DEVELOPMENT OF PENETRANT TESTING NON-DESTRUCTIVE TEST MONITORING USING IOT SYSTEM

By

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Project Submitted in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Mechanical Engineering (Hons.) in the Faculty of Information Sciences and Engineering

May 2023

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DEDICATION

This Project is dedicated to my beloved parents,

Dr. Abdul Haris Semendawai, S.H, LLM. and Aida Milasari S.Si.

Who educated me and enabled me to reach at this level.

Abstract of project presented to the Senate of Management & Science University in partial fulfillment of the requirements for the degree of Bachelor of Science in Mechanical Engineering (Hons.).

ABSTRACT

DEVELOPMENT OF PENETRANT TESTING NON-DESTRUCTIVE TEST MONITORING USING IOT SYSTEM

By

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May 2023

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Penetrant testing is an important quality control measure used in the manufacturing industry to detect surface defects in welded components. Ensuring the consistency and reliability of the testing process is crucial for obtaining accurate results. According to ISO 3452-1:2021, the ambient temperature should be between 10°C and 50°C during the testing process. The light intensity should be at least 500 lux. However, manual monitoring and control of the testing process can be time-consuming and error-prone, and may not provide sufficient visibility into the process. The main objective of this project is to automate the penetrant testing monitoring and reducing the need for manual monitoring and control using IoT system. The methodology used to develop the IoT-based device for monitoring the penetrant testing process is design the prototype using Solidworks Software. Hardware used are Arduino Uno as Microcontroller with NodeMCU ESP8266 as Wi-fi Connectivity module, temperature and light intensity sensor to collect data on various parameters. It connected to mobile app or web interface that can be monitored remotely by the operator. The expected result of this project is to reduce the need for manual monitoring for the penetrant

testing process, collects data on parameters, including temperature and light intensity, and provides alerts if any issues are detected. Ensures that the parameters of the testing process meet the requirements specified by ISO 3452-1:2021. The IoT-based device designed for monitoring the penetrant testing process holds promising potential in enhancing the effectiveness and precision of the testing procedures., as well as provide greater visibility and control for manufacturers.

Keywords: *Penetrant testing, non-destructive testing, IoT system, quality control, ISO.*

Abstrak tesis yang dikemukakan kepada Senat Management & Science University sebagai memenuhi sebahagian keperluan untuk ijazah Bacelor Sains Komputer (Kepujian).

ABSTRAK

DEVELOPMENT OF PENETRANT TESTING NON-DESTRUCTIVE TEST MONITORING USING IOT SYSTEM

By

KEMAL FIRDAUS SEMENDAWAI

May 2023

Fakulti: Sains Maklumat dan Kejuruteraan

Ujian Penetrant adalah langkah kawalan kualiti penting yang digunakan dalam industri pembuatan untuk mengesan kecacatan permukaan pada komponen berkepaikan. Memastikan konsistensi dan kebolehpercayaan proses ujian ini adalah penting bagi memperoleh hasil yang tepat. Menurut ISO 3452-1:2021, suhu persekitaran sepatutnya berada antara 10°C hingga 50°C semasa proses ujian berlangsung. Intensiti cahaya juga sepatutnya sekurang-kurangnya 500 lux. Objektif utama projek ini adalah untuk mengautomatikkan pemantauan ujian penetrant dan mengurangkan keperluan pemantauan dan kawalan manual dengan menggunakan sistem IoT. Kaedah yang digunakan untuk membangunkan peranti IoT untuk memantau proses ujian penetrant adalah dengan merancang prototaip menggunakan perisian Solidworks. Peranti keras yang digunakan termasuk Arduino Uno sebagai pengawal mikro dengan NodeMCU ESP8266 sebagai modul sambungan Wi-Fi, pengesan suhu dan intensiti cahaya untuk mengumpul data tentang pelbagai parameter. Ia disambungkan dengan aplikasi mudah alih atau antara muka web yang boleh dipantau secara jauh oleh operator. Hasil yang dijangka dari projek ini adalah untuk mengurangkan keperluan pemantauan manual dalam proses ujian penetrant,

mengumpul data mengenai parameter seperti suhu dan intensiti cahaya, dan memberikan amaran jika terdapat sebarang isu yang dikesan. Ia memastikan bahawa parameter memenuhi keperluan yang ditetapkan oleh ISO 3452-1:2021. Peranti IoT yang dicadangkan untuk memantau proses ujian penetrant mempunyai potensi untuk meningkatkan kecekapan dan ketepatan proses ujian, serta memberikan pengetahuan dan kawalan yang lebih baik kepada pengilang.

Kata kunci: *Ujian Penetrant, ujian tidak merosakkan, sistem IoT, kawalan kualiti, ISO.*

ACKNOWLEDGEMENTS

First and foremost, I would like to express my heartfelt gratitude to Allah SWT, the Most Merciful and the Most Gracious, for His blessings, guidance, and unwavering support so I can finish this final thesis report with the title :

DEVELOPMENT OF PENETRANT TESTING NON-DESTRUCTIVE TEST MONITORING USING IOT SYSTEM

The authors would like to express their sincere gratitude to the following individuals and organizations for their unwavering support throughout the completion of this report.:

1. Management and Science University, as author's institution of study in Malaysia.
2. Politeknik Negeri Jakarta, as author's institution of study in Indonesia.
3. Dr. Nur Faiqa Binti Ismail, as Supervisor for the guidance, expertise, and unwavering support throughout the project.
4. Mrs. Nor Fazlina Binti Mohd Lazim, as Evaluator for the time, dedication, and valuable input.
5. To my parents Dr. Abdul Haris Semendawai, S.H, LLM. and Aida Milasari, S.Si, and family Mahsya Maharani Adilia, Zeeshan Adiyat Semendawai, Ridhoni Sholeh Semendawai, and Sisie Rahmasari Semendawai, I owe a debt of gratitude for their love, encouragement, and support.
6. To my significant other Jihan Nurfaidah who has been a source of support and encouragement throughout this endeavor.
7. To my friends Rafid Khairi Nugraha, Muhammad Raihan Hafizh, Athallah Pria Naufal, Ridha Rossy Pusparini, Rizkika Rafa Thyssen, and Dafiq Achmad for their companionship, encouragement, and understanding.
8. To my housemate Akbar Tedi Ismunanto, Alyudha Putra, Daffa Adila Barlianto, M. Khalil Gibran, and M. Ikhsan Nurrachman for their constant support and encouragement troughout this journey.
9. To Arago partner Ananda Abdullathif Fathurrachman, Ihsaan Fakhri, and Wahid Andriansyah, and M19 Family for the support on this journey.
10. Lastly, I would like to acknowledge and appreciate myself for the hardwork and determination invested in this project.

To all those mentioned above and anyone else who has directly or indirectly contributed to the success of this project, I express my deepest gratitude. Your support and contributions have been invaluable, and I am truly blessed to have had you by my side.

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Penetrant testing is an important quality control measure used in the manufacturing industry to detect surface defects in welded components. Ensuring the consistency and reliability of the testing process is crucial for obtaining accurate results. This paper introduces an innovative device based on IoT technology that aims to monitor and control the penetrant testing process. The device uses sensors to collect data on various parameters of the testing process, including temperature and light intensity. The collected data is processed and analyzed by a microcontroller, which can be accessed remotely through a web interface or a mobile app. The device allows manufacturers to optimize the testing process, ensure that it is being performed consistently and reliably, and provide alerts if any issues are detected. In addition, the device provides greater visibility and control over the testing process, enabling manufacturers to make informed decisions and improve the efficiency of their quality control processes.

1.2 PROBLEM STATEMENT

To ensure the consistency and reliability of the penetrant testing process result accuracy, there are some of parameters needs to achieve. According to ISO 3452-1:2021, the ambient temperature should be between 10°C and 50° during the testing process. The light intensity should be at least should be at least 500 lux. The penetrant dwell time will depend on the properties of the penetrant, the test temperature, the material of the part under test and the defects to be detected, in this case is >30 min. - ≤60 min [1]. However, manual monitoring and control of the testing process can be

time-consuming and error-prone, and may not provide sufficient visibility into the process.

As a result, there is a need for a device that can automate and remotely monitor the penetrant testing process, providing greater visibility and control for manufacturers. The device should be able to collect data on various parameters of the testing process, including temperature and light intensity, and provide alerts if any issues are detected. It should also be able to optimize the testing process by adjusting the timing of the application of the penetrant and developer based on the collected data, and ensure that the parameters meet the requirements specified by ISO 3452-1:2021.

The goal of this project is to design and implement an IoT-based device for monitoring and controlling the penetrant testing process, which meets the above requirements and provides a cost-effective and efficient solution for manufacturers.

1.3 OBJECTIVE

The objectives of this study are:

1) To design the IoT-based Penetrant Testing monitoring device using Solidworks 2020.
2) To construct and analyze IoT-based Penetrant Testing monitoring device system using Schematic Circuit and Simulation.
3) To evaluate the function of the IoT-based Penetrant Testing monitoring device.

1.4 SCOPE OF THE PROJECT

The current study is have the scope to design a monitoring device for penetrant testing with the implementation of Internet of Thing (IoT) system. This device is specifically designed for industrial application. In the development of this project, this device able to do data collection for various parameters including

the temperature and light intensity. All the collected data can be monitored through mobile application.

1.5 SIGNIFICANCE OF THE PROJECT

This project contributes a great significance to the industrial application for monitoring and controlling of penetrant testing. This project provides a monitoring device with a complete IoT system which it monitors automatically the temperature and light intensity during penetrant test. This device promotes high efficiency and accuracy of the test and also provide greater visibility and control for manufacturers as well. The collection data method allows the device to optimize the timing of the application of the penetrant and developer. By implementing this solution, the testing process can be enhanced in terms of accuracy, reliability, and compliance with the standards outlined in ISO 3452-1:2021. Automating the testing process with the device reduces the need for manual monitoring and control, which can be time-consuming and error-prone. Remote monitoring of the testing process allows manufacturers to access real-time data on the parameters of the process, and receive alerts if any issues are detected. This can help to ensure that the testing process is being performed consistently and reliably, and that any problems are addressed in a timely manner.

This project has the potential to support Sustainable Development Goals (SDGs) number 9 (Industry, Innovation, and Infrastructure) which highlights the significance of robust infrastructure, promoting inclusive and sustainable industrial development, and fostering innovation. By automating the testing process and collecting data on the parameters of the process, the device can help

to improve the efficiency and accuracy of the testing process, which can lead to more sustainable and resilient industrial practices. Additionally, the device can contribute to enhancing product quality and mitigating the likelihood of defects, ultimately resulting in cost savings and increased customer satisfaction, which also supports SDGs 9 by promoting sustainable and inclusive economic growth. Therefore, this project holds promise for substantial enhancement in efficiency and accuracy of the penetrant testing process, as well as provide greater visibility and control for manufacturers. This has the potential to enhance product quality and minimize the occurrence of defects, leading to cost reductions and heightened customer satisfaction..

1.6 LIMITATION OF THE PROJECT

One potential limitation of the proposed IoT-based device is its dependence on internet connectivity. If the device loses connectivity, it may not be able to function properly. Additionally, the device may be limited by the range and accuracy of the sensors used to collect data on the parameters of the testing process. Data security is another potential concern, as the device may store sensitive data such as test results and quality standards, which could be at risk of unauthorized access. The device may also require an initial investment, which may not be feasible for all manufacturers.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The main objective of this current study was successfully achieved. The designing and implementing an IoT-based device for monitoring and controlling the penetrant testing process was developed. The device's design is made to provide a cost-effective and efficient solution for manufacturers. Through evaluation and testing, the device proves its capability to monitor and control the testing process accurately, effectively, and remotely.

The development of Penetrant Testing Non-Destructive Test Monitoring System was effectively addressed the challenges and limitations associated with manual monitoring and control of the penetrant testing process. By automating and remotely monitoring the process, the system ensures consistency, accuracy, and reliability of the testing results. The device collects data on parameters such as temperature and light intensity, providing real-time visibility and generating alerts for any deviations from the specified requirements. Through the integration of IoT technology, manufacturers can optimize the testing process and ensure compliance with ISO 3452-1:2021 standards.

By providing an automated and IoT-enabled solution, this project contributes to enhance the efficiency, accuracy, and reliability of the penetrant testing process. Manufacturers can benefit from improved visibility, real-time monitoring, and data-driven optimization, ultimately leading to higher quality testing results. In conclusion, this project has demonstrated a success lay of foundation for further advancements and applications in the field of non-

destructive testing, supporting the growth and progress of industries that rely on accurate and efficient testing processes.

5.2 RECOMMENDATIONS

1. Further refinement of the system: Despite the successful development of the prototype, there is always room for improvement. Fine-tuning the system's hardware and software components can enhance its performance, reliability, and user-friendliness.
2. Robustness and durability: Consider implementing measures to enhance the robustness and durability of the system, ensuring it can withstand various testing conditions and environments without compromising functionality.
3. Integration with additional sensors: Explore the possibility of integrating additional sensors or functionalities that can further enhance the system's capabilities, such as humidity sensors or data logging features.
4. User interface enhancement: Continuously improve the user interface, both on the physical prototype and the accompanying mobile app (Blynk connection), to ensure a seamless and intuitive user experience.
5. Field testing and validation: Conduct extensive field testing and validation to ensure the system performs reliably in real-world scenarios. This will help identify any potential limitations or areas for improvement.
6. Collaboration and industry adoption: Engage with industry experts and professionals in the non-destructive testing field to gather feedback, suggestions, and potential opportunities for collaboration or commercialization.

By implementing these recommendations, the Penetrant Testing Non-Destructive Test Monitoring System can be further optimized and refined, making it a valuable tool for

non-destructive testing applications, enhancing efficiency, accuracy, and overall productivity in the field.

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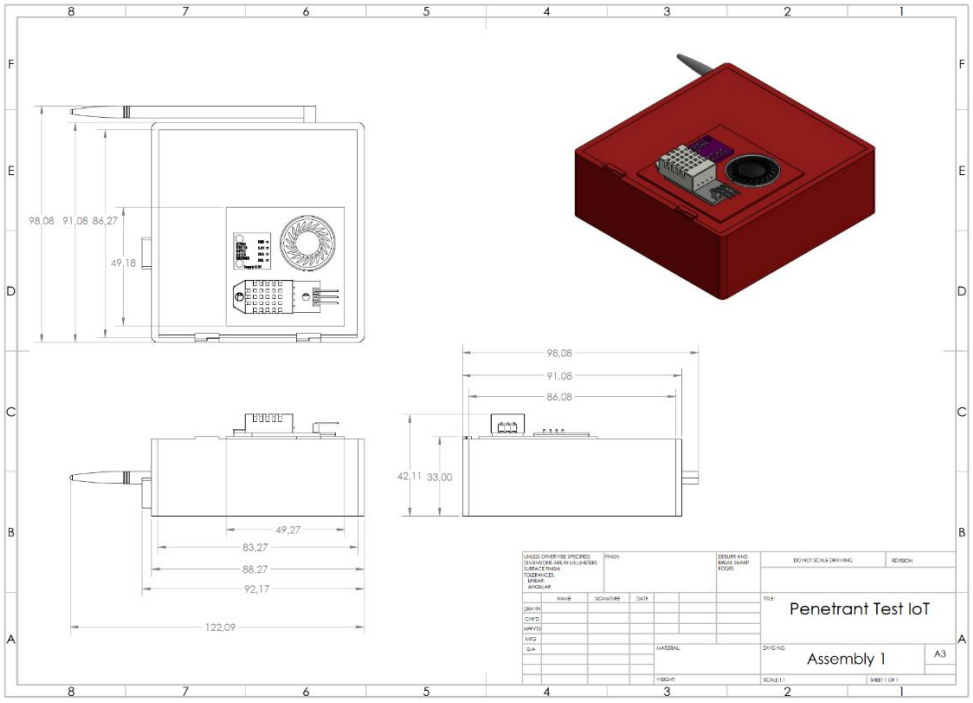
APPENDIX 1
Project Schedule Gantt Chart

Task	Week																							
	Dec'22				Jan'23				Feb'23				Mar'23				Apr'23				May'23			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Start FYP	✓																							
Project Class Session	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discussion and Meeting with Supervisor	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Project Title Selection	✓																							
Project Title Approval	✓	✓																						
Literature Review		✓	✓	✓																				
Proposal Research			✓	✓																				
3D Modelling Prototype				✓	✓																			
Proposal Defense Presentation					✓																			
System Configuration					✓	✓	✓	✓	✓															
Circuit Design						✓	✓	✓	✓															

Simulation																								
Project Progress Presentation									✓															
Build Physical Circuit									✓	✓	✓	✓	✓											
Integrate Hardware Components													✓	✓	✓	✓								
FYP 2 Presentation																	✓							
Integrate Android Application																	✓	✓	✓					
3D Print Box System Casing																			✓	✓				
System Testing																				✓	✓	✓		
System Troubleshooting																					✓	✓	✓	
System Finalization																						✓	✓	
Technical Paper and Poster																							✓	
Final Presentation (IREX)																								✓

APPENDIX 2

Preliminary Result Engineering Drawing



APPENDIX 3

Final Result Engineering Drawing