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Measurement of diesel fuel volume using a smart device for heavy equipment units

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Abstract

Indonesia is one of the countries that produces large amounts of minerals, including coal, nickel, and others. The demand for heavy equipment to assist the mining industry is consequently extremely high. One of the most crucial aspects of managing a heavy equipment company is the high fuel cost. Businesses that operate heavy machinery face losses because of the existence of individuals who commit fraud by providing inaccurate fuel volume data. Because it is difficult to identify the validity of fuel use statistics, this issue remains in several mining businesses. The purpose of this research is to create a device that can measure the amount of fuel delivered into the tank so that the business owner can get the data in real-time. This device utilizes a microcontroller as its primary component to transmit sensor data to the owner of the heavy equipment unit. The amount of fuel data obtained will be saved on the SD Card storage media and transmitted via the internet network, which can be viewed via the website or the Android application. This research can reduce the company's possible losses from fuel volume manipulation.

Keywords

Fuel Volume, Smart Device, Measurement, Fossil Fuel

Introduction

Fuels are concentrated sources of energy that can be used for various purposes, including heating, transportation, and electricity generation. One of the major components necessary for a machine to run is fossil fuel. The operating expenditures required for purchasing gasoline in an industry are very significant. Unresponsible individuals take advantage of this chance to benefit themselves at the company's expense, specifically by manipulating information on the fuel consumption of heavy equipment units. This situation commonly happens in the mining sector that utilizes heavy equipment units. Several businesses, including mining and transportation, face the same issues everywhere in Indonesia. Utilizing a flow meter sensor to precisely

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determine the quantity of fuel added to the engine unit tank is the solution to this problem.

In the conduct of their research, a lot of researchers measured flow rates using flow meters. New technologies using Coriolis flow meters (CFMs) and a novel patented signal processing system known as the Prism have been presented. When coupled with Prism, CFMs have the capacity to complete these challenging high-speed measurements. CFMs are frequently utilized for flow measurement not only in the automotive industry but also in other industries [1]. A Techno-economical system can be created by installing a microcontroller-based turbine flow meter in a solar water heater to measure the flow of water through the system [2]. The injection rate meter was constructed according to W. Zeuch's method for measuring multiple injection rates. It consisted of a small cam-driven piston that was powered by an electric motor. The amount was calibrated to ensure that it met precise standards [3]. Using the in-cylinder pressure signal, another study focuses on the detection of the Air-Fuel ratio and the trapped mass in the cylinder after the intake valve closes. Estimation of the air-fuel ratio may allow the replacement of the lambda sensor; the estimation method relies on a statistical methodology [4]. Utilizing an Arduino Mega 2560 microcontroller and a positive displacement flow meter sensor, research was undertaken on building a fuel measurement device for suppliers [5]. To evaluate the energy efficiency of fishing vessels under various operating conditions, a new fuel consumption monitoring system was installed for research purposes [6]. The consumption of fuel by gasoline and diesel engines can now be measured using one of two novel approaches that have just been developed. The first system incorporates a wide-band Lambda sensor in addition to a Mass Air Flow (MAF) sensor [7]. According to a method of static weighing calibration that was established, there was not a significant difference between the calibration that was determined by the flow meter manufacturer using water and the calibration that was determined by NTTL using diesel fuel [8]. The flow meter was subjected to calibration testing using a static weighing system, which demonstrated that it was capable of meeting this accuracy requirement for flow rates that were at least 31.8 kg/h and that it was only slightly inaccurate for flow rates that were lower than that [9].

We couldn't find any reports of diesel fuel engine flow meter sensor measurements in heavy equipment tank units. The goal of this research is to create a new tool for measuring the flow of diesel fuel through a heavy equipment machine's tank. The apparatus utilized an ESP32 microcontroller to gather the data from the flow meter sensor. Then, a web-based website is created to display data from the microcontroller. Details concerning refueling times are included in the material provided on the website. Furthermore, the data is saved on a storage medium in the form of an SD Card.

Method

Fuel flow meter device

Using a flow meter sensor, the intelligent monitoring device is able to perform its function of measuring the quantity of fuel that is put into the tank of the heavy equipment unit. The calculated fuel flow will be recorded by the microcontroller that is part of the circuit system. The results of the measurements taken by the sensor, which are then sent on to the microcontroller, will be stored on the storage media provided by the SD Card. In addition, the data from the measurements can also be shown through the use of an android application or a website. The fuel flow meter device designed in a simple shape is shown in Figure 1.

Figure 1. Fuel flow meter device

Figure 2 shows the schematic of the fuel flow monitoring device. This device is divided into three parts, namely input, process, and output components. The input component is the part that provides the signal to be forwarded to the process section, in this case, the flow meter sensor. The process component processes data received from the sensor and displayed it on a small LCD screen.

The main part of the process component is the Arduino Uno-type microcontroller. The results of processing data are also stored on a storage medium in the form of an SD card. As a source of energy, a 9-volt battery is utilized by this apparatus. The flow meter sensor demands 9 volts of power; however, the microcontroller requires 5 volts; therefore, a lower voltage must be applied. The amount of fuel measured by the sensor is also automatically transmitted through the internet of things network and displayed on a website.

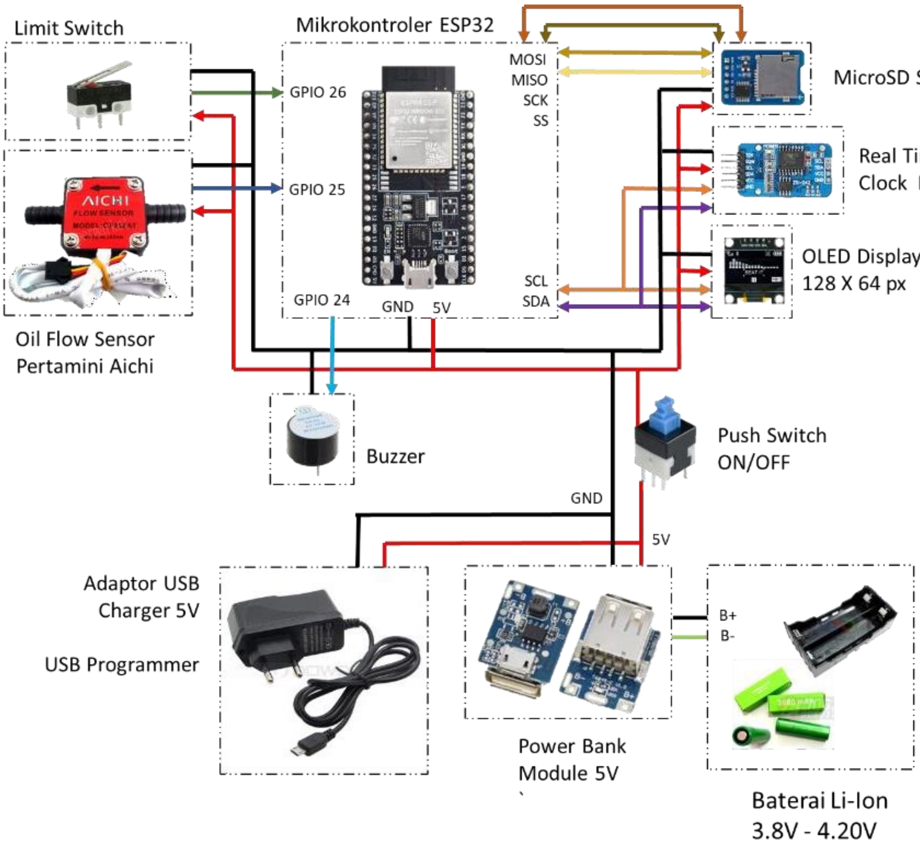

Figure 2. Schematic of fuel flow meter device

Experimental data

Figure 3 shows the refueling of the unit using the smart monitoring device. When refueling the unit, the fuel passes through the flow meter sensor. The unit used in this research is an excavator Caterpillar 305.5. When the flow meter sensor is functioning properly, the buzzer will sound, and the data will be delivered to the microcontroller for processing.

Figure 3. Refueling of the unit using the smart monitoring device

Figure 4 shows the comparison data collected from SD Card, server data and monitor device. The type of data on the amount of fuel captured by the sensor is kept in the SD

Card in the form of txt. This format allows the data to be easily read and analyzed. The data information saved consists of refueling time, fuel flow rate, and total volume of fuel.

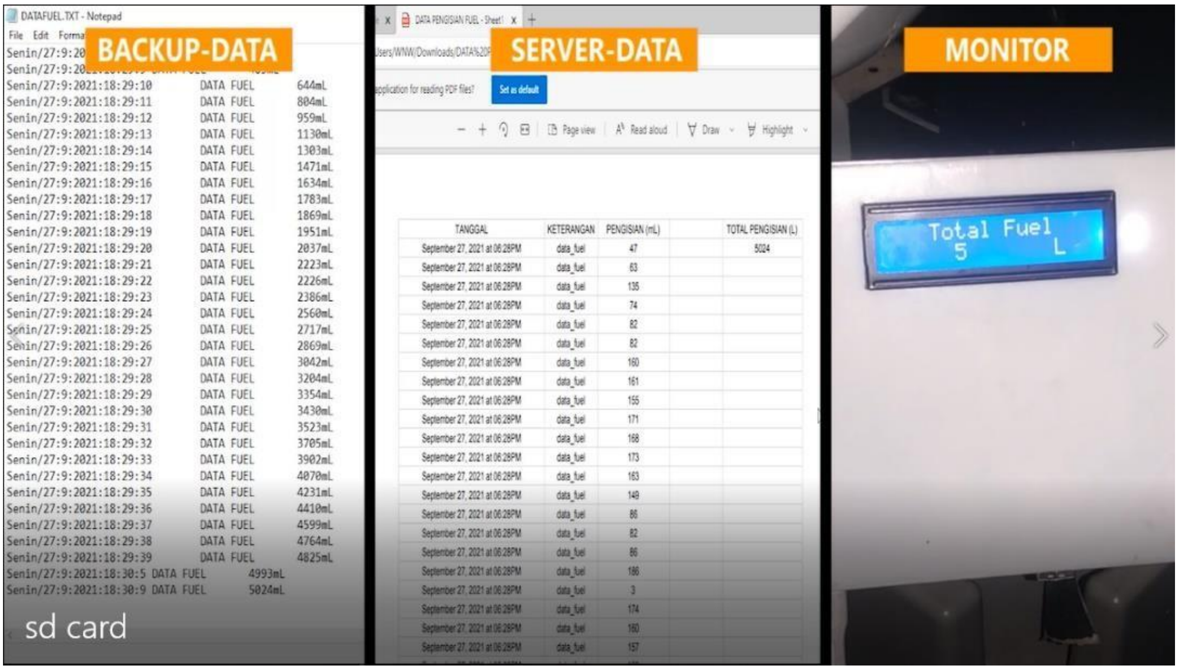

Figure 4. Comparison data collected from SD card, data server and monitor device

The data displayed on the webpage is shown in Figure 5. The data saved in csv file is linked to the data that is presented on the website. The website can immediately read the amount of fuel that is being read by the sensor in real- time, which allows for information to be obtained regarding the volume of fuel that is being loaded into the tank.

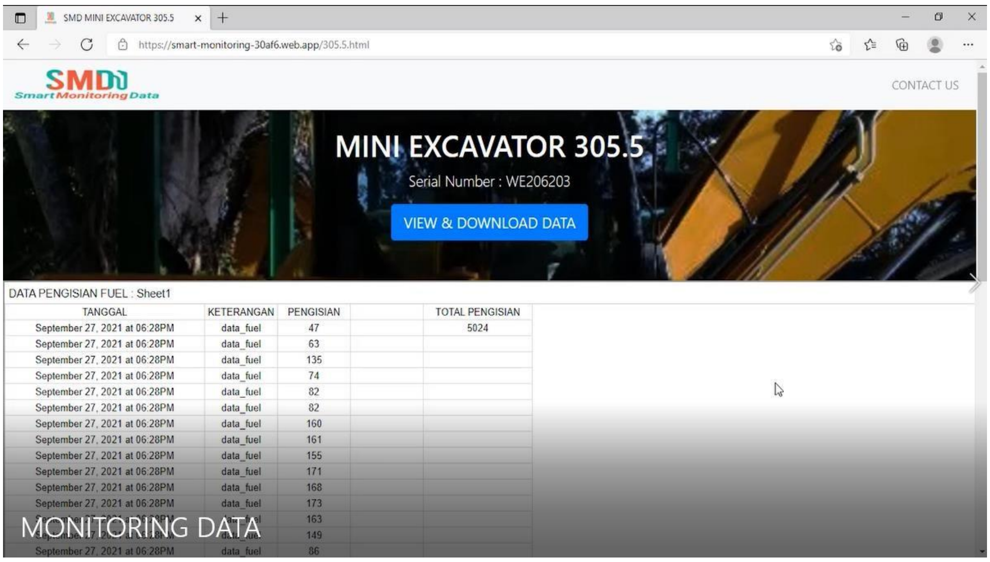

Figure 5. Data displayed on webpage

Result and Discussion

Flow meter sensors must be calibrated for their results to accurately reflect the actual flow rate. Periodic calibration is required to gather information regarding the amount of fuel pumped into the tank. The pulse frequency, flow rate, and calibration factor are the three most significant factors to consider when calibrating the flow meter sensor. Multiplying the flow rate calculation by the output frequency specification number, which changes based on the type of flow meter, yields the output frequency. The input water flow sensor is the Pulse Frequency, which is obtained by reading the magnetic area of the flow meter sensor. Using this information, the input frequency is then determined. Since the sensor output computation represents the actual flow frequency of the fluid flow, it is essential that the flow rate detected by the flow meter sensor remains constant every second while the container is being filled. The third element, following the maintenance of a constant flow rate, is the calibration factor. This calibration factor is necessary to adjust the quantity of fluid entering the sensor to the quantity of fluid being detected by the sensor.

Conclusion

The Smart Monitoring Device work system focuses the reduction of refueling fraud in Indonesian heavy equipment. This technology can provide data in real time to business owners, enabling them to accurately determine the volume of refilling for heavy machinery units. This Smart Monitoring Device is not capable of preventing all instances of fraud and loss in the fuel industry. This device intends to reduce the occurrence of this problem while also contributing to the development of a more effective fuel data management system in the fuel industry.

Acknowledgments

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