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DEVELOPMENT OF IOT NETWORK FOR PRODUCTION QUALITY CONTROL

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Abstract. The network structure for achieving quality control of production based on the Internet of Things (IoT) technology is constructed. IoT network elements as analyzers, cloud platform, application port is described. Five criteria for selecting an IoT cloud platform are proposed. The mobile application for quality production is developed.

Keywords: IoT network, production quality control, IoT cloud platform.

Introduction

The Internet of Things is a collection of multiple technologies, which includes a variety of technologies such as sensors, network communication, device information security, device compatibility and data processing. Thus, for the multiple, large amount of data generated in the production process, IoT technology an effective technical means of quality control of production.

Currently, relevant researchers have used IoT technologies for quality control of production. For example, an IoT-based water quality monitoring system was developed in the reference [1]. An air quality monitoring platform based on IoT was created in the reference [2]. The reference [3] proposed a smart manufacturing system engineering (SMSE) approach to design a smart product quality monitoring system (SmartPQMS) with a practical application in steel production process as an example. In the paper [4], an IoT-based coffee quality monitoring and processing system was proposed.

However, in order to achieve quality control of production using IoT technology, a variety of IoT-based network elements need to be developed.

IoT structure network for milk quality control

For the specific production quality control, for instance, the production quality control of milk, a specific IoT network structure model needs to be constructed. The IoT network structure based on quality control of milk production was constructed. Figure 1 shows the basic structure of this network model. The model is composed of multiple milk analyzers, sensors, microcontrollers, gateway, IoT cloud platform and mobile applications. The data measured by the milk analyzer is transmitted through sensors and microcontrollers. By using the MQTT protocol to transfer the data to the gateway and then from the gateway to the cloud platform. Pre-processing and analysis of data in cloud platform by using the rule engine. In the cloud platform, the processing of data can be generally divided into two types, one is to directly send the data in the cloud platform to mobile devices for processing, and the other is to send the results of processing data in the cloud platform directly to mobile devices, so that the users of mobile devices can directly obtain the processing results. Which way to transfer data depends on different requirements.

Thus, an IoT network model based on quality control of milk production was constructed, but in order to better apply and implement the model, the details of the elements in the model need to be analyzed. The next part is the analysis of the elements in the model.

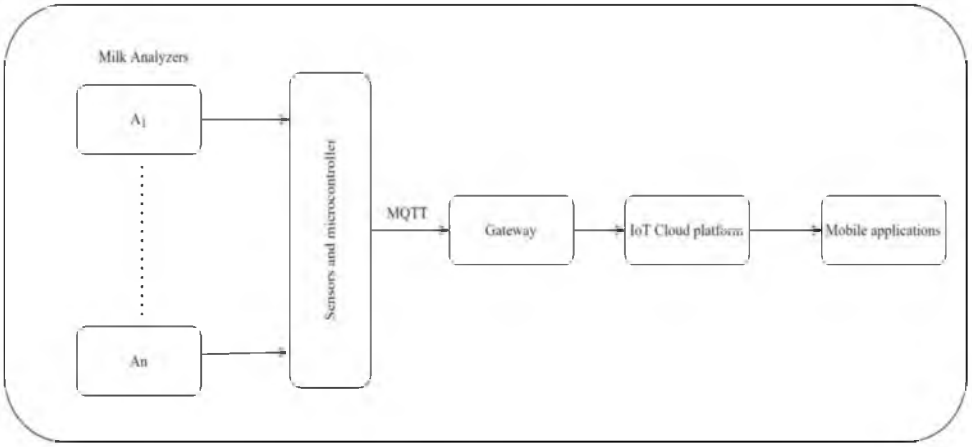


Figure 1. The IoT network structure for milk monitoring

Milk quality monitoring

The milk quality analyzer is a device for determining the quality characteristics of milk and products based on some indexes (fat content, density, sample acidity, lactose, sample temperature, etc.). A complete milk analyzer usually consists of hardware and software. For the hardware part, there are mainly included a multispectral sensor, a light source module, a quartz sample cell, a light-shielding cover, a collimator, a Raspberry Pi, a touch displays, a booster module, a battery management module, a Cooling fan, a Lithium battery, a power switch and so on.

For the software part, there are mainly two subsections, first subsection is data acquisition software, another is milk compositions analysis software. The first part is to collect data (the index of protein, fat, and density, etc.) from the milk, another part is for the analysis of milk compositions.

Port structure

With the development of sensing technology, communication technology and Internet of Things technology, the way to analyze milk quality using IoT technology corresponds to Automation 4.0.

In order to archive the Automation 4.0 on the milk quality assessment in dairy farms in different regions. In addition to communication technology, different communication ports are also required. However, different farms may use different type milk analyzers, the information from different milk analyzers can be received via parallel or serial ports. That means the milk analyzers can use the different ports and protocols. To make sure the received information to interact with the hardware of the cloud platform, it is necessary to provide the gateways-converters. A port structure known as MOXA has developed a solution that can make the connecting diverse devices and COM port simple [5].

Cloud environment platform

The IoT cloud platform is the central system of the entire IoT system and plays a vital role in the entire system. The IoT cloud platform is the technology fusion of the IoT platform and cloud computing. Accordingly, the IoT cloud platform can serve as a reliable gateway between the milk quality analyzer and the network, it can also provide cloud computing, data storage, data processing, etc., and can support the huge amount of data generated by the devices, as well as allow bilateral communication between devices. Of necessity, in addition to these capabilities, the IoT cloud platform needs to provide reliable and secure data transfer capabilities. In view of the IoT cloud platform has such powerful capabilities, there are many IoT platforms emerged, such as Microsoft Azure IoT cloud platform, Google Cloud's IoT Platform, IBM Watson IoT platform, AWS IoT platform, Ali cloud IoT cloud form, Cisco IoT Cloud Connect platform and Huawei IoT Cloud Platform, etc. However, every IoT cloud platform has its own pros and cons, how to choose the most suitable IoT cloud platform according to our requirements needs to be evaluated based on suitable assessment metrics. Here, some appropriate evaluation metrics are proposed for the selection of IoT cloud platforms.

1. Scalability. A reliable IoT cloud platform must support millions of devices connecting and communicating at the same time, and be capable of stable and normal operation, as well as supporting the scaling of device performance and number.

2. Equipment Control Capabilities. To reliably control end devices remotely through the IoT cloud platform, the IoT cloud platform can provide device management capabilities such as cloud application programming interfaces(APIs), developer tools, event logs, device command and control, diagnosis and prevention of device faults. In particular, the cloud API allows users to connect to and access back-end services such as databases, cloud services and cloud computing, the developer tools can be used to reprogram and manage IoT devices. The event logs provide access to the most relevant and valuable data to improve device management and operation by providing event recall capabilities. The function of diagnosis and prevention of equipment failure can provide the latest status of equipment operation, so that devices that are likely to fail can be detected and repaired, thus reducing property damage and safety accidents.

3. Over-the-Air Firmware Updates capability. This capability provides the solution to send new functionality to the device remotely and enables developers to optimize and enhance device functionality readily and reliably. However, it is worth noting that the implementation of this function requires the coordination of IoT hardware, device firmware, network connectivity and IoT cloud devices. The implementation of this function is an important indicator to examine the IoT cloud platform.

4. Security. The security performance of the IoT cloud platform is also an important evaluation indicator. Security does not only mean information and data security, but also hardware access security. The security features of IoT cloud platforms usually include information encryption, role access control, authentication, port control, etc.

5. Data Management. Device data can be seamlessly interfaced with the services provided by existing IoT cloud platforms, which will reduce the commissioning and access costs for devices to connect to the cloud platform.

These five metrics will provide a reliable evaluation system for selecting the right IoT cloud platform. Although some other indicators such as supported application protocols and cloud platform prices are also worth considering, users can make a reasonable choice of new indicators based on their own conditions relative to the five evaluation indicators mentioned above. According to the above five indicators, Aliyun IoT cloud platform will be a rational choice that can provide corresponding capabilities.

Application

The smartphone is simulated in android studio, which is a powerful tool for developing Android apps. As a result, the Milk Analyzer App was created in android studio. Figure 2 shows the structure of the system for collecting and analyzing milk quality indicators.

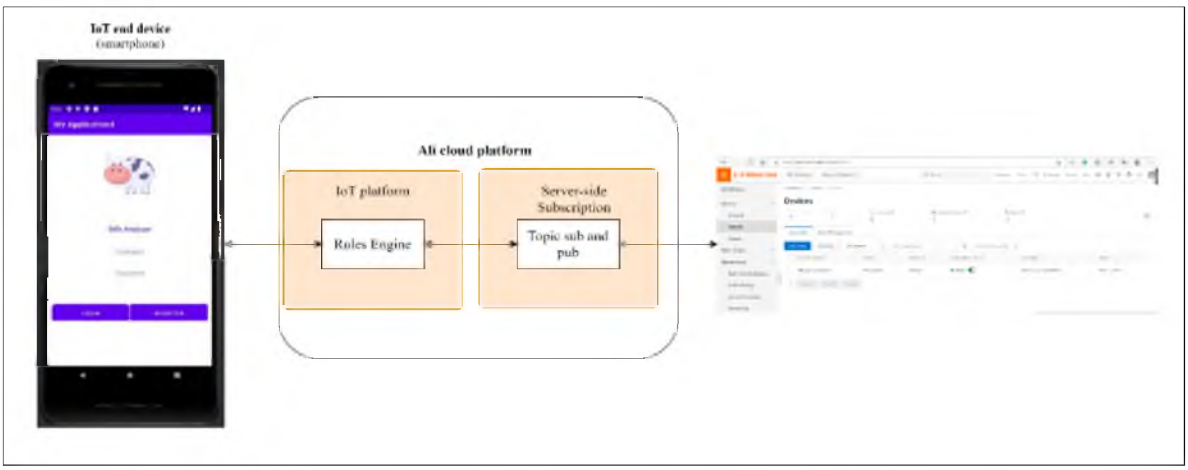
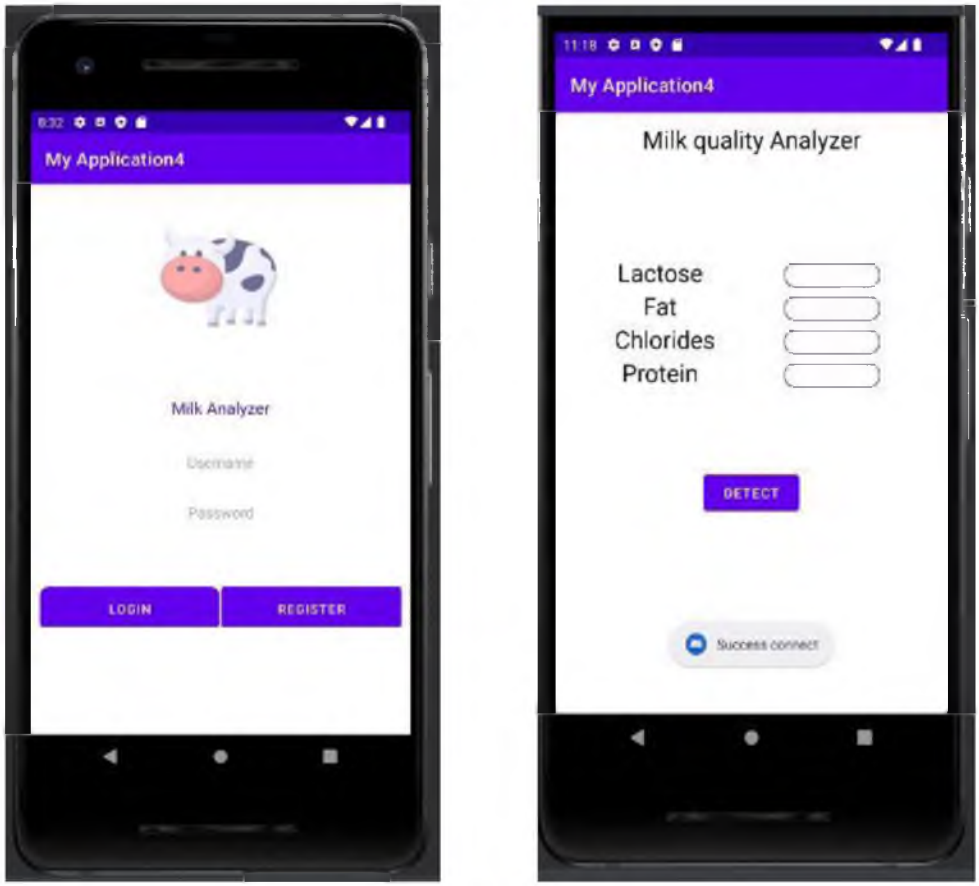


Figure 2. General structure of emulation of the IoT network on the Ali platform

On a mobile device, the application is divided into two sections: the login screen and the data processing screen (Figure 3). The user's work begins with login and registration (Figure 3, *a*), users enter

their username and password to access the data processing screen. In the data processing interface (Figure 3, *b*), four indicators are included in this interface: lactose, fat, chloride, and protein. Users can get data from the IoT cloud and test that data, for example, to distinguish whether it is normal quality or mastitis milk.



a *b*

Figure 3. The section of application: *a* – The interface of login and registration; *b* – The interface of data processing

At that some elements of the IoT network based on quality control of milk production have been developed.

Conclusion

This paper considers some basic elements of IoT networks for milk production quality control, such as milk analyzers, port structures, IoT cloud platforms and applications on mobile devices. First, an IoT network structure for milk analysis is constructed, then the details of IoT network elements are described.

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