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INVESTIGATION ON THE PERFORMANCE OF IOT BASED ELECTROCHEMICAL DISCHARGE MACHINING

Mrs.R.Jayashree, **Dr. R.Surendran**, Assistant professor, Department of PG- Manufacturing Engineering , Government College of Technology, Coimbatore, 641 013. Tamil Nadu, India.
Mr.S.Vijay, PG Scholar, Department of Manufacturing Engineering , Government College of Technology, Coimbatore, 641 013. Tamil Nadu, India. vijays16072001@gmail.com
Dr.T.Sekar, Associate Professor, Head of the Department, PG-Manufacturing Engineering, Government College Of Technology, Coimbatore, 641 013. Tamil Nadu, India.

ABSTRACT
This project focuses on the investigation and development of an Internet of Things (IoT)-based Electrochemical Discharge Machining (ECDM) system, a hybrid machining process combining electrochemical and thermal energy to process hard and brittle materials with precision. The integration of IoT aims to enhance the monitoring, control, and efficiency of the ECDM process.The study involves designing an IoT-enabled framework to collect real-time data on critical process parameters such as voltage, current, spark discharge frequency, electrolyte temperature, and material removal rate (MRR). These parameters are transmitted to a cloud-based platform for real-time analysis, visualization, and process optimization using advanced algorithms.The experimental phase evaluates the performance of the IoT-based ECDM system on various materials, focusing on achieving high surface finish, dimensional accuracy, and reduced tool wear. The study also investigates the impact of process parameters on machining efficiency and introduces machine learning models for predictive analytics and parameter optimization.The project demonstrates the potential of IoT integration in ECDM to achieve automated, precise, and sustainable machining operations. The findings contribute to advancing smart manufacturing technologies, paving the way for intelligent machining systems in Industry 4.0 applications.
Keywords:
IoT, Electrochemical Discharge Machining (ECDM), hybrid machining, real-time monitoring, process optimization, material removal rate (MRR), spark discharge frequency, surface finish, Industry 4.0, smart manufacturing, predictive analytics, machining efficiency, tool wear reduction, cloud-based platform.

I. Introduction

Electrochemical Discharge Machining (ECDM) is a non-traditional machining process that combines aspects of electrochemical machining and electrical discharge machining. The Electrochemical Discharge Machining (ECDM) is a non-conducting machining process which combines the features of Electric Discharge Machining (EDM) and Electrochemical Machining (ECM). The material is removed by thermal melting and chemical dissolution. Both conductive and non-conductive materials can be machined.In ECDM, material removal occurs through the application of electrical energy, utilizing both electrochemical reactions and electrical discharge pulses. The process involves creating sparks between the tool electrode and the workpiece, which results in localized melting and vaporization of the material

II. Component selection

1.1 Thermister Sensor

The working principle of the DS18B20 Waterproof temperature sensor is similar to any other temperature sensor. The resolution of the sensor ranges from 9-bits to12-bits. But 12-bit is used as the default resolution to power up this sensor. It measures temperature, as well as the conversion of Analog-to-Digital (A-to-D), which can be done with a convert-T command.

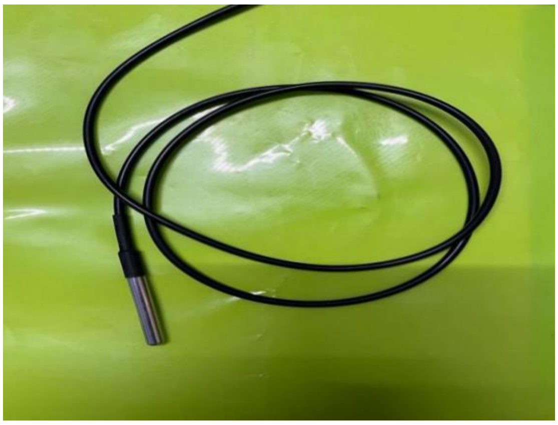

Figure 1: Temperature Sensor DS18B20

2.2 Arduino Board:

Arduino is an open-source platform used for building electronics projects Arduino consists of both a physical programmable circuit board and a piece of software or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

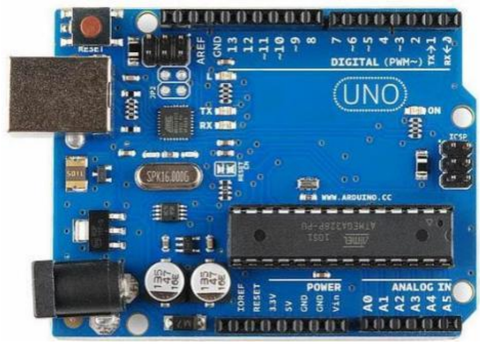

Figure 2: Arduino board

2.3 Resistor:

A 4k7 resistor, also known as a 4.7k ohm resistor, is an electronic component with resistance of 4.7 kilo-ohms, or 4,700 ohms. The “k” in 4k7 stands for “kilo,” which means 1,000. The resistance of a resistor is measured in ohms, a unit of electrical resistance. Resistors are used to limit the flow of electric current in a circuit and are commonly used In various electronic devices.

Figure 3: Resistor

2.4 Encoder

An encoder sensor is a device that translates motion or position into an electrical signal. It’s commonly used in various applications, from robotics to industrial machinery, to precisely measure and track the movement of an object or a motor shaft. Here we using incremental encoder to finding the distance of the tool movements.

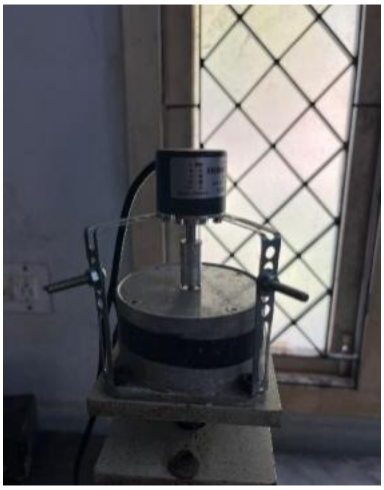

Figure 4: Encoder

2.5 Bread Board

A breadboard consists of plastic block holding a matrix of electrical sockets of a size suitable for gripping thin connecting wire, component wires or the pins of transistors and integrated circuits. A breadboard (sometimes called a plug block) is used for building temporarycircuits.

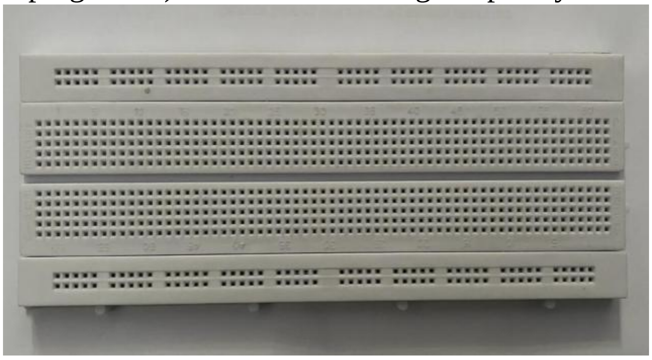

Figure 5: Bread Board

2.6 Ultrasonic sensor

An ultrasonic sensor is a device that measures distance or detects objects using ultrasonic waves. It typically consists of a transmitter and a receiver. The transmitter emits ultrasonic waves, usually at a frequency higher than the human ear can detect. These waves travel through the air and bounce off objects in their path. The receiver then detects the reflected waves and measures the time it takes for them to return. By calculating the time. It takes for the waves to travel to the object and back, the sensor can determine the distance to the object.

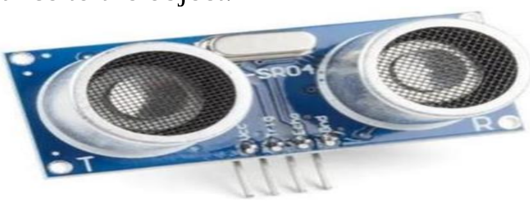

Figure 6: Ultrasonic Sensor

III. Conclusion

In conclusion, the data analysis conducted on electrochemical discharge machining (ECDM) provided valuable insights into the process. Through the project, modifications were suggested and implemented to enhance the efficiency and precision of ECDM. These modifications were based on a thorough analysis of the collected data, resulting in improved performance, reduced energy consumption, and increased accuracy in material removal. The findings underscore the significance of data-driven approaches in optimizing manufacturing processes like ECDM for better productivity and quality outcomes.The project's integration of Investigations and performance of electrochemical discharge machining, combined with real-time monitoring of temperature, pH value, TDS, and Ultrasonic, showcases a promising approach for enhancing precision and control in manufacturing processes. Through comprehensive data analysis, this project not only enables insights into process optimization but also offers a pathway for predictive maintenance and continuous improvement in electrochemical machining. The seamless integration of IoT technology with data analytics paves the way for more efficient, accurate, and adaptive machining processes, potentially revolutionizing industrial practices by ensuring enhanced productivity and quality control.

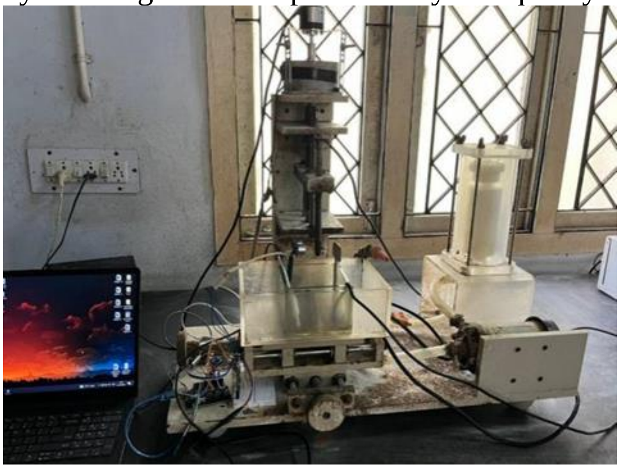

Figure 7: Total Setup

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COM7

Temperature31.62
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.06
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.56
TDS:10ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.62
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.56
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.69
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.12
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.75
TDS:8ppm
 ph:4.71
encoder:-5
Distance:4cm
Temperature31.06
TDS:10ppm
 ph:4.71
encoder:-5
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Figure 8: Sensor Outputs

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