Research on Intelligent Fueling Gun and Remote Meter Reading Technology Based on NB-IoT Communication

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ABSTRACT

The consumer rights and interests have been damaged and even legal disputes have never stopped because of the quality of the oil at the gas station and the lack of fuel during the refueling of the vehicle. In addition to the fueling staff factor, the main means of fraud is false display data and modification of the tanker program. In response to the various fraudulent links of gas station refueling, we reconstructed the traditional refueling gun based on NB-IoT communication technology, placed the NB-IoT communication module in the refueling gun, and collected the real refueling data directly from the refueling gun. The data from all gas stations are brought together to form a fueling big data platform. This technology not only solves the problem of integrity of gas stations, but also provides big data analysis and decision-making services for end users, and provides resource allocation services for gas stations. The paper specifically describes the combination of the fueling gun and NB-IoT communication technology, the setting of communication data interface between tanker and monitoring PC, acquisition of fueling data, and technology for connecting fuel guns to the internet of things.¹

KEYWORDS

Fueling Gun; Gas Station; Nb-Iot; Internet of Things; Communication Interface

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INTRODUCTION

Over the years, because of the quality of the oil at the gas station and the lack of fuel during the refueling of the vehicle, the consumer rights and interests have been damaged and even legal disputes have never stopped. In the annual sampling inspection process of various quality inspection departments, gas stations including China Petroleum, Sinopec and private oil companies also have blacklists due to low octane number, excessive sulfur content and shoddy filling. However, the investigation from the regulatory authorities did not completely eliminate the hidden rules behind the sale of gas stations. For most car owners, the gas station staff lifted the gun on the machine and stuffed the muzzle into the fuel tank port. Starting the refueling program seemed to be a simple semi-automatic programmatic business process. The extremely simple refueling steps are full of hidden stealing methods. The main fueling data counterfeiting methods include the following four methods: low-grade oil posing as high-grade oil, fueling personnel stealing oil, display digital false report, and modifying the tanker program. With the gradual regulation of the market and the increasing supervision of the regulatory authorities, it is relatively common practice at some gas stations in the market to sell low-grade oil as high-grade oil to consumers. At the end of the refueling, the refueling gun is slowly slamming. Some of them are fueled by the fueled in advance and laid to add oil. Some gas stations will even add fuel to the previous owner, and then add fuel to the next owner to achieve the goal of less fuel. Some gas stations can also achieve the goal of not enough oil by modifying the fuel dispenser display program.

In response to the falsification of gas station fueling data and various fraudulent links, we reconstructed the traditional refueling gun based on NB-IoT communication technology, placed the NB-IoT communication module in the refueling gun, and collected the real refueling data directly from the refueling gun. The data from all gas stations are brought together to form a fueling big data platform. On the basis of providing the integrity of the gas station, it provides big data analysis and decision-making services for end users, and provides resource allocation services for gas stations.

SETTING OF COMMUNICATION DATA INTERFACE BETWEEN TANKER AND MONITORING PC

In order to ensure the smooth implementation of the petrochemical refueling IC card project, according to the petrochemical refueling IC card application specification and the petrochemical refueling IC card project overall plan, a unified petrochemical refueling IC card project gas station computer refueling machine and monitoring PC communication data interface protocol was formulated. The communication mode and information exchange content and format between the unified tanker and the monitoring machine enable the monitoring machine and various fuel dispensers to communicate in a unified mode. Figure 1 shows the
schematic diagram of the tanker and the background control system. Authorized fuel dispenser consists of motor, oil pump, oil separator, flow measuring transducer, control valve, encoder, meter control board, indicating device, oil gun, IC card reader, thermal printer, metal keyboard, voice device, barcode it consists of main components such as a scanning device. The tanker uses an authorized fuel card to complete the IC card transaction and form a normal IC card transaction record. The security enhancement function still follows the technical route of mutual authentication between PSAM card and metering chip. The authorization verification code is input to the dispenser via a keyboard or barcode scanning device. For any refueling method, you can directly refuel through the refueling gun. The IC card holder shall comply with the requirements of the petrochemical tanker application software compatibility and basic function testing outline. Each oil gun should be equipped with a pull-off valve to prevent the danger caused by the abnormal loss of the oil pipe.

Figure 1. Schematic diagram of the tanker and the background control system.
The shut-off valve must be installed at the inlet of the oil pipeline of each submersible pump model authorized tanker to prevent the danger of the authorized tanker being abnormally tilted or collapsed[1][2]. The user card holder selected by the authorized tanker should have a lock card device, and the card will be automatically played after the fuel is added. The authorized tanker should be able to work normally in a power supply environment with a nominal voltage amplitude change of +10% to -15% and a frequency change of 1 Hz. The deviation of measurement accuracy shall not exceed 0.1%. The electrostatic discharge immunity shall comply with the provisions of the electrostatic discharge immunity test in GB/T 17626.2-2008. The radio frequency electromagnetic field radiation immunity shall comply with the provisions of the RF electromagnetic field radiation immunity test in GB/T 17626.3-2008[3]. Tests on I/O signals, data, and control ports are only performed when the data line, signal line, or control line length exceeds 1 m. Surge immunity should meet the requirements of the surge (impact) immunity test in GB/T 17626.5-2008. The open circuit test voltage is 2 (1 ± 10%) kV[4]. Authorized fuel dispensers should retain all data in full during the refueling process when power is interrupted due to power failure. When a fault occurs, the display time of the secondary fueling amount is not less than 15 minutes. After the tanker is started, the oil gun is turned on to circulate the test oil throughout the system. While observing the oil finder to the absence of air bubbles, return the oil gun to its original position. Pick up and turn on the oil gun again to the maximum flow position and record the value displayed by the 1 minute counting system, which is the flow rate of the measured fuel dispenser. The flow rate should not exceed 10% of the rated flow[5][6].

**NB-IOT INTELLIGENT REFUELING GUN AND REMOTE METER READING TECHNOLOGY**

With the mature development of Internet of Things technology, based on big data analysis and the new generation of IoT transmission core technology, we can construct an IoT data network to achieve comprehensive collection, transmission and analysis of terminal device data. As a new generation of narrowband Internet of Things technology, NB-IoT has enabled energy management to enter the era of the Internet of Things. By securely setting up the NB-IoT communication module in the refueling gun, based on the NB-IoT network, we can provide an efficient and reliable solution for remote reading of refueling data. The fueling data is placed in the cloud storage, thereby unified management of various NB-IoT device data, and an open interface to the third-party application system, so that various applications can quickly build their own gas station IoT business.
Acquisition of Fueling Data

The motor-driven oil pump separates the fuel in the oil storage tank from the oil and gas through the oil pipeline and the filter pump. The fuel is delivered to the motor vehicle via the flow meter and the oil gun under pump pressure. The angular displacement of the output shaft of the flow measuring device is converted into a corresponding electrical pulse signal by the encoder. The electronic counting indicating device displays the cumulative volume of the delivered fuel. The pump of the submersible pump refueling machine is set in the fuel of the oil storage tank, and can output fuel to a plurality of flow measuring instruments, and then discharge through the refueling gun. During the refueling process, when the oil of the oil receiver is filled to the gun position of the oil gun, the self-sealing oil gun automatically closes the main and auxiliary valves of the oil gun to prevent oil from overflowing. When the oil supply of the tanker is interrupted, the oil nozzle outlet is closed by the auxiliary valve of the oil gun, and the oil in the oil gun is continuously discharged[7]. When the fuel gun handle is pulled, the main valve is opened by the push of the jack. The oil passes through the main valve, filling the container from the oil discharge pipe and generating a negative pressure at the negative valve. Since the small hole through the vent pipe and the outlet pipe is connected to the atmosphere, the air is replenished through the small hole. The handle mechanism loses balance, the main valve is closed, the oil supply is stopped, and the self-sealing process is completed. After the signal is transmitted to the electromagnetic switch, the 220V power supply is sent to the oil pump[8]. After the oil pump is activated, the oil is transferred to the tanker through the pipeline. After the oil is filtered through the filter, it flows to the flow meter when the solenoid valve is opened. After the oil passes through the flow meter, the oil flows through the skin tube and the oil gun is oiled. After the flow meter is activated, the pulse generator transmits the signal to the electronic board for measurement.

Technology for Connecting Fuel Guns to the Internet of Things

Narrow Band Internet of Things has become an important branch of the Internet of Everything. Focusing on the low-power, wide-coverage IoT market, NB-IoT is a technology that can be used globally. The NB-IOT uses the license band and can adopt three deployment modes: in-band, guard band, or independent carrier to coexist with the existing network. On the refueling equipment side, the refueling gun integrates the NB-IOT chip and communicates with the telecom IoT open platform through the CoAP protocol. The payload of the CoAP packet is the application data of the device. The application server communicates with the platform through the http/https protocol, and controls the device by calling the platform's open API. The platform pushes the data reported by the device to the application server. The platform supports protocol parsing of device data and conversion to standard json format data[9]. The NB device is connected to the telecommunication IoT open platform through a wireless network, and is accessed by using the CoAP protocol.
Data information of the fueling gun is reported to the platform. The NB-IOT controller implements mobility management and session management for the terminal, establishes a user plane bearer for the terminal, and transmits uplink and downlink service data. In order to send IoT data to different application ports, we defined the control plane CIoT EPS optimization solution in EPS. The uplink data is transmitted from the NB to the MME. The transmission path is divided into two branches, either transmitted to the PGW via the SGW and then transmitted to the application server, or connected to the application server through the SCEF[10]. The downstream data transmission path is the same, but in the opposite direction. This solution does not need to establish a data radio bearer, and the data packet is sent directly on the signaling radio bearer. Therefore, this scheme is very suitable for non-frequency small packet transmission. Introduced specifically for NB-IoT, SCEF is used to transport nonIP packets on the control plane and provides an abstract interface to network services.

REFERENCES