

# Design of Remote Engine Room Monitoring System Based on Wireless Network Technology

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**Abstract:** This paper analyzes the significance and status of the ship engine room automation and fault diagnosis technology, proposed the method of remote monitor and control system. The host computer system is developed on ASP.NET platform, the backstage SQL database based on Server, and the.NET three layer structure model with them. Using ADAM-6500 acquisition module data acquisition machine. Through the GPRS wireless network will ship shore connected. Also used the ActiveX control in the monitoring interface, AJAX technology and Web technology, the main function is to run the diesel ship cabin machine A state of real-time display, alarm and fault diagnosis. Fault diagnosis using the method of rough sets and fault tree combination, make use of the merits of the fault diagnosis of ship cabin. Through the Internet user at any time to master the operation condition of the ship, to achieve the monitoring and fault diagnosis of the ship's running situation.

**Key words:** GPRS; remote monitoring; rough set; fault tree; fault diagnosis

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## 1 Introduction

Study on information processing and real-time monitoring in engine room automation of modern ships are more and more, it can make the correct realization of engineers in the engine

room of the host, generators and other equipment inspection management and control of <sup>[1]</sup>. from marine equipment reliability, maintainability and automation level, timely and accurately grasp the running state of the ship system the diagnosis and prediction, and the existence of a potential failure, become a modern ship management target <sup>[2]</sup>.

The domestic application of engine room monitoring system is backward, most data transmission monitoring system is transmitted via satellite, but limited resources <sup>[3]</sup>; data transmission protocol TCP/IP, the transmission efficiency is relatively low, UDP protocol is suitable for small amount of data, the data loss often occurs leak.

Now for the diagnosis of ship fault technology <sup>[4]</sup>: direct measurement method based on the method of mathematical model. Based on the existing shortcomings: not using expert experience; lack of reasoning ability; do not have the learning mechanism; lack of solution on the diagnosis results.

In the design of the communication system by GPRS wireless network, has extensive network coverage, high transmission rate, flexible use, the advantages of wireless network system. The introduction of GPRS vessel monitoring system and.NET technology, the.NET three layer structure model with which, based on uIP TCP/IP

protocol and 3DES encryption algorithm to the past monitoring the transmission system and data leakage and packet loss is reduced greatly. The fault diagnosis using the rough set and fault tree combination, the use of the merits of fault diagnosis of ship cabin.

## 2 GPRS Wireless Network

### Technology

#### 2.1 The Concept of GPRS

GPRS is the group developed in GSM on the basis of the exchange system, the purpose is to provide packet data service for users. Using GPRS as wireless data transmission network, can develop a two-way wireless data transmission, wireless remote detection and control of GPRS in resource utilization is better and can also pass [5] voice and data.

#### 2.2 Communication Principle of GPRS Remote Monitoring

The GPRS module in the network proxy server for transmission channel, real-time communication. GPRS module and the monitoring center of the mobile communication system is allocated to it an address, send applications to connect to the server, the server to establish a connection with the GPRS module channel detection. The monitoring center login application connected to the server, the server for the same the client to establish a connection. Through the connection with the server, the client and the terminal equipment for real-time communication, read the GPRS terminal equipment acquisition information or to

the issued instruction. The communication principle of [6] as shown in Figure 2.1:

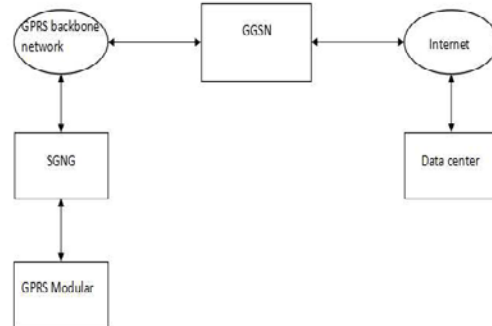


Figure 2.1 GPRS and internet connection schematic

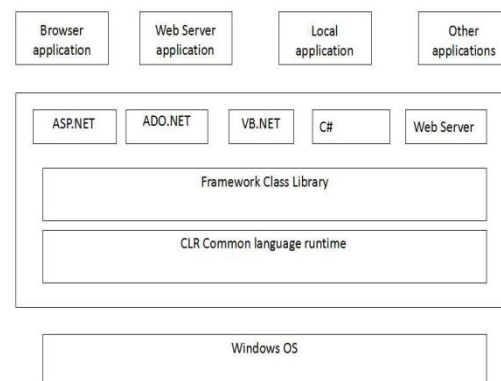
### 3 NET Technology

ASP.NET is the establishment of the .Net platform architecture, the use of general-purpose language runtime at the back end of the server to provide users with a powerful enterprise class Web application programming framework.

Figure 3.1. NET framework class library structure

#### 3.1 AJAX Technology

AJAX is in a new way to use these



technologies, so that the previous B/S approach to the development of Web has a new vitality, its engine model shown in Figure 3.2 [7]:

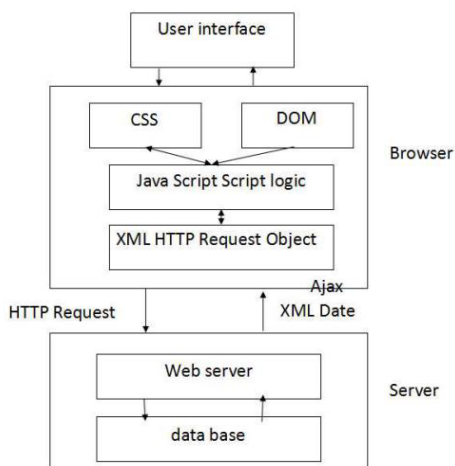


Figure 3.2 AJAX engine model

### 3.2 Web Services

Web service is a kind of deployment on Web, which has the advantages of object technology promises. At the same time, the Web service based on XML based, open Web specification based on the technology, compared with other open object technology better, is a new. Web service platform to build distributed and interactive applications the is a set of standard, which defines how the application in the Web to achieve interoperability, we can use any language, write the required Web service <sup>[8]</sup> on any platform.

### 3.3 Database Connection --ADO.NET

ADO.NET is mainly composed of DataSet and .NET data provider to complete the main function of. DataSet is the core component of the .NET data broken open structure provides the program includes Connection, Command, DataReader, DataAdapter, Dataset several objects. These objects has two main functions: data access and data representation. Two types of contact with each other, in the development of

the database two types will be used <sup>[9]</sup>. ADO.NET architecture is shown in Figure 3.3:

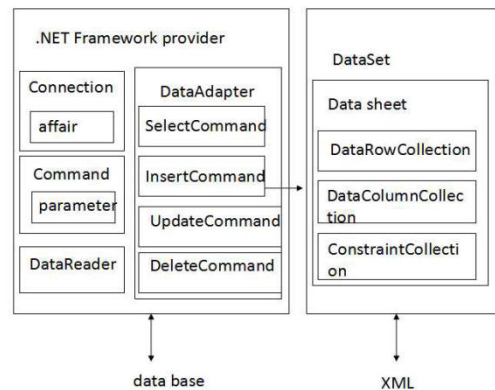


Figure 3.3 ADO.NET architecture diagram

ASP.NET file access to the database need to lead the ADO.NET namespace, different data sources need to introduce a different namespace, as shown in Table 2.1, as shown in table <sup>[10]</sup>:

Table 3.1 ADO.NET Namespace

ADO. NET namespace	Explain
Provides the base class for the ADO. NET architecture	Provides the base class for the ADO. NET architecture
System. Data. SqlClient	Data access class designed for Microsoft SQL Server data source
System. Data. OleDb	Data access classes designed for OLEDB data sources
System. Data. Odbc	Data access classes designed for ODBC data sources

## 4 Software Design of Monitoring System

### 4.1 System Structure Design

This system is mainly composed of the ship and shore monitoring /

management system monitoring / management system consists of two parts, each part includes database, LAN, browser, server, GPRS wireless communication network composed of several parts, design the overall structure of the system is shown in Figure 4.1:

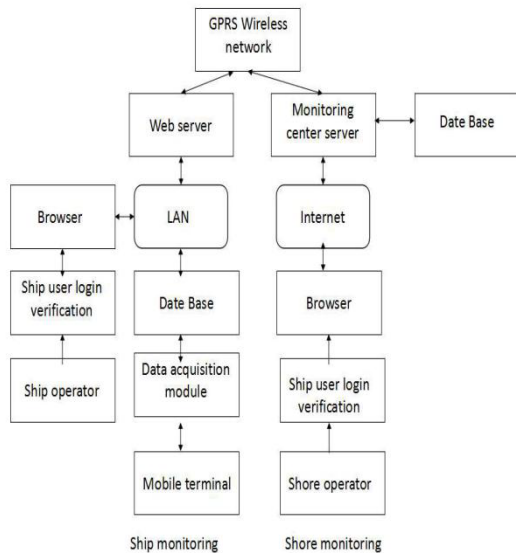
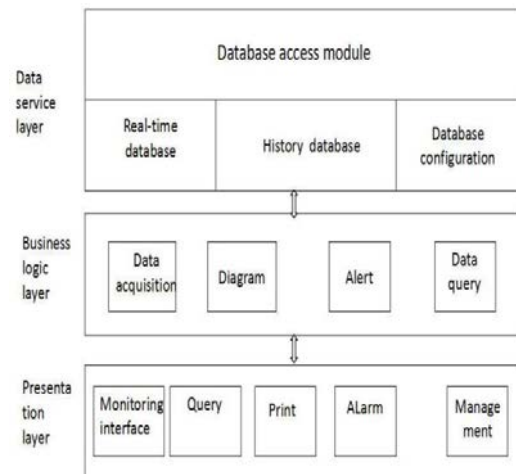


Figure 4.1 Overall structure design of the system

The ship is loaded in the mobile terminal monitor, connected to the data acquisition module, data acquisition module. The collected information is transmitted to the GPRS communication module. GPRS wireless communication network is uIP based on TCP/IP protocol, the user does not need to know the specific content of the agreement, the agreement will pass the information to the monitoring center server. Mainly responsible for the operation of the ship will be wirelessly transmitted to the monitoring center, the monitoring center and the information interaction between ships.

## 4.2 System Software Design

### 4.2.1 Three layer structure model



The system divides the whole system into logical layers: presentation layer, business logic layer and data service layer, as shown in Figure 4.2:

Figure 4.2 System structure design of the three layer

The presentation layer for said user interface and business layer class and object to drive the interface, display and visualization of the operation for the user interface, mainly by the configuration tool, monitoring interface, alarm, report and so on. The business logic layer is the monitoring center server, used to access data from the data access layer, data layer. Modify the data, delete data, and returns the result to the presentation layer. The data service layer by the database and data access components.

### 4.2.2 System database design and workflow

The system database with real-time database, alarm database, history database, fault diagnosis standard reference library, library, library and library attendance alarm threshold. The operation record data stored in the cabin monitor daily in the database, the system

a total of the cabin host, generator, clutch, rudder and propeller, a total of 37 analog parameters the springboard was recorded.

The working process of the system is divided into two parts as shown in Figure 4.3, the client and server. The client, operator login through LAN, authenticated connection to the server in the system need to read or query service, the operation parameters of the engine room in view, once found the alarming situation in a timely manner.

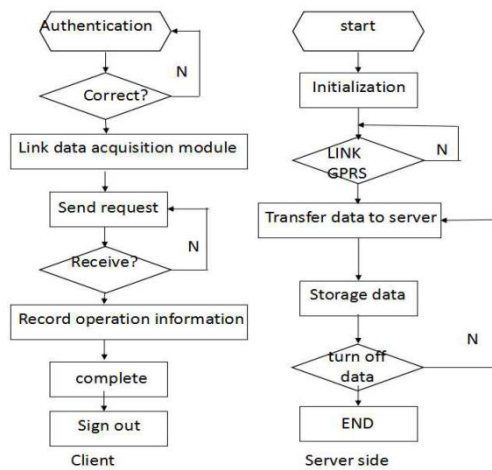


Figure 4.3 System workflow

### 4.3 Main functions of the system

The software design uses the modular programming idea. By dividing the function module, the data flow between the design of each module, in order to maintain good readability, portability and expandability. According to the different functions of the software module is divided into data acquisition module, query module, monitoring module, management module, trend map module, fault diagnosis module and other functional modules. The overall block diagram shown in Figure 4.4:

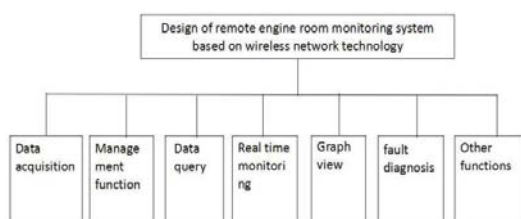


Figure 4.4 System software function block diagram

### 4.4 System security

#### 4.4.1 Authentication and authorization

ASP.NET provides many different types of authentication measures for practical applications, including basic authentication, the authentication, forms authentication. The authentication mode is different by setting up, these settings can be applied in the application's web.config file, or with IIS. As shown in Figure 4.5, .NET security display service system between them.

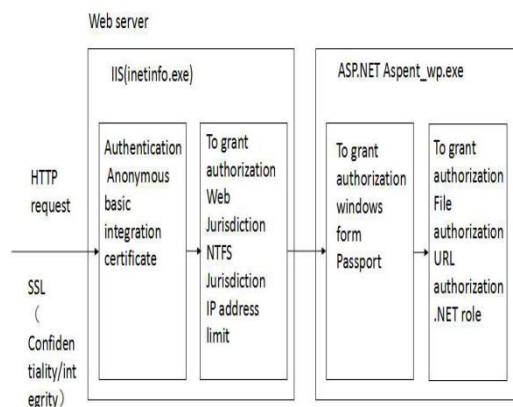


Figure 4.5 ASP.NET security service system

When through the authentication, ASP.NET will check identity. If enabled, ASP.NET applications using the client's identity to the identity of the client is selectively executed. Otherwise, ASP.NET applications use the machine identification operation, the specific process is shown in Figure 4.6 below:

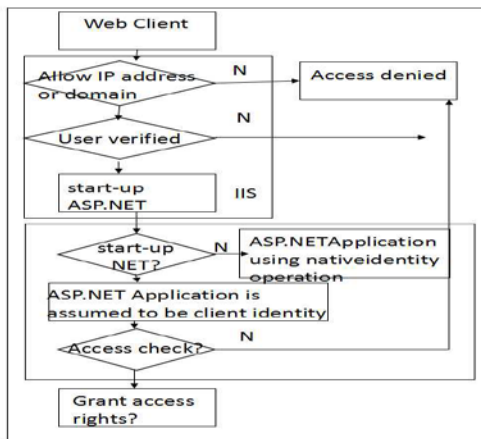


Figure 4.6 Authentication process

#### 4.4.2 Digital encryption technology

##### 1) Authentication encryption

In this system, the use of MD5 encryption algorithm, the user submits the encrypted passwords stored in the database. The user password after MD5 encryption storage field in the database, the user through the authentication, according to the corresponding permissions to access the resources required to ensure the safety of the password.

##### 2) Data transmission encryption

3DES (Triple DES) is a DES encryption algorithm to AES transition, is a safer deformation DES. It uses DES as the basic module, through the design of packet encryption algorithm combined the grouping method, its implementation is as follows: (a) and  $D_k$  ( $E_k$ ) encryption and decryption process on behalf of DES algorithm.  $K$  represents the DES algorithm using key  $P$ , on behalf of plaintext,  $C$  represents density table, as follows:

*3DES encryption process:*  $C = E_{k3} (D_{k2} (E_{k1} (P)))$

*3DES decryption process:*  $P = D_{k1} (E_{k2} (D_{k3} (C)))$

## 5 Fault Diagnosis Based on Rough Set and Fault Tree

Fault diagnosis methods based on rough set and fault tree by combining the two methods, was used for fault diagnosis of diesel engine power shortage by using their own advantages. With the method of fault tree construction rules set, generating decision table, then the attribute reduction of the decision table by using rough set method to generate the minimum set of rules in the rule base in the fault diagnosis of first call this rule, if the match is successful will continue to search until you find the satisfactory results. The diagnostic process is shown in Figure 5.1:

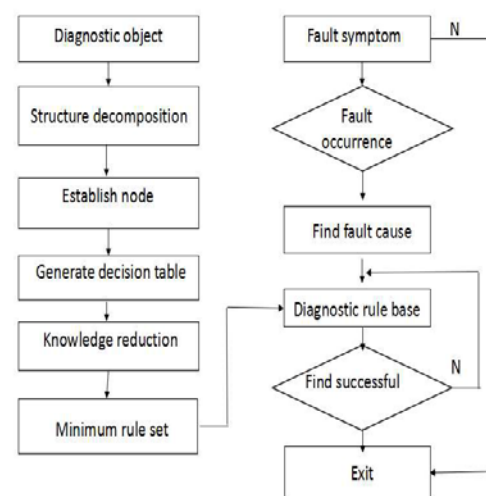


Figure 5.1 Flow chart of fault tree diagnosis based on rough set

**Table 5.1 The Meaning of Each Domain in The Original Information System**

Field	Meaning
$t_1$	Diesel engine overheating
$t_2$	Ambient temperature is too high
$g_1$	Power shortage
$g_2$	Abnormal percussion sound

$q_1$	Cylinder head and body joint leakage
$q_2$	Intake and exhaust valve leakage
$q_3$	Valve spring damage
$q_4$	Incorrect valve clearance
$p_1$	Connecting rod bearing wear
$p_2$	Wear of Journal
$s_1$	Fuel lines, etc., into the air or plug
$s_2$	Fuel injection pump does not spray
$s_3$	Poor injection or low injection pressure
$j_1$	Air filter clogging
$j_2$	The exhaust pipe of coke

The principle of fault diagnosis according to the above introduction of rough sets and fault tree combination, a tree structure diagnosis object with VS2005 C# language, SQL Server2000 database into the inventory

generation rules, and then use the theory of rough set rules rules set for attribute reduction, a minimum rule for the diagnosis of specific set. The process is as follows:

1) Decision table based on fault tree

According to the fault tree of figure 4.1 figure, the establishment of information system of  $S=(U, AUD)$ ,  $U$  is the set of objects that the parts of the diesel engine state set,  $A=\{T1, T2, G1, G2, Q1, Q2, Q3, Q4, P1, P2, S1, S2, S3, J1, j2\}$  on behalf of conditions attribute, each parameter domain represents the engine components as shown in table 4.2: Among them, the decision attribute, 1 said overheating fault, the cylinder head component of the fault of 2, said the connection shaft and the surface of the neck of the hair of the fault, the 4 said the fuel system failure, said the exhaust system into the 5 fault, 6 indicates that the system failure is normal.

**Table 5.2 Diesel Engine Output Power Shortage Decision Table**

Sample number $U$	Condition attribute														Decision attribute $d$	
	$t$	$t$	$g$	$g$	$q$	$q$	$q$	$q$	$p$	$p$	$s$	$s$	$s$	$j$		$j$
	$1$	$2$	$1$	$2$	$1$	$2$	$3$	$4$	$1$	$2$	$1$	$2$	$3$	$1$		$2$
1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	5
2	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	4
3	1	0	0	0	0	0	1	1	1	0	0	1	0	0	0	4
4	0	0	1	1	0	1	0	0	0	0	2	0	1	1	0	4
5	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	2
6	0	0	0	1	0	0	0	1	1	1	0	0	0	0	0	3
7	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5
8	1	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1
9	0	1	1	1	0	1	1	0	0	1	0	0	1	0	0	2

10	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	2
11	0	1	1	1	0	0	0	0	0	0	0	0	2	0	0	4
12	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	5
13	1	0	0	0	0	1	1	0	1	1	0	0	0	0	0	3
14	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	5
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6

**Table 5.3 Decision Table after Reduction**

Sample number <i>U</i>	Condition attribute										Decision attribute <i>d</i>	
	<i>t<sub>1</sub></i>	<i>t<sub>2</sub></i>	<i>g<sub>1</sub></i>	<i>g<sub>2</sub></i>	<i>q<sub>1</sub></i>	<i>q<sub>3</sub></i>	<i>p<sub>1</sub></i>	<i>p<sub>2</sub></i>	<i>s<sub>3</sub></i>	<i>j<sub>1</sub></i>		
1	0	1	0	0	0	0	0	0	0	0	1	5
2	0	0	0	0	0	0	1	0	1	1	0	4
3	1	0	0	0	0	0	1	1	0	0	0	4
4	0	0	1	1	0	0	0	0	0	1	1	4
5	0	0	1	1	1	0	0	0	1	0	0	2
6	0	0	0	1	0	0	0	1	1	0	0	3
7	1	0	0	0	0	0	0	0	0	0	1	5
8	1	1	0	0	0	0	1	0	1	0	0	1
9	0	1	1	1	0	0	1	0	1	1	0	2
10	0	1	1	1	1	1	1	0	0	0	0	2
11	0	1	1	1	0	0	0	0	0	2	0	4
12	0	1	0	0	1	0	0	0	0	0	1	5
13	1	0	0	0	0	0	1	1	1	0	0	3
14	0	0	0	0	1	0	0	0	0	0	1	5
15	0	0	0	0	0	0	0	0	0	0	0	6

2) Knowledge reduction of decision table by rough sets

In order to improve the diagnosis speed, accuracy, attribute reduction of the decision table by rough set method. After a clear function and reduction rules after the treatment, the reduction of the table as shown in table 4.3. Attribute information which can replace the original decision attribute table information, to simplify the purpose.

3) Create database table

The reduction of the table can be obtained by Then minimum reduction rules are as follows: IF T1 T2 G1 G2 Q1 and and P1 and and S3 and J1 Then D, etc. the above rules into the database, the establishment of a data table, the main attributes of the and P2, Q3 and and:

Table Nodes: storage node information;

Infault table: storage node fault information, fault code, fault name, fault content and maintenance methods and other



attributes;

Table Brule: storage rule;

Table Arule: storage rule;

Rule table: Brule and Arule table linked

In order to verify the running results of the system, the system for a week within 24 hours, the system is tested, and achieved good effect; combined with the fault diagnosis of diesel engine power shortage, result analysis and comparison results are shown in table 4.4:

**Table 5.4 Analysis and Comparison of Results**

Algorithm	Diagnostic speed	Accuracy
Rough set	Fast	97.6%
Fault tree	Fast	98.1%
Combination of the two	Fast, there are obvious mention	98.9%

## 6 Conclusion

The system mainly completes the data acquisition, data query and print, real-time monitoring, alarm, trend display, fault diagnosis function. Application of remote technology, maintenance, the Shipping Co to give any place in the ship maintenance expert opinion. The authentication and authorization and digital encryption technology to improve the safety of the system and interface; code separation provided by .NET technology and three tier architecture improves the speed of development, database using scalable SQL Server database. In the monitoring room at the same time, the system provides the fault diagnosis function, so as to be able to appear in the first time to the fault. Expert advice, take effective measures to solve the problem.

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