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VEHICLE THEFT DETECTION SYSTEM BASED ON ARDUINO

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ABSTRACT
Fuel shortage is a prevalent issue in Indonesia, leading to numerous incidents of vehicle fuel theft. To address this problem, an Arduino-based vehicle fuel theft detector system has been developed. This prototype utilizes an Arduino UNO microcontroller, an IComSat v1.1 SIM900 GSM/GPRS Shield for mobile communication, a fuel level sensor for monitoring volume, and a push button to detect the state of the fuel tank lid. The system operates by detecting whether the fuel tank lid is open. When the lid is opened, the system initiates a phone call. Additionally, it continuously monitors the fuel volume; if there is a significant drop in volume, the system sends a notification via SMS to the vehicle owner regarding the decrease. The communication success rate between the Arduino UNO and other electronic devices is reported to be 100%. The fuel level sensor demonstrates an accuracy of 90%, while the push button switch achieves a detection success rate of 100%. The GSM Shield communication has a success rate of 90%.
Keywords: Arduino, fuel theft, fuel level sensor, GSM Shield.

I.INTRODUCTION
Fuel scarcity is a significant issue in Indonesia. According to the Directorate General of Oil and Gas, the country's fuel reserves are diminishing, resulting in shortages across various regions. This situation has led to an increase in fuel theft, as stolen fuel has become a lucrative source of income for thieves in certain areas. These individuals typically siphon fuel from vehicles by opening the fuel tank and using a long hose to extract the fuel into containers, which they then sell at local retail outlets. This crime poses a particular threat to businesses that rely on vehicles. To tackle the problem of fuel theft, this paper presents the design of an Arduino-based fuel theft detection system. Several strategies to combat fuel theft have been proposed previously. For example, anti-siphon devices act as filters to prevent unauthorized fuel extraction, although they can sometimes be bypassed. Diesel dye can change the appearance of fuel to deter resale, but it can be reversed with sunlight. Additionally, tank locks and alarm padlocks can secure fuel tanks, but these require someone to be present for refueling, complicating the process. Surveillance cameras can monitor vehicle and driver activity, yet they involve high costs and necessitate constant oversight. Previous research has produced various systems for fuel theft detection. For instance, Sidabutar et al. developed a system utilizing GPRS, GPS, and microcontrollers that requires a password to operate the fuel valve and can

detect unauthorized attempts using an ultrasonic sensor. If the valve is accessed without the correct password, the system sends an alert to the owner via SMS, including the vehicle's coordinates. Similarly, Rilwano created an Arduino-based system for measuring motorcycle fuel consumption, employing a Low Current Sensor Breakout (LCSB) for fuel level monitoring, paired with GPS to track speed and travel time. This system effectively measures fuel usage throughout different times of the day.

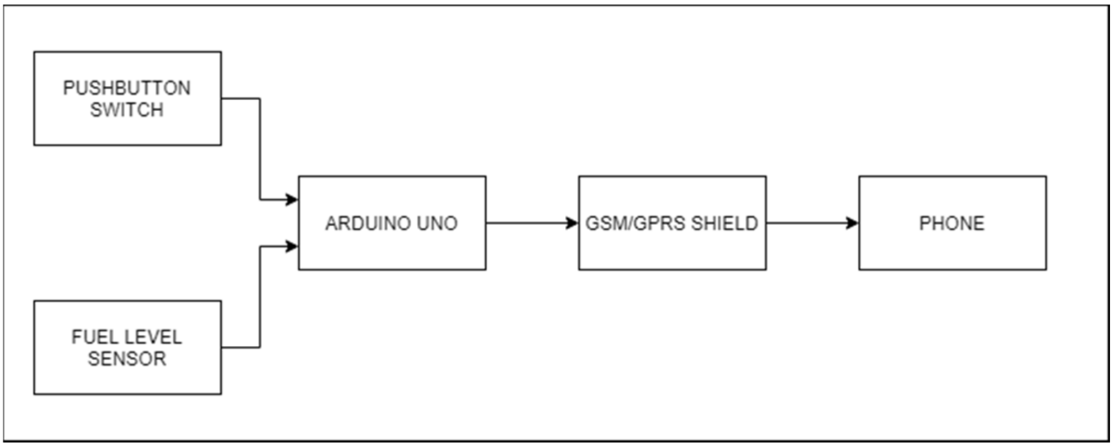
Mirzazoni and Zaini also designed a system that assesses fuel consumption in vehicles, calculating average fuel usage and kinetic energy loss during different periods of the day using LCSB. The objective of this research is to develop a system that detects fuel theft by monitoring unusual declines in fuel levels and reporting the time and location of such incidents to the vehicle's owner or the responsible individual via SMS.

II. METHODS

The methodology employed in this research involves a literature review focused on the hardware design of the system, techniques for detecting vehicle fuel theft, the electronic components utilized, and the theoretical aspects and characteristics of the microcontroller implemented in the system. Following the literature study, an experimental assessment is conducted to evaluate the accuracy of the sensors, test the communication between the sensors and the microcontroller, and verify the overall functionality of the system.

System Block Diagram Design

The proposed fuel theft detection system utilizes Arduino UNO as its main controller. This microcontroller can sense its environment by receiving inputs from various sensors, processing these inputs, and generating specific outputs to control different devices. Arduino UNO is a cost-effective board based on the ATMega328 microcontroller, featuring 14 digital input/output pins, 6 analog input pins, a 16 MHz crystal oscillator, a USB connection, a power jack, an In-Circuit Serial Programming (ICSP) header, a reset pin, 32 KB of flash memory, 2 KB of SRAM, and 1 KB of non-volatile EEPROM memory. It is programmed using the Arduino Integrated Development Environment (IDE), employing a programming language based on Wiring.



To monitor the vehicle's fuel level, the system incorporates a fuel level sensor, specifically the ALAS I Adjustable Fuel Sender, which operates within a resistance range of 240 Ω (empty) to 33.5 Ω (full). This sensor utilizes a buoy-shaped lever arm to detect the fuel level and produces an analog output that can be converted to digital form, requiring one input/output pin on the Arduino.

A push button switch is also integrated to determine whether the fuel tank is open or closed. This switch connects or disconnects the electrical current flow, remaining in an ON state when pressed and switching to OFF when released.

The communication with the vehicle owner is facilitated by the IComSat v1.1 SIM900 GSM/GPRS Shield module, which enables the sending and receiving of phone calls and SMS messages.

The system receives inputs from the push button switch and the fuel level sensor. The push button input indicates the status of the fuel tank, while the analog input from the fuel level sensor is converted to digital data using the Analog-to-Digital Converter (ADC) within the Arduino UNO. This data is then stored in the microcontroller's EEPROM memory. The system outputs a notification via a phone call when the fuel tank is opened, along with an SMS alert regarding any detected fuel theft incidents.

This research employs a literature study focused on the hardware design of a vehicle fuel theft detection system, methods for detecting fuel theft, electronic components, and the characteristics of the microcontroller used. Following the literature review, experimental studies were conducted to evaluate the accuracy of the sensors, test the communication between the sensors and the microcontroller, and verify the system's overall functionality. The system utilizes Arduino UNO as its main controller, which processes inputs from various sensors to control output devices. The fuel level sensor used is the ALAS I Adjustable Fuel Sender, which detects fuel levels through a buoy-shaped lever arm. The sensor provides an analog output, which is converted to digital data by the Arduino. A push button switch is incorporated to indicate whether the fuel tank is open or closed. When the switch is pressed, the system recognizes that the fuel tank is closed; when released, it indicates that the tank is open.

Communication with the vehicle owner is facilitated by the IComSat v1.1 SIM900 GSM/GPRS Shield module, allowing for phone calls and SMS notifications regarding the fuel tank's condition. The system processes inputs from both the push button switch and the fuel level sensor. The input from the push button switch indicates the state of the fuel tank, while the fuel level sensor’s analog output is converted to digital data and stored in the microcontroller's EEPROM memory. If the fuel tank is opened, the system triggers a notification via phone call and sends an SMS alert regarding potential fuel theft.

The next phase determines if there is a drastic decrease in fuel levels, which would indicate a possible theft. The average fuel flow rate is calculated using two measurement variables. A theft is suspected when the average of 15 measurements falls below -0.01. If a significant decrease in fuel is detected, the data is saved to EEPROM, and the system instructs the GSM Shield to

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send an SMS notification to the vehicle owner.

To convert sensor readings to liters, a linear equation is employed:

$$ x = \left(\frac{(y - y_1)(x_2 - x_1)}{(y_2 - y_1)} \right) + x_1 $$

Where:
- x = Fuel tank volume (liters)
- x_1 = Lower limit (0 liters)
- x_2 = Upper limit (4.59 liters)
- y = Sensor reading
- y_1 = Lower limit of sensor reading (54)
- y_2 = Upper limit of sensor reading (965)

After testing, it was found that the sensor values' limits correlate with the actual fuel tank capacity.

III.RESULTS AND DISCUSSION

The prototype of the system has dimensions of 27 x 17 x 10 cm and is constructed from acrylic material for durability and lightweight characteristics. When the fuel tank is empty, the system registers a sensor value of 54 and a corresponding fuel volume of 0.00 liters. The system activates when the push button switch is not pressed (indicating the tank is open), taking measurements over 15 intervals. If the switch is pressed (indicating closure), the system deactivates and resets the fuel measurement. The system can simulate fuel decrease through a faucet, allowing for controlled tests. It successfully detects significant fuel volume decreases indicative of theft, triggering the necessary alerts. Multiple tests were conducted to evaluate the system's functionality, including fuel level sensor accuracy, response to specific fuel volume decreases, push button functionality, and communication via phone calls and SMS messages. The fuel level sensor was tested across two scenarios, measuring fuel level changes under controlled conditions. Results indicated that while some readings fluctuated unexpectedly due to noise, overall accuracy was at 70%. The introduction of a Low Pass Filter (LPF) improved this accuracy to 90%, significantly reducing noise. Further tests confirmed the system's ability to detect a 1 cm decrease in fuel volume, translating to a corresponding decrease in the larger fuel tank. Measurements confirmed that the system reliably detected decreases above the threshold. Testing of the push button switch confirmed its accuracy, as it reliably detected open and closed states of the fuel tank. The system's communication capabilities were validated through successful phone calls and SMS alerts, achieving a 90% success rate in both cases.

IV.CONCLUSION

The developed Arduino-based vehicle fuel theft detection system operates effectively, with a 100% communication success rate between the Arduino and sensors. The fuel level sensor achieves 90% accuracy with the implementation of an LPF, while the push button switch accurately detects the fuel tank's status with 100% reliability. Finally, the GSM communication system maintains a 90% success rate for alerts sent to the vehicle owner.

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