IMPLEMENTATION OF IOT-BASED ENGINE AND TRANSMISSION HEALTH MONITORING SYSTEM FOR KOMATSU GD825A-2 AT PT KALIMANTAN PRIMA PERSADA SITE TMRB

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Abstrak

The Komatsu GD825A-2 motor grader plays a vital role in mining operations, particularly in maintaining road quality to ensure efficient transportation and production. However, manual maintenance methods often lead to inaccurate monitoring, resulting in unexpected failures and increased downtime. To address this issue, implementing an IoT-based predictive maintenance system is proposed. By integrating real-time monitoring with advanced data analytics, this system enhances failure prediction, minimizes repair costs, and optimizes equipment availability.
Keywords: Predictive Maintenance, IoT, Heavy Equipment, Komatsu GD825A-5, Real-time Monitoring, Data Analytics.

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I.INTRODUCTION

For machinery to sustain efficiency in operation to prevent excessive downtime, heavy equipment maintenance is crucial in mining operations. Manual assessments, which are the basis of traditional monitoring methodologies, are prone to errors and delays when recognizing component failures. There is currently no comprehensive predictive maintenance system on the Komatsu GD825A-5, an important instrument in mining operations.

Figure 1. Komatsu motor grader GD825A-2

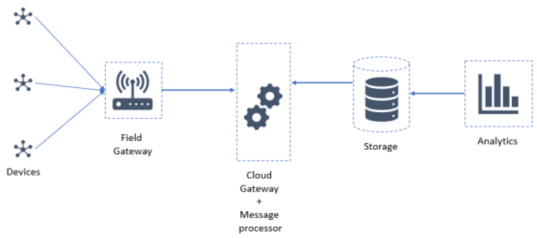
A solution is offered by putting in place an IoT-based predictive maintenance system, which makes it possible to monitor conditions in real time and identify problems early. This method takes use of intelligent sensors to constantly gather data, which is afterwards examined to anticipate possible malfunctions before they materialize. Mining businesses can increase overall reliability of equipment, decrease unscheduled breakdowns, and boost maintenance planning through using this technology. likewise preventive maintenance techniques are made potential by including IoT technology, ensure any potential issues can be fixed before they progress into catastrophic failures.

Figure 2. Manual measurement to determine engine & transmission health

II. RELATED WORK

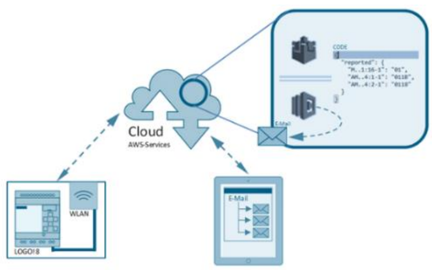
The beneficial impact of predictive maintenance in manufacturing environments is being demonstrated through multiple research. It has been proven that adding IoT, big data analytics, and machine learning into maintenance plans could reduce unplanned downtime and improve equipment lifespan. fortunately to ensure precision and dependability, present technologies frequently rely on robust sensors and a consistent network infrastructure. A successful predictive maintenance strategy has been proven by PT United Tractors' CBM V3++ system, which utilizes automated data processing and cloud-based monitoring .

Figure 3. Cloud flowchart diagram



The advantages of predictive maintenance for improving equipment reliability have been shown in several types of case studies. IoT-based maintenance strategies, for instance, have significantly reduced failure rates and extended the life cycle of crucial parts in the manufacturing and automotive sectors. These scenarios show how a well-designed predictive maintenance system can reduce unexpected breakdowns and improve operational efficiency, resulting in it an ideal option for heavy machinery in mining operations.

Figure 4. Cloud transmission data PLC to Iot broker



III. SYSTEM DESIGN AND IMPLEMENTATION

A. Iot-Based Predictive Maintenance Framework

The Komatsu GD825A-5's hydraulic system, engine temperature, and transmission represent some of the most critical components of the recommended system which have real-time sensors installed on equipment. Operational information is collected constantly by these sensors and transmitted to a cloud-based platform for analysis.

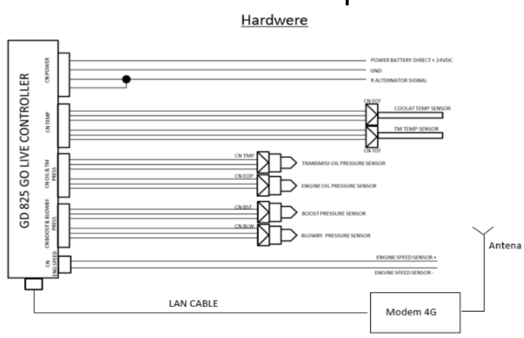


Figure 5. Schematic wiring diagram IOT Module

Figure 6. Component inside IOT Module

The solution removes the need for periodic manual inspections by utilizing IoT technology to enable continuous monitoring. Maintenance technicians may recognize abnormalities early and take corrective action before breakdowns occur according to this real-time data gathering. likewise by learning from previous data, predictive techniques can be enhanced over time, improving their precision in identifying failures and prediction.

B. Network Infrastructure and Data Processing

A secure and reliable network infrastructure is required to guarantee efficient data transfer. Trend analysis and real-time notifications are provided with accessible by the system's low-latency cloud integration and wireless connectivity. Real-time and historical data are processed to machine learning algorithms with the aim to detect abnormalities and detect potential breakdowns.

With the goal to transform raw sensor data into valuable information, data processing is important. Large-scale data analysis is made accessible by cloud-based computing and storage, which guarantees accurate handling of massive amounts of operational data. likewise, to protect against cyber threats and protect the integrity of transferred data, security measures involving encryption and access controls are set in places.

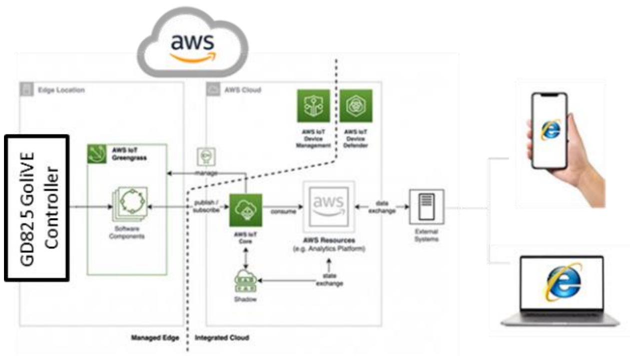


Figure 7. Aws comunication diagram with IOT Module

C. User Interface and Reporting System

Maintenance teams may obtain comprehensive data about equipment conditions via a web-based dashboard. Proactive decision-making is made accessible by the interface's real-time alerts, performance trends, and recommendations.

User may easily interpret vital performance indicators according to the dashboard's user-friendly design. Teams can generate full evaluations on equipment health, maintenance history, and performance trends via customizable reporting tools. likewise remote access to maintenance alerts becomes accessible through integration with mobile applications, providing optimizes decision-making responsiveness and efficiency.

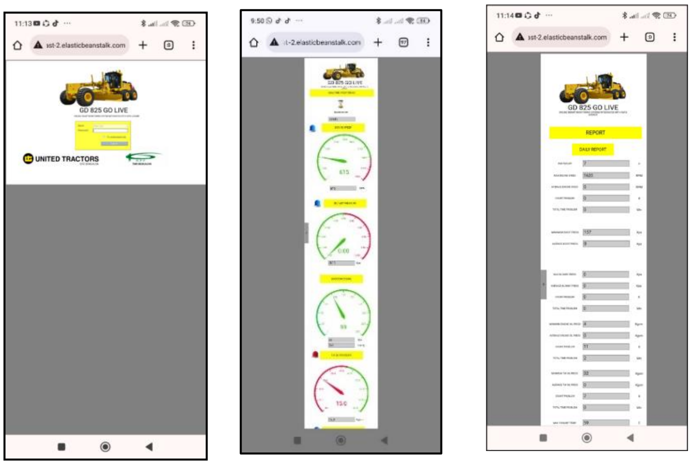


Figure 8. Online Web App for realtime monitoring

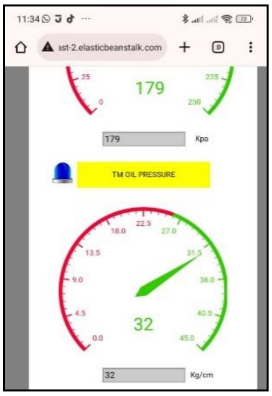


Figure 9. Smart detection warning lamp at Web App

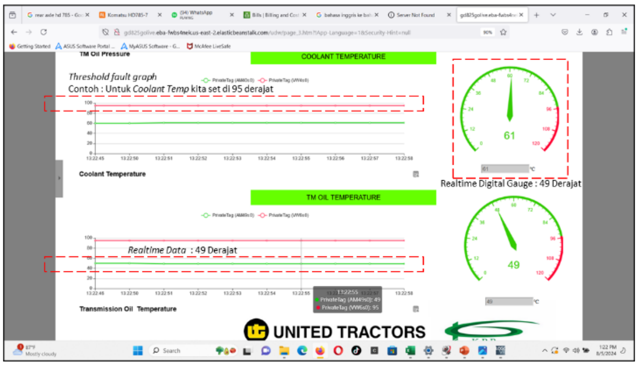


Figure 10. Realtime data graph at Web App

IV. CHALLENGES AND SOLUTIONS

A. Sensor Reliability and Environmental Conditions

While heavy machinery operates in difficult environments, sensor durability is the main concern. Industrial-grade sensors, such PT100 temperature sensors, are used to address this, providing robust resistance to vibrations and high temperatures.

Figure 10. Various type of sensor for IOT system installed to machine

To improve reliability, redundancy procedures and sensor calibration are further implemented. In the case one particular sensor fails, redundant sensor arrangements ensure that data accuracy is preserved. Periodic recalibration enhances the precision of measurements even further, providing technicians trust in the system's diagnostic information.

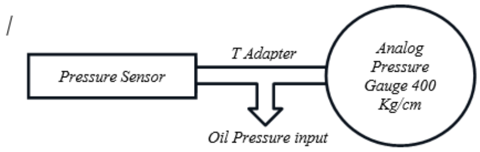


Figure 11. Calibration methode for oil pressure sensor

Figure 12. Calibration process for oil pressure sensor

B. Data Accuracy and System Scalability

The precision of predictive maintenance might be affected by inconsistent data readings. The accuracy of predictions is improved through the utilization of adaptive machine learning models, which are continually updated in connection with fresh data. In addition, the system's flexibility across different fleet equipment types increases overall operational efficiency.

Scalability becomes crucial as mining operations grow. Additional sensors and equipment can be easily integrated via a modular IoT framework without involving significant system overhauls. Due to that flexibility, predictive maintenance plans may arise with the company's growth, ensuring effectiveness and efficacy over time.

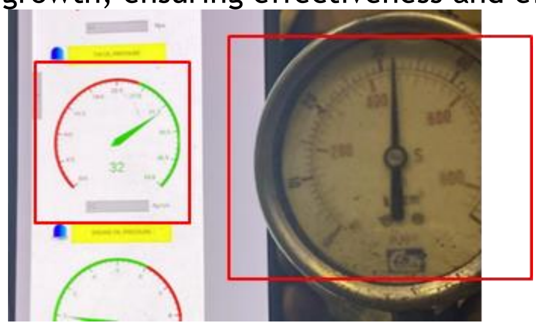


Figure 13. Accuracy test for oil pressure sensor

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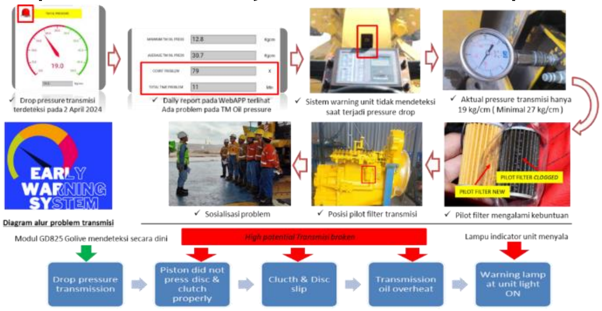
Figure 14. Accuracy test for oil pressure sensor

V. RESULTS AND DISCUSSION

The IoT-based monitoring system's preliminary evaluations indicate significant improvements in maintenance efficiency and failure detection accuracy. Unexpected breakdowns and maintenance costs have reduced based on data collected through experimental placements. Early identification of failures in engine and transmission components has been successfully carried out by the IOT system, leading to early preventive maintenance

The benefits of real-time condition monitoring in reducing maintenance schedules have been demonstrated by feedback from maintenance teams. Accurate failure prediction has led to enhanced asset utilization, lower labor costs, and optimized maintenance workflows. likewise improved resource utilization has resulted via data-driven decision-making, which has improved operational efficiency even more.

Figure 15. Iot system proven for early detection of drop at transmission oil pressure



VI. CONCLUSION

For heavy machinery like the Komatsu GD825A-5, implementing in place an Internet of Things (IoT)-based predictive maintenance system increases operational efficiency, reduces downtime, and minimizes repair costs. The next steps are going to focus on improving system integration across various device models, improving algorithm accuracy, and simplifying network performance for real-time data transfer.

The further development of predictive maintenance techniques will be significantly supported by continuous research and technical developments. Predictive maintenance solutions can reach greater precision and reliability by integrating IoT with advanced technologies like edge computing and AI-driven diagnostics, propelling the next stage of industrial efficiency gains.

Figure 16. Iot module (GD825 GOlive) installed to machine

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