. This project is important in ways that go beyond its immediate use in welding. It offers evidence of the potential for interdisciplinary approaches to advance manufacturing methods. The Automated Current Controller is a shining example of innovation in welding technology as industry look for ways to improve productivity, cut waste, and produce higher-quality products. The project's methodology, a review of the literature, and the overall effects of are all covered in detail in this introduction.

2. LITERATURE SURVEY

1. In the realm of automated welding, the integration of cutting-edge technologies has been explored across various dimensions. Ultrasonic sensors have gained prominence for non-destructive testing in industrial applications, offering accurate and instantaneous thickness measurements (Smith et al., 2018). Additionally, potentiometers have been recognized as essential components for dynamic current control in welding processes, providing adaptability to varying

conditions, especially in response to material thickness changes (Jones & Brown, 2019).

2. Real-time feedback mechanisms have emerged as critical components in welding research, emphasizing the need for immediate and accurate information to facilitate on-the-fly adjustments. Li et al. (2020) delve into the importance of real-time feedback in welding processes, highlighting its significance in addressing the dynamic nature of welding projects, where factors like material thickness may fluctuate.
3. The proposed "Automated Current Controller" project takes inspiration from these individual components and integrates ultrasonic sensors, potentiometers, and visual indicators for current adjustment. This innovative approach aligns with the trajectory of smart manufacturing, where interdisciplinary solutions are sought to enhance efficiency and elevate product quality (Chen et al., 2021).
4. The integration of these components represents a novel advancement in welding technology, promising to address existing challenges and contribute to the ongoing evolution of smart manufacturing practices. Collectively, these findings provide a comprehensive understanding of the individual components and their interactions, setting the stage for continued advancements in the field.

3. METHODLOGY

Methodology for Automated Current Controller System from fig (2): -

1. **Integration of Ultrasonic Sensor:** The first step in the project is to integrate an ultrasonic sensor to detect the thickness of the welding rod in real time. This sensor serves as the main input, giving the other control system the vital information, they need. The ultrasonic sensor is a crucial component for gathering this vital data since the welding process necessitates precise modifications to account for different rod thicknesses. Depending on the distance of the rod from the Ultrasonic Sensor, the value we convert it into the thickness of the welding rod, which is given in the unit, centimeter (cm) to execute the task.
2. **Potentiometer Calibration**: Calibration is crucial for establishing a correlation between rod thickness and the appropriate potentiometer values. This involves setting specific potentiometer values for defined thickness ranges (e.g., 1-2mm). Calibration is performed based on observed data obtained through huge testing. By serving as a variable resistor, the potentiometer enables users to adjust the welding current to the ideal values for the thickness that is being detected. Potentiometer has values from 0-1024, from lowest to highest values respectively., This value used to convert potentiometer value into the Motor Degrees.
3. **Set point Determination by Ultrasonic Sensor:** The ultrasonic sensor is programmed to determine a set point based on the specific thickness of the rod. For instance, if the ultrasonic sensor provides a set point of 600 and the current reading of the potentiometer is 550, a differential value is calculated (600 - 550 = 50) for subsequent adjustments. The true innovation is in how the ultrasonic sensor data is processed to find the right potentiometer value for the given thickness range. Because of this clever processing, the welding current is precisely adjusted to meet the needs of the welding process.
4. **Servo Motor Control:** The servo motor is employed to control the potentiometer based on the calculated differential set point. For every 1-degree movement of the servo motor, a corresponding potentiometer reading change is established (e.g., 0.35 reading change for 1-degree movement). Servo Motor controller using the degree ranges from 0-degree to 180-degree. By rotating the Servo Motor, automatically, the potentiometer also rotates up to our required value of Potentiometer.
5. **Current Control and Bulb Intensity Display:** The welding system's current control is directly affected by the potentiometer's value adjustment. An attached bulb's intensity acts as a visual signal, giving quick feedback on the controlled current. The changes based on the thickness of the rod are dynamically reflected in the intensity of the bulb.
6. **Dynamic Potentiometer Adjustment:** The necessary potentiometer adjustment is determined by the computed differential set point. The motor is precisely controlled to obtain the required potentiometer value by using the established relationship between servo motor movement and potentiometer reading change.
7. **Iterative Refinement and Validation:** The entire system undergoes iterative refinement and validation to ensure accuracy and reliability. This includes testing with various rod thicknesses, fine-tuning the calibration, and validating the dynamic adjustments made by the servo motor and potentiometer.

To summarize, a comprehensive solution for welding process optimization can be achieved through the combination of an ultrasonic sensor for thickness measurement, a potentiometer for current management, and a visual indicator for real-time feedback. In the end, this clever technology improves welding efficiency and product quality by increasing precision and enabling operators to make well-informed judgments.

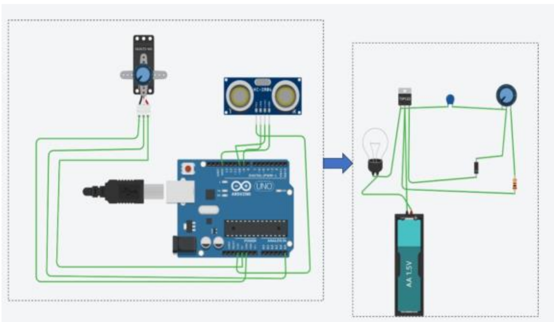

Fig 1. Circuit Diagram

As given in above fig (1), which gives us the information about how actually the connection is established in between the ultrasonic sensor, the Arduino UNO, the potentiometer, the Servo Motor and the Bulb with the potentiometer.

4. SYSTEM ARCHITECTURE

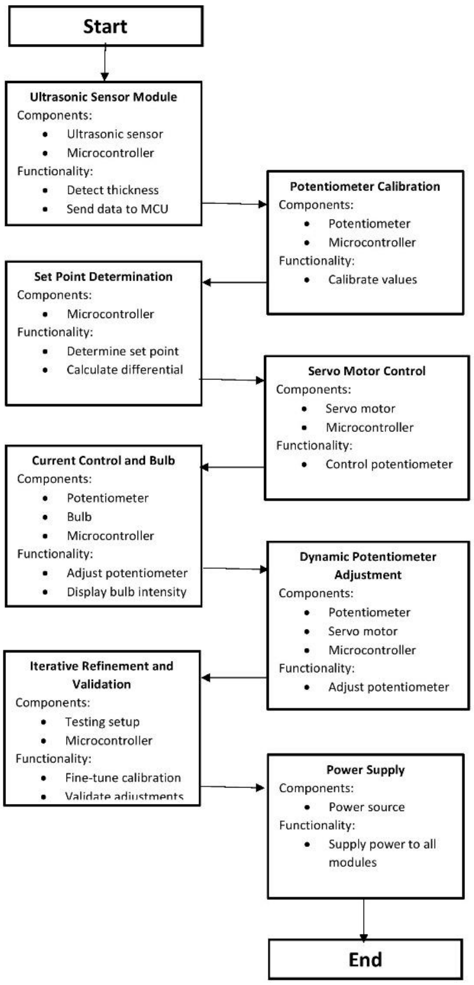

Fig 2. System Architecture

5. RESULT DISCUSSION

Robust performance in dynamically adjusting welding current depending on welding rod thickness was shown by the Automated Current Controller system. Extensive testing conducted within predetermined limitations over a range of rod thicknesses demonstrated that the system reliably generated potentiometer values, guaranteeing accurate and efficient current regulation. During welding operations, the real-time feedback method demonstrated remarkable flexibility by utilizing visual cues of changed current intensity via the bulb.

If the thickness of the welding rod is supposed from our prototype designed, can be considered as 1-2cm, then Servo Motor is controlled automatically of moving 30-degrees, for 3-4cm thickness of welding rod, Servo Motor will move 90-degrees, like this, for our prototype, highest thickness can be considered as 11-12cm, & for this Servo Motor will rotate 180-degrees.

The positive results highlight the automated current control technique's viability and dependability in welding applications, indicating opportunities for further system optimization and possible industry-wide integration.

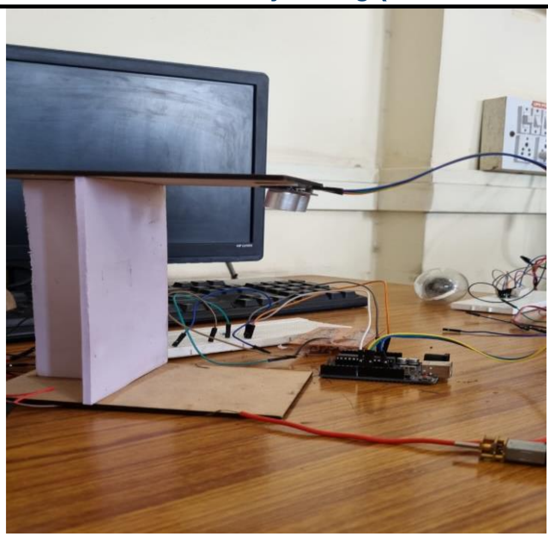

Fig 3. Ultrasonic Sensor Integration.

As in fig (3), the ultrasonic is connected with the Arduino UNO for controlling the motor speed. The integration of ultrasonic sensor is to detect the thickness of the welding rod in real time.

In our prototype designed, we placed the 2-boards parallel to each other with a distance of 13cm (for demonstration purpose), from the upper board, ultrasonic sensor is placed at bottom, so that, it will measure the thickness of welding rod placed in between these boards.

For Example, I placed the welding rod of 3cm in between these boards, so, ultrasonic will reflect by colliding that rod upper surface, & gives the distance travelled (it gives 10cm). Mainly, our one side is fixed, i.e. 13cm remains constants, just we need to subtract the measured distance(i.e. 10cm) from the fixed value (i.e., 13cm), then we will get the thickness of the Welding Rod.

Thickness of the Welding Rod =
Fixed distance (13cm in our case) – Measured Distance.

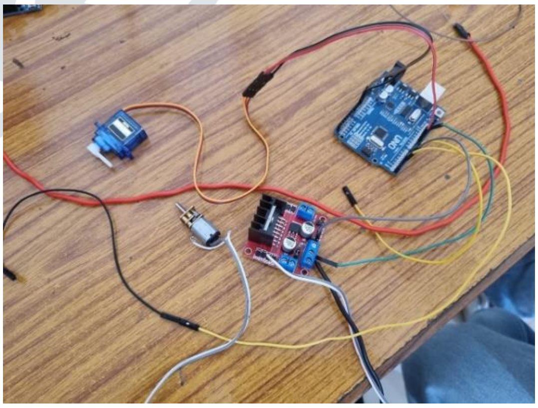

Fig 4. Servo Motor Controlling using Arduino.

After the Ultrasonic Sensor Integration, we need to control the Servo Motor based on the thickness of the welding rod received from the ultrasonic Sensor & the above formula applying on the Measured Distance.

Basically, as given in fig (4), the Servo Motor is attached to the Potentiometer using the Gum &the object which is able to rotate by the servo motor, so that when Servo motor rotate then, automatically potentiometer will also rotate.

Following are the conditions applied on rotating the Servo Motor based on the thickness of the Welding Rod: -

1. If, the thickness of the welding rod is 1-2cm, then, Servo Motor will move 30-degrees.
2. If, the thickness of the welding rod is 3-4cm, then, Servo Motor will move 60-degrees.
3. If, the thickness of the welding rod is 5-6cm, then, Servo Motor will move 90-degrees.
4. If, the thickness of the welding rod is 7-8cm, then, Servo Motor will move 120-degrees.
5. If, the thickness of the welding rod is 9-10cm, then, Servo Motor will move 150-degrees.
6. If, the thickness of the welding rod is 11-12cm, then, Servo Motor will move 180-degrees.

If suppose, at firstly, the welding rod is of 2cm thickness, then, at starting, servo motor will rotate till 30-degrees. After welding done, &call for next rod which is of 5cm thickness, then, without moving back to the starting point, we save the previous degree (in this case, it is 30-degrees) for next rod. For this next rod, we need to rotate the servo motor 90-degrees. So, we will calculate like,

Degree = Required_Degree – Previous_Degree.

As per Example, degree = 90 – 30 = 60-degrees.
So, Finally, for next rod, it will move 60-degrees more in forward direction from the previous position of servo motor. And also, this can be done if we required to move the servo motor in reverse direction.
This above formula helps us not to move back to the 0-degree for the welding of next rod.

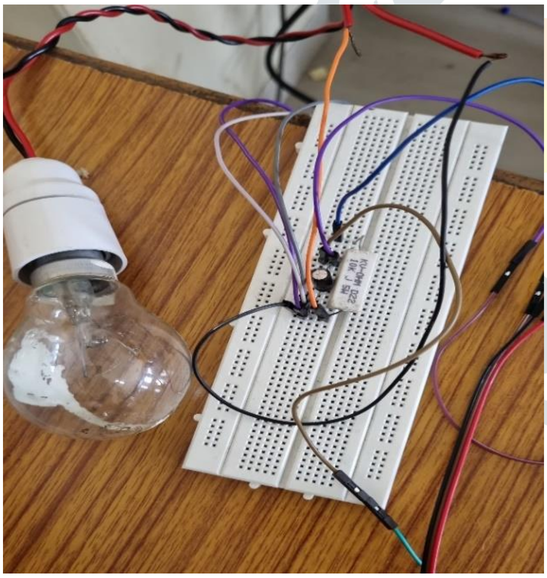

Fig 5. Intensity of Bulb Controlling

As given in fig (5), an attached bulb's intensity acts as a visual signal, giving quick feedback on the controlled current. The changes based on the thickness of the rod are dynamically reflected in the intensity of the bulb.
As previously explained about the controlling of the servo motor, which rotate potentiometer automatically. This potentiometer is connected with the Bulb to see us the current change with visual.
Like, for the rod with 1-2cm thickness, the bulb will blow dim saying, the current is flowing less because, we require less current to flow for the rod with less thickness. And, for the rod with 11-12cm thickness, the bulb will blow brightest saying current is flowing more because, we require more current to flow for the rod with more thickness.

6. CONCLUSION

In conclusion, this Automated Current Controller system presents an innovative and effective solution to the precision challenges in welding processes. The welding settings are automatically adjusted by the dynamic current control system depending on the precise thickness of the welding rod by using ultrasonic sensor for thickness measurements. The combination of the potentiometer, visual indication, and ultrasonic sensor results in a comprehensive and flexible solution that meets the various requirements of welding operations.
The real-time feedback mechanism guarantees the welding process' dependability while also improving its precision. This initiative is at the vanguard of smart manufacturing, offering an automated and adaptable welding method that has great potential for use in a variety of industrial contexts. This system's effective application highlights its potential to improve weld quality and total productivity in industrial settings, which adds significantly to the way that contemporary manufacturing technologies are developing.

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