The Monitoring System Architecture Development

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Abstract:

To implement the principles of the IoT concept, many production facilities must be re-equipped. Some of them must completely replace all existing equipment with new ones. This leads to significant costs. However, it is possible to develop external monitoring systems that, when connected to existing equipment, greatly expand the capabilities of the equipment. This allows you to modernize existing equipment and introduce IoT principles into production. In this article, the authors present the development of such a monitoring system for production.

Key words: IoT, Monitoring system, Production parameters, Sensor.

Introduction

Internet of Things and monitoring systems together play a key role in today's world. IoT is a network of connected devices that exchange data and interact with each other without direct human involvement. These devices can be of various types: from smartphones, household appliances to sensors that measure the level of liquid in the tank or the temperature in the room [1]-[8].

IoT monitoring systems use this technology to collect, transmit and analyze real-time data from a variety of sources. This may refer to the control of production processes, monitoring of the condition of equipment, monitoring of environmental indicators, etc. IoT monitoring systems are implemented in various industries such as agriculture, medicine, logistics, urban planning, etc. They allow you to collect valuable data that contributes to process management, cost optimization and productivity improvement [9]-[13]. Also, various methods and approaches can be used for these purposes [14]-[19].

In order to eliminate violations in the technological process, it is necessary to resolve the issue of timely maintenance of technological equipment. As a result, the solution to this issue is urgent. To solve this issue, it is necessary to create a monitoring system that could assess the condition of the equipment in the production and prevent violations of the technological process.

The production process monitoring system is an effective tool that allows you to quickly, accurately and adequately assess and analyze the current situation, make reasonable and timely management decisions. The system provides dispatch services and enterprise management with the opportunity to view key information about the current state of technological and production processes in the enterprise's divisions in real time. The monitoring system built on the principles of IoT is more economical in terms of integration and development than the traditional automated process control system based on industrial controllers and SCADA systems.

Related works

More and more scientific work is devoted to the development of monitoring systems for enterprises. Such systems make it possible to use IoT principles without changing equipment in enterprises, thus reducing the cost of re-equipping enterprises. Let's look at some recent works on this topic.

In paper [20] based on the integrated model, an NC machine tool intelligent monitoring and data processing system in smart factories is developed. W. Chen proposes a reference architecture and construction path for smart factories by analyzing industrial IoT technology and its application in manufacturing workshops [21]. The results show that the author's system is effective in the monitoring of production line data. Authors in [22] note that the Internet of Things technology combined the advanced technologies and provides hardware network foundation and technical theory for designing the real-time tracking and monitoring system of intelligent workshop products. Their developed system has the advantages of low cost, rapid deployment, and convenient expansion, which traditional manufacturing enterprises realize intelligent management based on IoT application platform.

In study [23], sensors mostly used in indirect tool condition monitoring systems and their correlations between tool wear are reviewed to summarize the literature survey in this field for the last two decades. Researchers in [24] note that the modification of existing concepts of multiparameter monitoring systems into Industrial Internet of Things (IIoT) concepts is one of the hot issues of IIoT. The existing concepts of three remote multiparameter monitoring systems, as well as their novel IIoT concepts and multilayered frameworks, are described in detail in [24]. The article's [25] aim is to synthesize and analyze existing evidence on cyber-physical process monitoring systems, real-time big data analytics, and industrial artificial intelligence in sustainable smart manufacturing.

In research [26], prior findings were cumulated indicating that the interoperability between Internet of Things-based real-time production logistics and cyber-physical process monitoring systems can decide upon the progression of operations advancing a system to the intended state in cyber-physical production systems. Nath, C. [27] presents the state-of-the-art of the tool condition monitoring systems covering three major machining operations, discusses their application feasibility in industry environments, and states some current tool condition monitoring systems implementations. In [28] scientists propose insights into the area where artificial intelligence monitoring system can be implemented to analyze the input data associated with agricultural activities and help the biofuel industry to improve its production possibilities.

Authors [29] propose a smart manufacturing systems engineering approach to designing smart product-quality monitoring systems with its real application example in iron- and steel-manufacturing process line. Research [30] considers the design of a monitoring system on smart manufacturing based on internet of things technology.

The electric drive monitoring system architecture development

The system architecture development consists of 3 main modules: data collection and transfer; data acceptance and storage; data display and management.

The system architecture is shown in Figure 1.

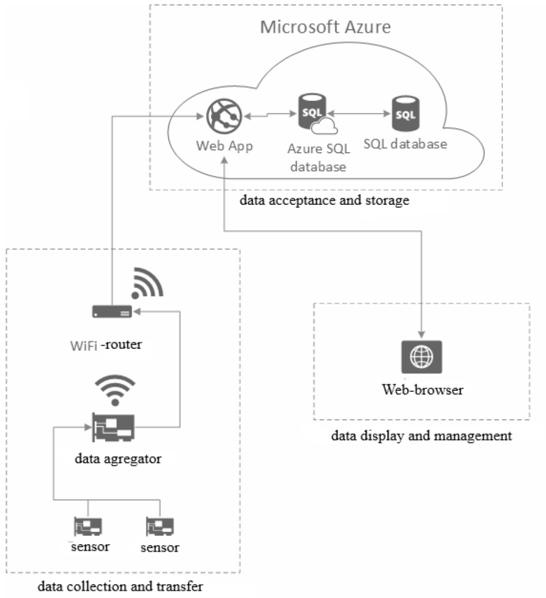

Figure 1: System architecture

The monitoring system architecture main modules description:

– data collection and transfer. The information collection board to which the temperature and vibration sensors are connected is responsible for collecting information. Sensors collect data on electric drives temperature and vibration. The collection board processes data from sensors, connects to a Wi-Fi access point and transmits data via the HTTP protocol to the Microsoft Azure Web App service;

– data acceptance and storage. Data from the collection board is transferred to the Microsoft Azure Web App service using a PHP data collection script that opens a connection with the database and writes data to the database table;

– data display and management. To display and manage data, the system user accesses the URL address of the web application. After that, the user can review the state of the electric drives, or perform administrative actions on the system data.

The system architecture is built on the basis of modular principles. There are no critical points in the system, each module can be replaced by a similar function class, and the structure is shown in Figure 2.

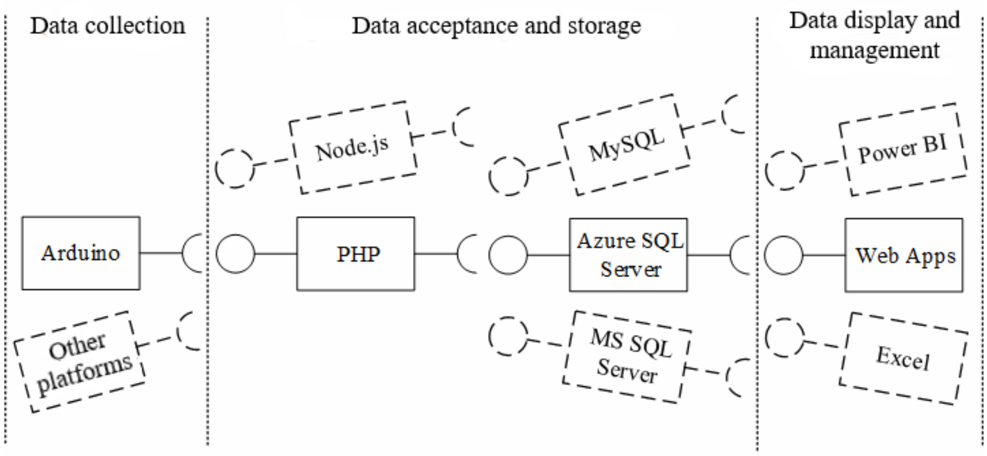

Figure 2: System modularity

Data collection includes boards and data collection controllers that have the ability to send telemetry via the http protocol.

Data acceptance and storage includes a server and a database.

The server can be any web application written in such programming languages as PHP, Node.js, Python with support for the http protocol and libraries for connecting to the database. Databases can be both SQL and NoSQL .

Data display and management includes web applications that can be written in a variety of programming languages for the web. Various BI systems can also be used for data visualization and analysis.

The algorithm of the program for polling sensors is shown in Figure 3.

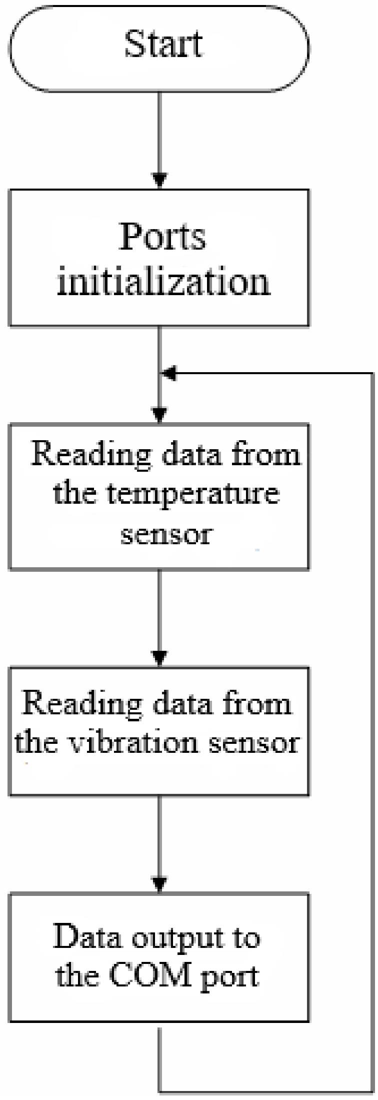

Figure 3: The sensor polling algorithm

The algorithm is built as follows, the first action is the initialization of the board ports. After that, the data reading functions are called. After the data have been read, they are displayed in the COM port.

The program code is shown in Figure 4.

```
#include <ESP8266WiFi.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS D6 // Пин датчик температуры
int pinVibration = D5; // Пин датчик вибрации
/* Настройка датчика вибрации */
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
void setup() {
  Serial.begin(115200);
  sensors.begin(); // Пуск считывания данных температуры
  pinMode(pinVibration, INPUT); // Настройка пина датчика вибрации
}

void loop() {
  float dataTemperature = readTemperatureData(); // Чтение данных температуры
  long dataVibration = readVibrationData(); // Чтение данных вибрации
  delay(50);
  /* Тестовый вывод данных */
  Serial.print("Температура = ");
  Serial.println(dataTemperature);
  Serial.print("Вибрация = ");
  Serial.println(dataVibration);
}
/* Функция чтения температуры */
  float readTemperatureData(){
  sensors.requestTemperatures();
  float dataTemperature = sensors.getTempCByIndex(0);
  return dataTemperature;
}
/* Функция чтения вибрации */
long readVibrationData(){
  delay(10);
  long dataVibration = pulseIn(pinVibration, HIGH);
  return dataVibration;
}
```

Figure 4: Snippet of sensor polling core

As a result of the program, data from the temperature and vibration sensor are displayed in the COM port

Conclusion

In this work, we developed the architecture of our monitoring system for the enterprise. It should be noted that such a system allows you to implement the principles of IoT without completely replacing the equipment in the enterprise.

This allows us to significantly reduce the costs of new equipment, but move to a new, more technological level of production.

The developed system tested temperature and vibration sensors, but it could be improved by using other types of sensors. When choosing sensor types, you should be guided by the type of production and the feasibility of monitoring certain parameters.

As a result, such a system can have a complex effect and perform the following functions.

Monitoring of production processes: monitoring of equipment operation, control of production lines, measurement of process parameters to ensure their efficiency and continuity.

Energy consumption monitoring: Measuring the consumed electricity and finding ways to optimize its use in the enterprise.

Security systems: Video surveillance, access control, fire detectors and other systems to ensure security on the territory of the enterprise.

Inventory management: Use of monitoring systems to control the inventory of raw materials, goods in the warehouse and their optimization.

Environmental monitoring: Means for measuring and controlling the level of environmental pollution, air and water quality.

Analytics and reporting: Systems that provide data analysis for management decision-making and reporting.

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