

## A GPRS Based Monitoring and Management System for Classification Results of Image by CCD Camera

**Cheng Kun Guo, Hui Hui Yu, Yingyi Chen**

Key Laboratory of Agricultural Information Acquisition Technology, Ministry of Agriculture,  
Beijing 100083, P. R. China  
Beijing Engineering and Technology Research Center for Internet of Things in Agriculture,  
Beijing 100083, P. R. China  
China-EU Center for Information and Communication Technologies in Agriculture,  
China Agricultural University, Beijing 100083, P. R. China  
Beijing Engineering Center for Advanced Sensors in Agriculture,  
Beijing 100083, P. R. China

*Received: 19 November 2013 / Accepted: 27 December 2013 / Published: 14 March 2014*

---

**Abstract:** Data acquisition plays an important role in the field of modern industry. In many cases, remote data should be transferred to monitor center which is far away from the manufacturing field. This paper presents a remote transmission system for the classification results of images which are got by a CCD sensor. The utilization of web application framework gives this system the advantage of minimum research work on the monitor center. A GPRS DTU treated as an information transmitting terminal was used to transmit a custom format of the classified images. In the system, The Users can use the browser anywhere to log on the website of the system so as to view and manage the experimental stations, sensors and users' information of the system. The results shows that the system can transmit and management the figures classified by Support Vector Machines (SVM). The figures those use other classified method will be tested in the future.  
*Copyright © 2014 IFSA Publishing, S. L.*

**Keywords:** GPRS DTU, Reporting system, Java web.

---

### 1. Introduction

In many factories, the state information of machines is required to transfer to the remote data center which is far away from the manufacturing field [1-5]. However, due to the factory, such as oil refineries, cotton ginning factory there are no cable network environment, people still rely on manual labor to collect and manage these data [6] [7]. And the demand of Data transmission in these factories is intermittent, sudden, frequent and small amount, GPRS meet exactly the demand [1].

There are many researchers build a remote and wireless monitoring and management system platform relies on the GPRS network [2-6]. This type of system incorporates advanced GPRS wireless communication technology, the computer control technology, data acquisition technology, database technology, with any types of sensor networks which needed to be managed as its object. GPRS is "General Packet Radio Service (General Packet Radio Service)" for short, it is a mobile data service for GSM mobile phone users. GPRS can be said that the continuation of GSM,

it is cheaper than 3G, and its average transmission rate from 20 Kbps to 30 Kbps [3] meet the communication requirements of the system, so we choose GPRS to connect the client and the server rather than 3G.

In this paper, the system can be divided into two subsystems, one is the data transmission subsystem and the other is data management subsystem. The monitor center software was developed by java language based on Apache Mina framework. The utilization of the framework makes it easy and reliable to acquire perform data and process data through multithreading. The client is developed by C++ spring + spring MVC + hibernate technology architecture solution is used to develop the web site of the system.

## 2. System Components

The system can be divided into two subsystems, data transmission subsystem and data management subsystem. C/S model is used in data transmission subsystem. The client is deployed in factories, collects the results got by sensors and transmits the results to the server by GPRS. The server receives and manages the results, then put the results information on a website, machines', experimental stations' and users' information are also managed by that website. The website is the main component part of the data management subsystem. The B/S model is used in the data management subsystem, the client side does not need to install any software and program but a web browser to view and manage the experimental stations, sensors and users information of the system. The system components are showed in Fig. 1.

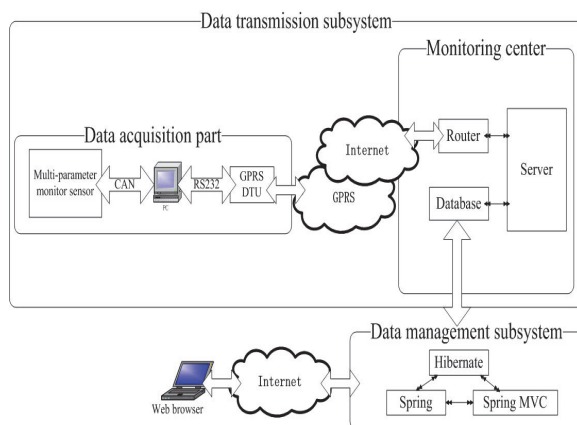


Fig. 1. The structure of the system diagram.

### 2.1. Data Transmission Subsystem

Data acquisition part is the client side and monitoring center is the server side. The C/S model is used in the data transmission subsystem. They communicate with each other through GPRS DTU.

#### 2.1.1. Data Acquisition Part

Data acquisition part includes Multi-parameter monitor sensors, a pc and a GPRS DTU. The sensors collect digital signal and transport the data to pc, the pc display the data and transport it to the monitoring center through the GPRS DTU which is connected to the pc through RS232. The data is stored in the SQL server 2008 which is deployed in the pc at the same time.

#### 2.1.2. Monitoring Center

Monitoring center utilizes Apache Mina to achieve network communication with data acquisition part, and finishes the functions of data receiving and parser. SQL Server 2008 is used to save the data.

### 2.2 Data Management Subsystem

To enable all users to get the information through web browser on a computer which is connected to Internet, the B/S (browser/server) model is used in our system. The client side does not need to install any software and program but a web browser. Spring + Spring MVC + Hibernate java lightweight framework is used in the subsystem.

## 3. Data Transmission Subsystem Design and Achievement

The subsystem is composed of data acquisition part and monitoring center. Data acquisition part could deal with the acquisition data, store and send them to the monitoring center through the GPRS DTU. Monitoring center finishes the functions of receiving and parser the data.

### 3.1. The Software of Data Acquisition Part

The software of data acquisition part is developed by visual C++. The function of this part is to display, store and report the data.

#### 3.1.1. Database Design

In industrial application, the amount of the information is large, and the software is deployed in windows, so the system uses the Microsoft SQL Server 2008 as the database.

Two tables, template table and result table are needed to be stored in the data acquisition part. Template table record artificial intelligence algorithms template which is used to classify different results got

by sensors. Result table record the detection results. The relationship between two tables is 1 to n. Fig. 2 shows two tables' character.

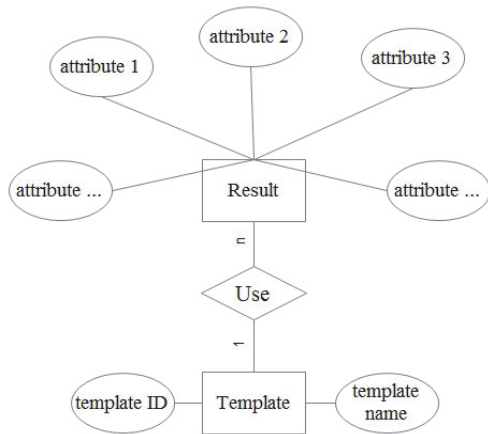


Fig. 2. Client database ER diagrams.

### 3.1.2. Stored Procedures of the Data Acquisition Part

The client is developed by VC++ 2010, and uses ADO (Active Data Object) to access database. ADO is an application layer programming interface. It is also an ActiveX data objects, it implements and achieve all the functions that OLE DB provides. ADO can access all types of data sources through OLE DB COM interface. Data acquisition part uses SQL Server 2008 as the client database. The process of storing data in client is shown in Fig. 3.

### 3.1.3. Reporting Procedures of the Data Acquisition Part

We use GF-2008AW modules from Jia Fu Xing Technology Co as GPRS modules in the system. This module is an industrial-grade GPRS module, provides standard RS-232/485/TTL interface. It can make devices which don't have IP system access the Internet, so as to realize the remote connection mode.

PC in the data acquisition part uses RS232 to connect GPRS module, baud is 9600 bps, the format is 8data bits, 1 stop bit, none parity.

Reporting procedure of client software is shown in the Fig. 4.

Two kinds of errors may happen during the report procedure. When the serial port could not be opened, the system would report the error. When the format of data got by sensors is wrong, the system would report error.

### 3.1.4. UI of the Data Acquisition Part

The results whose format is right are shown on the PC, and there is a button named reporting results whose function is reporting results (Fig. 5).

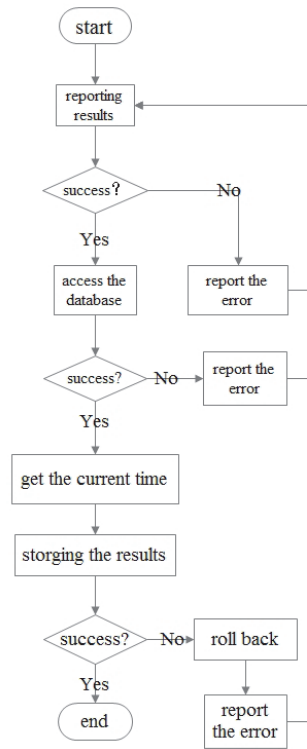


Fig. 3. Process of storing data in client.

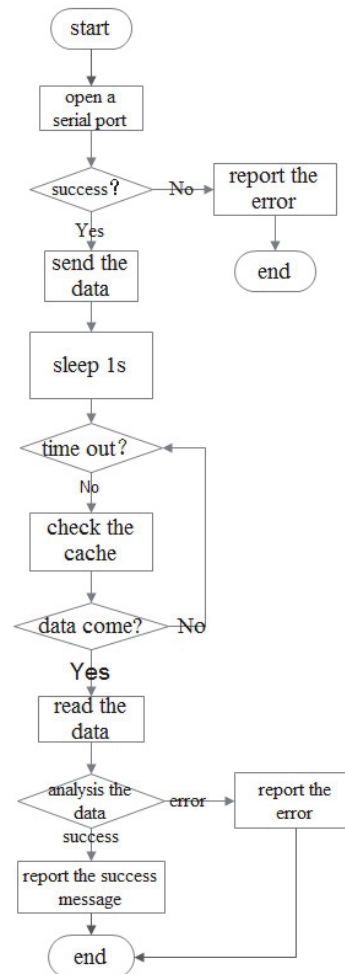


Fig. 4. Report procedure of client software.

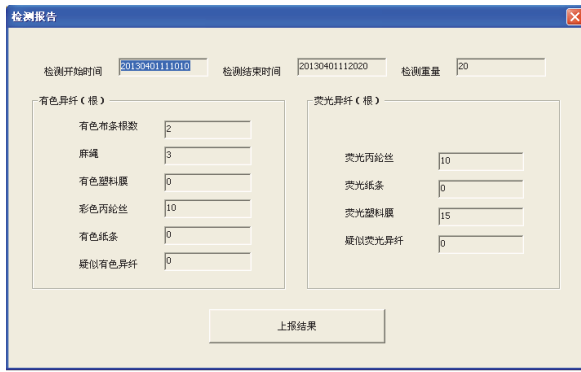


Fig. 5. UI of client.

### 3.2. The Software of Monitoring Center

The main functions of monitoring center are receiving and parser the data. The utilization of the Apache Mina framework makes it easy and reliable to acquire perform data and process data through multithreading.

#### 3.2.1. How to Receive Data

The Apache Mina framework is mainly based on TCP/IP, UDP/IP protocol stack framework for communications, and TCP/IP protocol is used in this system. Apache Mina can help programmers to develop high-performance, highly scalable network communications applications quickly. Apache Mina provides event-driven, asynchronous (Mina's asynchronous IO is used by default as the underlying supported JAVA NIO) operation programming model. Apache Mina also provides network communications server-side and client-side package, no matter which side, Mina in the entire network communication structures are in the following location. The location of Apache Mina in network is shown in Fig.6.

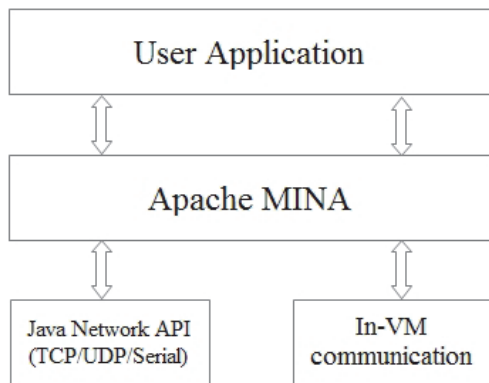


Fig. 6. Location of Apache Mina in network.

Execution flow of Apache Mina is shown in the Fig. 7.

- **IoService:** This interface is responsible for creating sockets in a thread, monitoring connection with its own selector.
- **IoProcessor:** This interface is responsible for checking on another thread if there is data to read or write on the channel, in addition, IoProcessor is responsible for calling filters registered in IoService, calling IoHandler after filter chain finished.
- **IoFilter:** This interface defines a set of interceptors, which may include log output, blacklist filtering, data encoding (write data) and decode (read direction), and other functions. Encode and decode are the most important functions.
- **IoHandler:** This interface is responsible for business logic, scilicet receiving and sending data, saving the right data.

The detail of receiving data procedure is shown in Fig. 8.

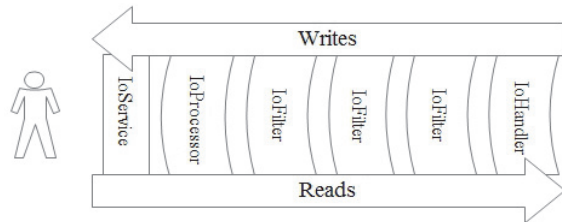


Fig. 7. Execution flow of Apache Mina.

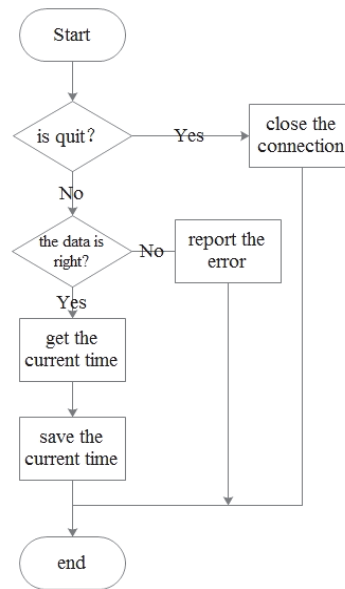


Fig. 8. The detail of receiving data procedure.

If format of the data is incorrect, the monitor center will send the error message to the data acquisition part.

### 3.2.2. Stored Procedures of the Monitoring Center

There are four tables in the monitoring center, Result table, Terminal table, user table and Machine table. Result table is used to record results what are received from the client. User table, Terminal table and Machine table are used to store users', experimental bases' and machines' information respectively. The structure of result table of the server is like that in the client, besides two foreign keys, terminalID and machineID, which link to Terminal table and Machine table respectively. Structure of terminal table, machine table and user table are as follows.

**Table 1.** Terminal table.

attribute	column	type	
ID	t_id	int	
Name	t_name	varchar	
note	t_note	varchar	

**Table 2.** Machine table.

attribute	column	type	
ID	m_id	int	
SN	m_sn	varchar	
note	m_note	varchar	

**Table 3.** User table.

attribute	column	type	note
ID	u_id	int	
Login name	u_loginName	varchar	
Password	u_loginPwd	varchar	
User type	u_type	Int	0 is administrators, 1 is users

### 3.3. Transport Protocols

#### 3.3.1. Transport Layer Protocol

The transmission of data via network complies with the tcp/ip protocol. The server follows these steps to connect the client.

- 1) Configure the host's IP address and port information
- 2) Setup the socket
- 3) Bind the socket
- 4) Listen the port
- 5) Receive or send data
- 6) Close the socket

The client follows these steps to connect the server.

- 1) Create a user socket
- 2) Connect server
- 3) Send/receive data
- 4) Close the socket

#### 3.3.2. Application Layer Protocol

According to the demand of multiple data formats, this system can monitor arbitrary format, arbitrary amount of data. It is due to the custom allocation layer protocol.

Firstly, client program needs to send cotton foreign fiber detection results to the server, so the protocol must include this part. Secondly, the server needs to know the detection time, which machine detected, detection happens in which cotton ginning factory.

Communication data is encoded by ASCII. In order to be able to separate two results, we put '\n' in the end of each result, and we use '\x20' to segment each attribute in one result. The design of the protocol is shown in Table 4.

**Table 4.** Application layer protocol.

attribute	type	Terminator
Factory ID	int	\x20
Machine ID	int	\x20
attribute 1	all	\x20
attribute 2	all	\x20
attribute 3	all	\x20
...	all	\x20
...	all	\x20
...	all	\x20
last attribute	int	\n

Attribute 1, 2, 3, etc can be any kind of attributes, so as to make the system be used in any industrial application.

### 4. Data Management Subsystem

We use Spring MVC + Spring + Hibernate integration framework to develop the website. This integration framework is a popular framework.

The integration framework is divided into four layers from duty: the presentation layer, business logic, data persistence layer and domain module layer, to help developers build a clearly structured, reusable and maintainable web application in the short term. We use Spring MVC as the system's overall infrastructure, it is responsible for MVC (module,

view and control) separation. We use Hibernate framework to support persistence layer, which is responsible for connecting and managing database. The Spring framework is used to manage Spring MVC and hibernate.

Website business processes is shown in the Fig. 10.

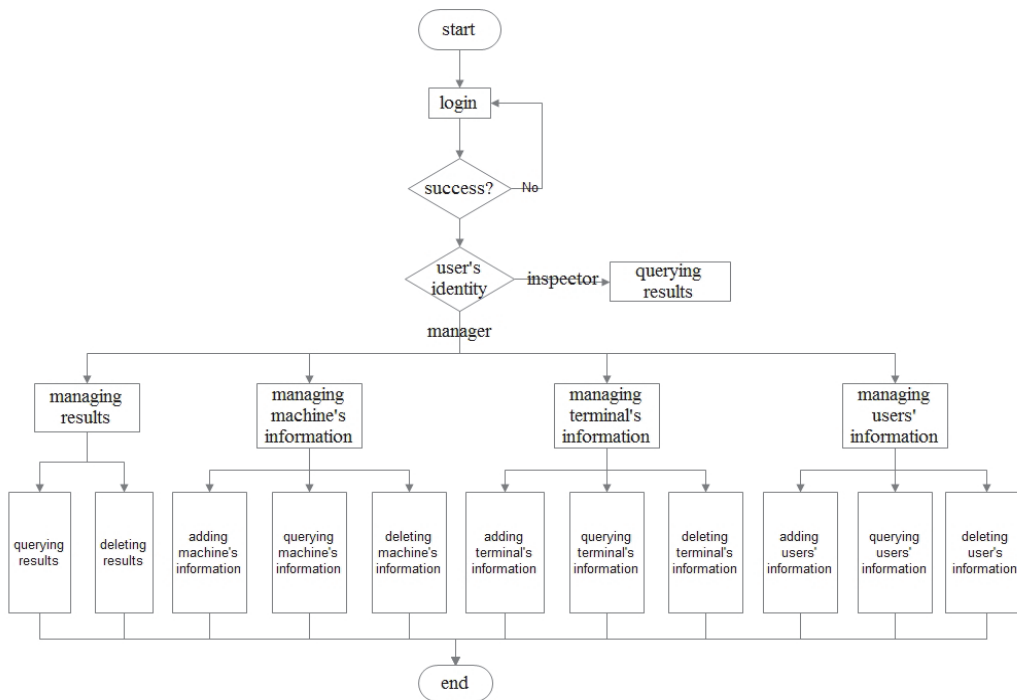


Fig. 10. Website business processes.

#### 4.1. UI of Web

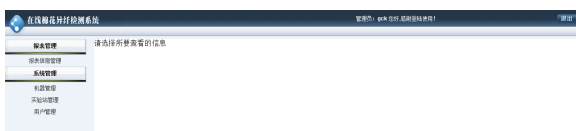
##### 1) Interface of login:



##### 2) Quality inspector query results interface:



##### 3) The Administrator Interface:



##### 4) Results Management Interface:



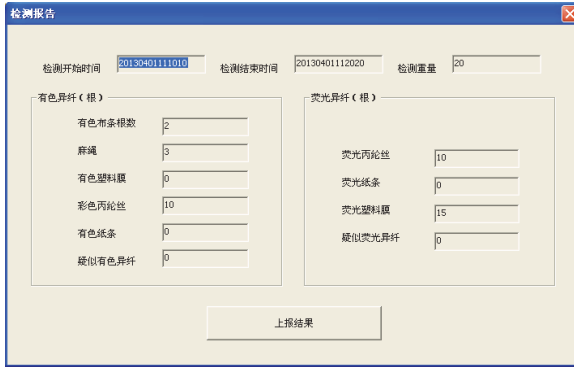
##### 5) Machine Management Interface:



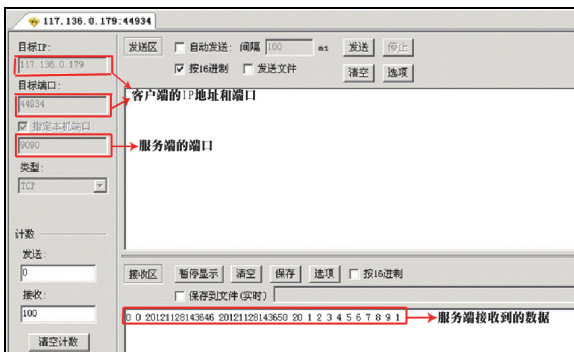
### 5. Discussion and Conclusions

The system can transmit any types of results which are generated by sensors to remote server. In experiment, we transmit results of a SVM classifier. The results are composed of 2 time-type attributes and 11 integer-type attributes. Below is a screenshot of the experiment.

1) Client gets the results:



2) We use TCP/UDP test tool to monitor the server's port, so as to watch the data received from the client.



3) When server receives the right data, it will save the data, and users can view the data on the web.



The system has been used in several mouths. Our own experience with using the system is that it can transmit data timely and stable. If the server cannot receive data correctly, the client will prompt an appropriate error message to help users repair the system. However, this system still exist some deficiencies. ASCII encoding mode cannot make full use of the channel, we may be able to use another

encoding mode to achieve the application layer protocol.

In experiment, we transmit results of a SVM classifier, 2 time-type attributes and 11 integer-type attributes are transmitted, and results of other classifiers will be tested in the future.

## Acknowledgements

This paper was supported by Shandong Province Self-innovation Projects (2012CX90204).

## References

- [1]. Qin Bin, Mao Xuanang, Zhao Junda, Liu Fang, Design of remote data acquisition system based on 3G, in *Proceedings of the International Conference on Intelligent Systems Design and Engineering Applications (ISDEA)*, 2012, pp. 1315-1318.
- [2]. You Xiangbai, Liu Yimin, Xu Wangming, Design of A Remote Monitoring System Based on Java, in *Proceedings of the 3<sup>rd</sup> IEEE International Conference on Computer Science and Information Technology (ICCSIT)*, 2010, pp. 149-152.
- [3]. Ali F, Almutairi, Fahad Al-Jame and Abdullah A-Buraikan, GPRS/EDGE/3G/HSDPA networks performance measurements in the State of Kuwait. in *Proceedings of the 5<sup>th</sup> IEEE GCC Conference and Exhibition (IEEE)*, 2009, pp. 123-127.
- [4]. Meihua Xu, Guoqin Wang, Mengwei Sun, Shuping Huang, Design of Remote and Wireless Streetlight Monitoring System Based on GPRS, in *Proceedings of the 4<sup>th</sup> IEEE International Conference on Computer Science and Information Technology (ICCSIT)*, 2011, pp. 478-482.
- [5]. Md. Syedul Amin, Jubayer Jalil, Accident detection and reporting system using GPS, GPRS and GSM technology, in *Proceedings of the International Conference on Informatics, Electronics and Vision (ICIEV)*, 2012, pp. 640-643.
- [6]. Wang Yan, Zhong Shunhu, Chun Yanma, Design of pipe network monitoring system based on GPRS, in *Proceedings of the International Conference on Apperceiving Computing and Intelligence Analysis (ICACIA)*, 2010, pp. 236-239.
- [7]. Li Changxing, Zheng Min, Sun Jingxian, Research of exploration well production parameters monitoring system based on GPRS, *Instrument Technique and Sensor*, 2, 2011, pp. 54-59.
- [8]. Ronghua Ji, Daoliang Li, Lairong Chen, Wenzhu Yang, Classification and identification of foreign fibers in cotton on the basis of a support vector machine, *Mathematical and Computer Modeling*, 51, 2010, pp. 1433-1437.