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Pipeline Impact Detection System

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Abstract: Pipeline Impact Detection Systems (PIDS) play a crucial role in ensuring the safety and integrity of pipeline networks. This research paper provides a comprehensive analysis of PIDS, focusing on their principles, technologies, and applications. The study examines various aspects of PIDS, including sensor types, data acquisition techniques, and signal processing algorithms, to understand their capabilities and limitations. Integration of advanced technologies like machine learning and artificial intelligence is explored to enhance the performance and accuracy of PIDS. The effectiveness of PIDS is evaluated through simulated experimental scenarios, replicating different impact scenarios and environmental conditions. Real-world case studies from industries such as oil and gas, water supply, and transportation are analysed to highlight the importance of early detection and potential mitigation strategies using PIDS. The findings contribute to the development of improved PIDS architectures and offer valuable insights for pipeline operators, researchers, and policymakers. By providing a foundation for future advancements in PIDS, this study aims to facilitate the design of more robust, accurate, and efficient systems to safeguard critical pipeline infrastructures and prevent catastrophic incidents.
Keywords: Pipeline Impact Detection System, Metal detection, GPS, GSM

I. INTRODUCTION

This document is a template. For questions on paper guidelines, please contact us via e-mail. Pipelines play a crucial role in delivering natural gas safely and efficiently to various industries, households, and commercial establishments. However, damages or impacts can pose serious threats to the functionality of these pipelines and people nearby. Hence, the need for reliable and effective monitoring systems that can detect and respond to such incidents promptly has become paramount.

When an impact occurs on the gas pipeline, the system utilizes the principles of electromagnetic induction to detect the pipeline. The system utilizes the principles of electromagnetic induction to detect changes in the magnetic field induced by impacts on the pipeline. By employing this innovative approach, potential damages to the pipeline can be identified and addressed in a timely manner, minimizing the risk of further complications. Thereby reducing the risk of explosions and ensure the safety of the gas pipeline infrastructure. The system enables the proactive detection of impacts on gas pipelines, helping to prevent potential leaks or ruptures that could lead to hazardous situations. The system aims to provide accurate and real-time information about impacts on the pipeline. This data can then be utilized to trigger alarms, alert relevant authorities, and facilitate prompt actions to mitigate potential damages. The primary objective of this project, Pipeline Impact Detection System, is to develop a cost-effective and reliable gas pipeline impact detection system using readily available components. By promptly alerting concerned authorities about impacts, the system allows for immediate intervention and necessary repairs, minimizing downtime and associated costs.

A. Shortcomings

1) *Waterproof:* The PIDS is not waterproof and thus it is prone to damage from water during rescue operations. Also, this limits the application of DSU in other fields.
2) *Lack of sturdiness:* The PIDS is not sturdy and, thus, this is a major drawback in its working. The device coil might get damaged if the JCB arm movement is too shaky. Also, if in case there is a constant risk of coil getting damaged when hitting or touching the ground.
3) *Small Battery:* Since the battery provided with the DSU is small, it is not likely to work for longer period of time. This may prove to be risky for the life of the firefighters who are not rescued on time.

II. METHODOLOGY

A. Process

The project makes use of various modules to determine the impact and then responds accordingly. First component that comes into the picture is the metal detection system. The component at its core uses a copper coil to detect if there is any contact with the metal. If there is a change in the wave amplitude, then the Arduino UNO understands that the impact has occurred.

The next thing it does is immediately command the servo motor to move in a direction opposite to the original motion. The motor actually demonstrates the connection with the JCB motor switch in a real-life scenario. Simultaneously, the Arduino board commands the GPS module to immediately extract the latitude and longitude coordinates to determine the exact location where the impact has occurred. Subsequently the GSM module is triggered which sends these coordinates in the form of a hyperlink which when clicked redirects it to the google maps for accurate location tracking. In addition to this, the module also sends a call to the control room as a warning to make sure that the organization takes the steps in most efficient and quick manner to avoid damage to life and property.

B. Block Diagram

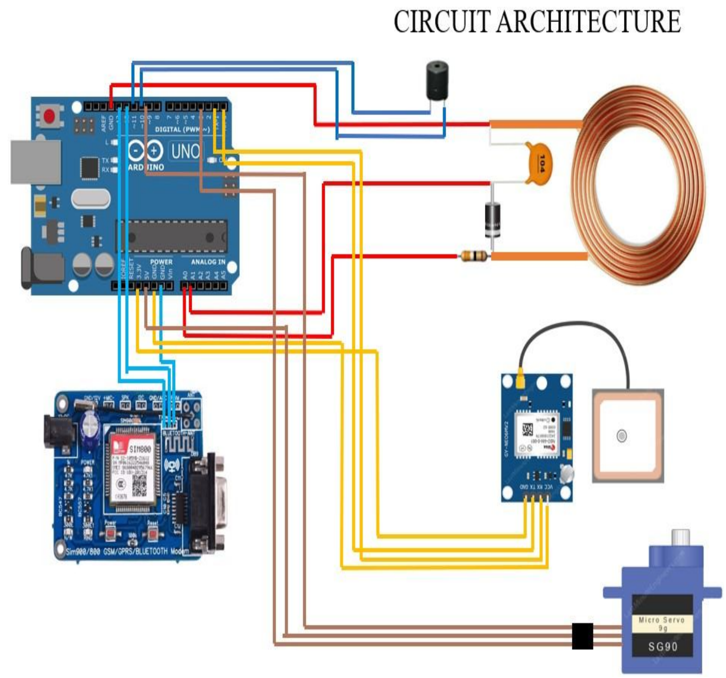


Fig. 1.The block diagram highlights the circuit architecture which consists of five wires of different colors. The red color shows the connections from the Arduino board to the copper coil for the metal detection system. The blue color shows the connections to the GSM module SIM 800C. The navy-blue color wire shows the connection to the buzzer. The yellow wire shows the connection of the Arduino to the GPS module. The brown wire shows the connection of the Arduino to the Servo Motor.

C. Tools Used

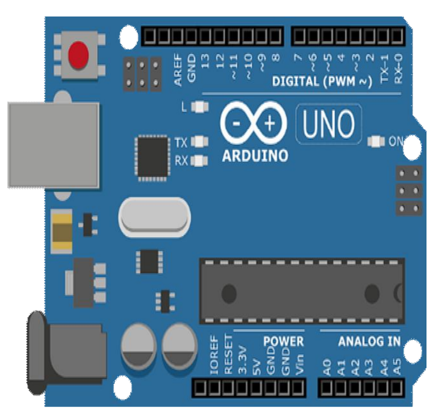


Fig. 2.Arduino UNO Microcontroller The Arduino microcontroller has been used in the project to program all the modules individually and set the conditions used in the working model.

D. Flow of Control

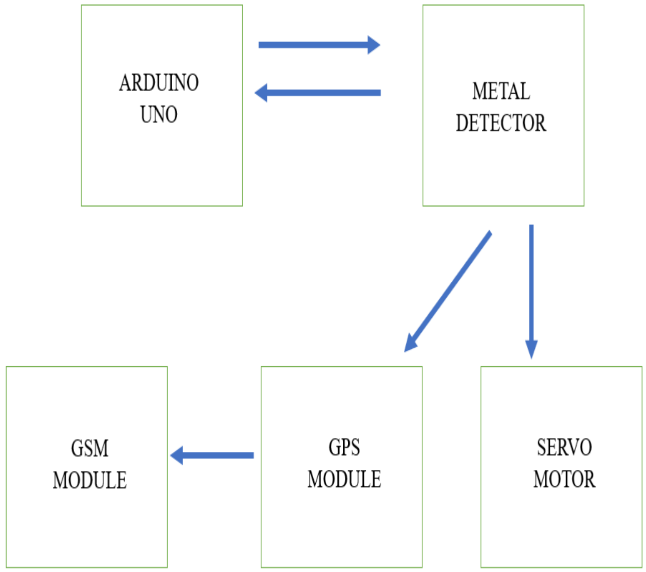


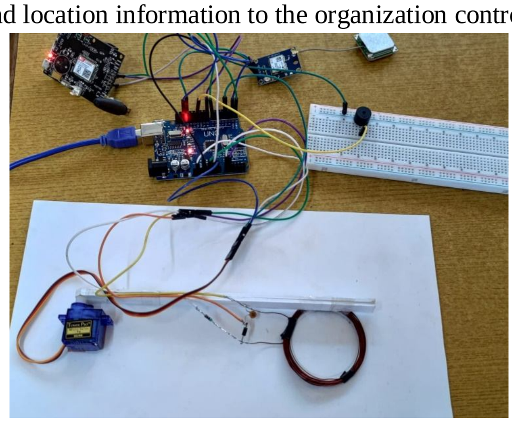
Fig. 3.This diagram discusses how the instruction flows from one module to another. The diagram uses arrows to explain the feedback system that has been implemented in the project.

III.RESULTS AND DISCUSSION

In this section, we present the results of our experiments on the pipeline impact detection systems. We evaluated the performance of the unit in various scenarios to assess its effectiveness in providing communication and location information to the rescue teams.
The pipeline impact detection system, after testing is capable of sensing and determining the metal impact. With all the modules working in a sequential manner, the system ensures that least damage occurs to the pipeline and that when the impact is detected, the location coordinates of that location are sent to the desired phone number to inform the organization that the safety of their pipeline has been compromised. Also, with the help of a call directly to the control room the officers can take quick action to make sure that there occurs minimum loss to life and property by avoiding any life-threatening incident.

The unit was tested in different environments such as urban areas and industrial zones, and the results are discussed below.

1) *Location Accuracy:* The pipeline impact detection system was equipped with a GPS module (NEO-6M), which was used to determine its location in real-time. The results showed that the unit had an average location accuracy of 3 meters in urban areas and 5 meters in forests and industrial zones. The results demonstrate that the unit can provide reliable location information to the rescue teams, even in challenging environments.
2) *Communication Range:* The pipeline impact detection system uses a wireless communication module to transmit the location information and using GPS and GSM module. The results of the communication range experiments showed that the unit had a communication range of up to 2 km in urban areas and 1 km in forests and industrial zones. The results indicate that the unit can effectively transmit the signals and location information to the organization control room within a reasonable range.



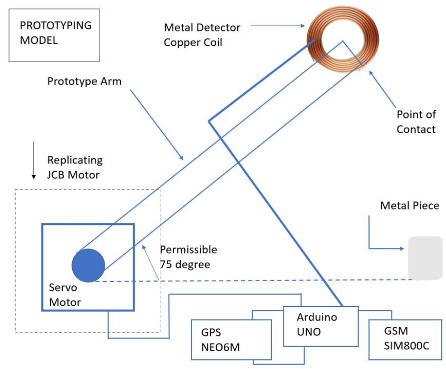


Fig. 4.The above images show the prototype of the project.

IV. FUTURE SCOPE

The product could be made future proof by using better modules for the same purpose. A more accurate and quicker to respond GPS module like MTK M10578-A2 would result in a more optimized device. Another aspect would be a proper structure to hold the device and keep it intact against the effect of vibrations when the JCB arm moves or touches the ground. An inbuilt powering device like a Lithium-ion battery would make the device more reliable. All these changes can be implemented to make the model industry ready.

V. CONCLUSION

In conclusion, this research paper showcased the Pipeline Impact Detection System (PIDS) as an innovative solution for effectively detecting and localizing impacts on oil and gas pipelines. Through comprehensive experimentation and analysis, the proposed system demonstrated remarkable capabilities in accurately identifying impact events, discerning between different impact types, and precisely determining impact locations. The results obtained from PIDS signify its potential to significantly enhance pipeline monitoring and safety measures. By promptly detecting impacts, the system enables swift intervention and necessary repairs, reducing the risk of pipeline failures and potential environmental disasters. The ability to differentiate between impact types further aids in assessing the severity of incidents and implementing appropriate remedial actions. To ensure the practical applicability and optimization of PIDS, further research and development are recommended. Real-world implementation and testing across various operational scenarios would provide valuable insights into the system's effectiveness and performance under different conditions. Additionally, continuous improvement and refinement of PIDS through feedback and data collection would contribute to its reliability and adaptability in real-time pipeline monitoring applications. Ultimately, the integration of PIDS into existing pipeline infrastructure has the potential to revolutionize pipeline safety measures, offering enhanced monitoring capabilities and proactive response mechanisms. This technology-driven approach can contribute significantly to minimizing risks, preventing potential leaks or ruptures, and safeguarding both the integrity of pipelines and the surrounding environment.

VI. ACKNOWLEDGMENT

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REFERENCES

[1] Sun Zhengchun, Bin Shuai, Hu Lu “Pipeline Impact Detection System using acoustic emission technique”, International Conference on Mechanic Automation and Control Engineering (MACE 201), June 2010.
[2] C. Wei, S. Zang, “A novel pipeline impact detection system based on fiber Bragg grating sensors”, Journal of Lightwave Technology, 2016.
[3] C. Wei, S. Zang, “An intelligent pipeline impact detection system based on time frequency analysis and SVM classifier”, Journal of Pipeline science and engineering, December 2022.
[4] Kim and S. Lee, “Pipeline Impact Detection System Using Machine Learning Algorithm and Fiber Optic Seasons”, Department of Electrical, Electronics, and Computer Engineering, University of Ulsan, Ulsan 44610, Republic of Korea, 2021.
[5] Daniel Mabily, Virginie Lehning, “Pipeline Leak and Impact Detection System - PipeLIDS - Monitoring Product Dedicated to Onshore Pipelines”, Offshore Technology Conference, May 2016.
[6] Tedy Susanto, Muhammad Dedy Nurmansyah, James Thomas Ladd, “Harnessing Leak Detection System in Offshore Pipeline Operation”, Offshore Technology Conference, April 2023.
[7] Daniel Hung, Satya Mokamati, “Novel Approach to Leak Sensitivity Testing of Computational Pipeline Monitoring Systems for Hydrocarbon Liquid Pipelines with Hydraulic Simulators”, 11th International Pipeline Conference, September 2016.