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Photovoltaic Power Station Monitoring System Using GSM Wireless Communication Network

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Abstract: *With the popularity of mobile communication, GSM system has become the most mature mobile communication system, most of the world's mobile operators have adopted this system. With the opening and vigorous development of GPRS,GSM network has been smooth transition to 3G mobile communication system, and it is estimated that the vast majority of mobile operators choose GSM - GPRS - 4G development ideas. The purpose of this paper is to make full use of the existing network resources, improve the network quality, service level, and ensure the important work of communication quality, so as to make the operation and management of photovoltaic power station staff more convenient and intelligent. This paper analyzes in detail the practical problems that wireless network optimization can solve to improve network quality through specific cases. On the basis of the whole GSM network optimization exposition, according to the author's existing optimization experience, the paper finally discusses the wireless network optimization of dual-frequency network, GPRS and 4G, so as to highlight the importance of GSM wireless network optimization in the wireless network optimization of mobile communications. The experimental results show that the development and operation of this system has established an efficient GSM wireless performance monitoring center for local network, which not only avoids human errors and omissions in system monitoring, but also greatly improves the work efficiency of wireless network optimization. 90% of the solutions and Suggestions provided to mobile operators through practical work are adopted.*

Keywords: *Wireless Communication Network, Photovoltaic Power Station, Monitoring System, GSM Theory*

1. Introduction

Mobile wireless communication is the most dynamic and promising communication mode in the field of communication, as well as the most personalized communication mode in the information society. In contrast to the traditional static fixed communication, moths in mobile communication are characterized by dynamic mobile communication, which introduces the mobility of users on the basis of wireless communication, that is, the dynamics of the second user on the basis of the dynamics of the first channel. Wireless communication. It is this dual power that guides the development of mobile communication technology. The development of mobile communication technology also focuses on how to adapt to the dual dynamics of channel and user. The third generation mobile communication technology introduces the third dynamic and the service dynamic on the basis of the dual dynamic, which greatly increases the complexity of the system.

As for China, it is a vast country with a very wide area of solar radiation. Moreover, the geographical environment in China is quite different from each other. There are plains, basins, mountains, islands, deserts and other landforms. Therefore, in order to solve the power supply problem in these areas, the research on solar photovoltaic power generation is of great significance, which is one of the best power supply methods under the current situation. Various typical solar photovoltaic power generation system research has matured, but the use of solar energy to reasonably and effectively, also to all parameters of the photovoltaic real-time monitoring, monitoring and control system to realize unattended, and meet the long-distance monitoring and can work under the bad environment stable, which requires a reasonable set of photovoltaic monitoring system. Therefore, it is very important to develop a high stability photovoltaic monitoring system to achieve real-time acquisition of its parameters and to effectively maintain the photovoltaic system.

Fuqiang Yao proposed a clut-based collaborative spectrum awareness (CSS) scheme for cognitive wireless communication networks (eh-cwcn) for energy acquisition. In CSS schemes, time resources are limited and Shared by energy capture, spectrum awareness, and data transfer. The purpose of this paper is to maximize the average throughput of eh-cwcn by determining the optimal set of parameters, including the duration of energy acquisition and spectrum sensing, local detection thresholds, and the number of CNs. In addition, it is difficult to determine the optimal local detection threshold in CNs with different receiving power. By constructing a virtual perception node (FCN) and assuming that the perception node has the same perception performance as the sink node, the process of finding the optimal local detection threshold is transformed into the process of finding the optimal SNR. Then, the general optimization problem under collision constraint and energy constraint is given. Based on this, Fuqiang Yao demonstrated the existence and uniqueness of time fractions for energy acquisition and spectrum sensing. The optimal parameter set is obtained by using the 50-50 method and the simplified linear search method. Finally, the influence of theoretical analysis and optimization parameters on system performance is verified through numerical simulation [1]. Improving the quality of the wireless experience is a key issue. Much of the accepted work centers on intracellular scheduling. They have shown that when the opportunistic scheduling approach takes account of channel damage, it can achieve higher throughput and, for the most efficient approach, higher fairness. However, if some of these efforts provide near-optimal results, considering a unit, a high QoE does not guarantee cell overload in the scenario. Cedric Gueguen has proposed a new intercellular scheduler that helps overloaded cells with dynamic cellular bandwidth allocation. Cedric Gueguen's resource allocation technique is based on an appropriate emergency parameter called average packet late downtime (MCPDOR). The performance evaluation shows that the proposed scheduler performs far better than the existing solution in various situations. Cedric Gueguen also proposed and evaluated a variant of the solution that does not consider MCPDOR [2]. Broadcast is the process of sending information from one node to all the other nodes in the network. Simple flooding is the simplest form of broadcasting in wireless networks. Simple flooding provides important control, routing discovery and network information update functions for unicast and multicast protocols. However, simple flooding can produce excessive duplication of broadcast messages over wireless networks. Minimum spanning tree (MST) -based flooding has been used in networks to reduce broadcast duplication by using global topology information to determine the broadcast tree. However, mst-based flooding still results in significant duplication of broadcast traffic. Nguyen Xuan Tien proposed an effective flooding, called "minimal retransmission" (MRT), to significantly reduce the duplication of broadcasts. The purpose of MRT is to minimize the number of forwarding nodes in the wireless network based on link-state information of the network. This advantage of minimizing the number of forwarding nodes greatly reduces the duplication of broadcast messages in wireless networks. The performance of MRT is analyzed [3].

In this paper, the research background and significance of this topic are explained, and the photovoltaic monitoring system at home and abroad is briefly introduced. Finally, the main content of this paper and the planning of each chapter are described. Secondly, the overall design framework of the monitoring system of photovoltaic power station is presented. The overall idea and design principle of this topic are emphatically elaborated. Then, the design method and sensor selection of each monitoring module are specified. Finally using GSM monitoring system hardware design, the overall structure of the hardware system was given, and then a detailed analysis of every circuit module design, and then expounds the arm-based software configuration, in MDK programming environment using C language programming, the program runs in the control chip STM32F100, this is a hardware circuit can realize data acquisition, data processing and data transmission (RS485 communication protocol) function of the important steps. At last, the content of this paper is summarized.

2. Proposed Method

2.1 Theoretical Basis of GSM

As shown in Figure 1, it can be seen from the system structure diagram that GSM network consists of MS (mobile station), MSS (mobile switched network subsystem), BSS (base station subsystem) and OSS (operation and maintenance subsystem). The BSS base station subsystem provides relay for both the fixed and wireless parts of the PLMN network. On the one hand, BSS communicates directly with the mobile station through the wireless interface; BSS, on the other hand, is connected to MSC, the mobile switching center of the mobile switching subsystem MSS. BSS can be divided into two parts. A base station transceiver station (BTS) connected to a mobile station via a wireless interface and a base station controller (BSC) connected to a mobile switching center. BTS is responsible for wireless transmission and BSC is responsible for controlling and managing ports. A BSS system consists of a

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BSC and one or more BTS, and the BSS subsystem can be composed of multiple BSC and BTS. Base station controller BSC can control dozens of BTS according to traffic demand. BTS can be connected directly to BSC or to remote BSC via base station interface device BIE. The base station subsystem should also include a transcoder (TC) and a submultiplexer (SM)[4].

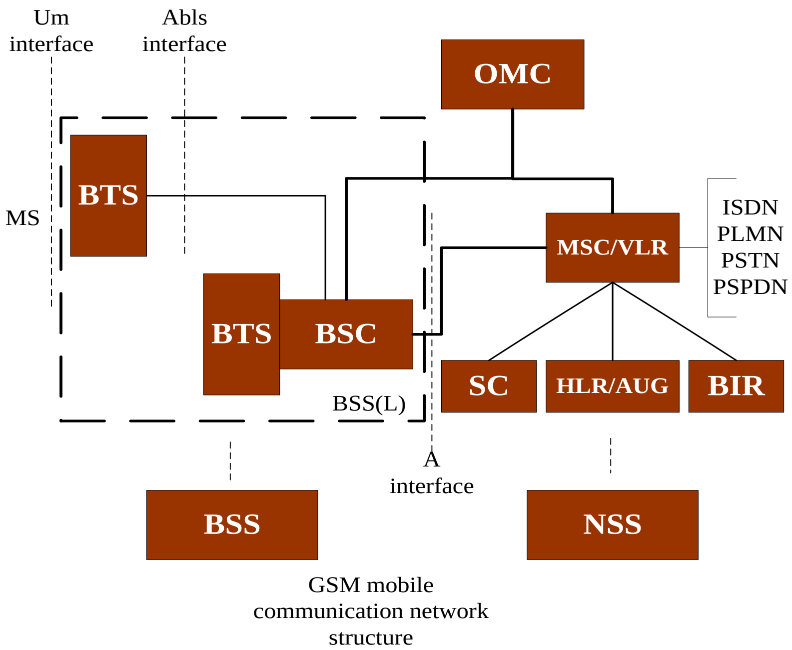

Figure 1: Network structure of GSM system

2.2 GSM Wireless Communication Foundation

Mobile communications use radio waves to transmit information, known as wireless channels. And the moving station is always in constant motion, so the amplitude and phase of the received signal will vary with time and place. In particular, GSM and other terrestrial mobile communication methods are heavily influenced by topography and function. Therefore, it is necessary to study the wireless environment in which the network is located. Because of using GSM mobile communication system, the mobile station antenna on the ground is low, the influence of the terrain and the artificial environment, direct wave often blocked, studies have shown that the frequency of the wave propagation characteristics and wave, the propagation distance, antenna polarization mode, antenna height, more importantly, the ground wave propagation path and terrain objects and the performance parameters of the "gas", over time, reasonable factors, such as seasonal change place investigation and determine the planning area of the comprehensive environmental conditions is very important to network planning[5-6].

(1) Radio wave propagation characteristics of GSM

The purpose of studying radio wave propagation is to predict the field intensity of mobile communication, estimate the loss of radio path, and formulate the networking and optimization scheme of wireless network equipment according to various characteristics of radio wave propagation. According to the classical theory of electromagnetic fields, a more accurate method of computing in free space approximates the propagation characteristics and radio wave losses on a smooth surface or sphere. However, as can be seen from the above discussion, the propagation of non-smooth surfaces and mobile environments and conditions is complex and difficult to deduce theoretically. In addition, in landmobile communications, because the mobile body (pedestrians and cars) need to talk while moving, and the antenna height of the mobile station is very low, usually 1-4 meters above the ground, it has important distinguishing features. It comes from other wireless communications: as the movement proceeds, the strength of the received signal field produces two kinds of fading, multipath fading and topographical fading, due to the continuous change of buildings, trees, topographical undulations, and other man-made and natural obstacles. The former is a rapid change in the small, also known as fast decline; The latter is a slow macro change, also known as slow fading or shadow effect[7-8].

(2) Optimization of GSM mobile communication network

The optimization and planning of cellular mobile communication network are two inseparable parts.

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The optimization of wireless network has many uncertain factors, which have a great influence on the wireless network. Of course, problems not considered in the planning stage of wireless networks, such as the uncertainty of radio wave propagation, changes in infrastructure, traffic loads depending on location and time, traffic requirements, and users' increasing requirements for service quality, all involve network optimization. Figure 2 shows the wireless network optimization process[9-10].

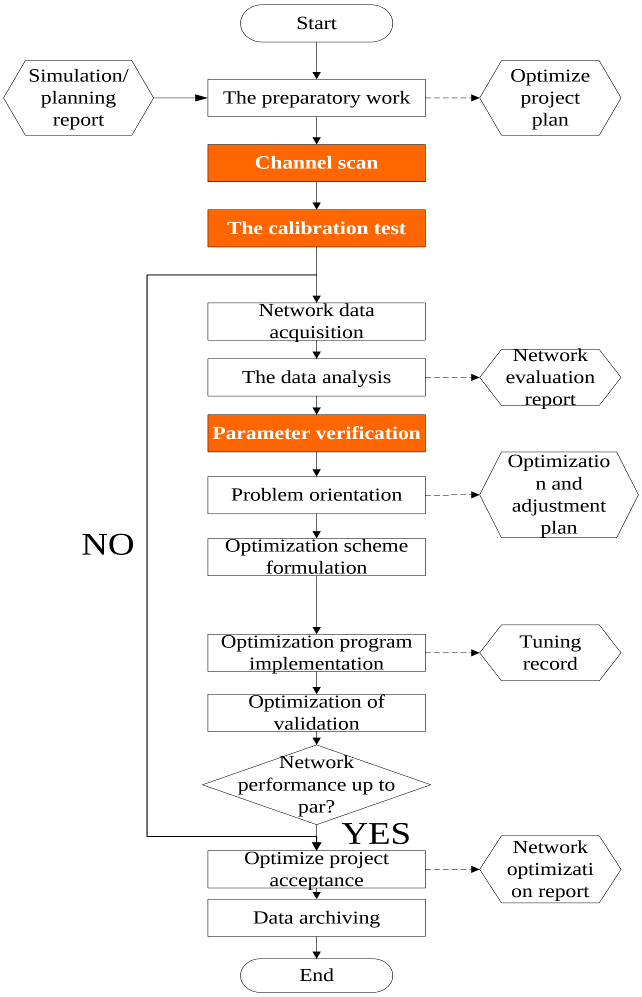

Figure 2: Wireless network optimization process

The network optimization process includes the following steps: preparation (optional), spectrum scanning (optional), calibration testing, network data acquisition, data analysis, parameter verification (optional), problem location, optimization plan formulation, optimization plan implementation, optimization verification, optimization project acceptance and data archiving.

2.3 Monitoring System of Photovoltaic Power Station

(1) Introduction of photovoltaic power generation system

A photovoltaic system is a system that converts solar energy into electrical energy. It consists of different parts: photovoltaic cells, electrical connections, mechanical devices, and methods of converting to electrical energy output. The resulting electricity can be stored in a separate system, stored in batteries or fed to a larger grid[11-12].

In general, photovoltaic power generation system can be divided into independent photovoltaic power generation system and grid-connected photovoltaic power generation system. The independent photovoltaic power generation system, also known as off-grid photovoltaic power generation system, USES photovoltaic modules to directly convert the solar radiation light energy into the power needed by the load to supply the load, and the remaining power can be stored in the battery through the charging controller. This kind of photovoltaic power generation system is more suitable for use in remote areas[13-14]. But it also has some disadvantages: for example, its stability is relatively poor, when night or rainy

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weather cannot or very little power generation, once the photovoltaic power generation system cannot provide to meet the needs of the load, will produce a series of problems. In contrast, grid-connected photovoltaic power generation system can overcome the related shortcomings of off-grid photovoltaic power generation system, which is composed of photovoltaic cell phalanx, controller and grid-connected inverter, because it can directly input power to the public grid through grid-connected inverter without passing through the battery. This avoids the energy loss caused by the storage and release of the battery[15-16].

(2) Overall scheme of photovoltaic monitoring system

The monitoring system of 3kW photovoltaic power station mainly includes two modules: upper computer and lower computer. The module of the lower machine is responsible for monitoring relevant parameters such as photovoltaic voltage, photovoltaic current, output voltage of the inverter, output current of the inverter, ambient temperature and irradiance, and sending the collected physical quantities to the upper computer in the form of data through the bus. The main functions of the upper computer are to display the monitoring parameters in real time, process the related monitoring data, and communicate and control with the lower computer. The serial communication mode of RS485 bus to RS232 bus is adopted for data transmission and real-time communication between the upper computer and the lower computer[17-18].

2.4 Design of Monitoring System Modules

(1) Solar irradiance monitoring module

Solar irradiance refers to the radiant energy per unit time per unit area on a solid surface, in watts per square meter, after solar radiation is absorbed, scattered and reflected by the atmosphere. There are two factors that affect solar irradiance. First, the attenuation of solar radiation as it passes through the atmosphere, including scattering, absorption and reflection, is limited by climatic and meteorological factors. Secondly, solar irradiance is obviously controlled by solar altitude Angle, which affects the propagation path of solar radiation and is therefore related to regional latitude, seasonal change (earth revolution) and the rise and fall of the sun during the day (earth rotation). Solar radiation plays an important role in the operation of photovoltaic power stations[19-20].

(2) Environmental temperature monitoring module

The operation status of photovoltaic power stations is significantly affected by environmental factors. There is no doubt that the environmental temperature affects the generation efficiency, generation capacity and system security of the whole power station to a large extent, so real-time monitoring of the environmental temperature of photovoltaic power stations is very necessary. Under normal circumstances, temperature measurement methods are mainly divided into two categories: contact type and non-contact type. So-called non-contact temperature measurement is through temperature measurement components measured target objects in contact with and feel the temperature of the object, the characteristics of this kind of sensor is measuring stability is good, structure simple and cheap, but its drawback is that require sufficient heat exchange when measuring temperature, therefore has the obvious lag phenomenon, in addition to the measured results can be affected by the situation of contact between the measurement and sensor. While non-contact temperature measurement refers to judging the temperature by receiving the thermal radiation emitted by the measured object, such as the common infrared radiation temperature sensor. The advantage of this method is that it can just overcome the deficiency of contact temperature measurement, but it also has the disadvantage of lower measurement accuracy[21-22].

Temperature sensor can be divided into many types, including heat resistance, semiconductor PN section and integrated temperature sensor, etc., in the selection of sensors, in addition to consider measuring range, accuracy of measurement, conditions of use, and other basic requirements, should also be considered to the key factors such as cost price and auxiliary circuit is simple, eventually try to choose high cost performance of the sensor. As far as this system is concerned, the integrated temperature sensor is characterized by high precision, small volume, good reproducibility, good stability, convenience in design and moderate price, etc., so the temperature detection module of this system chooses the temperature integrated sensor.

(3) Photovoltaic current monitoring module

According to a large number of practical engineering cases, if the dc current is small (usually referred to as a small current below 1A), the current signal is usually converted into a voltage signal using a sampling resistor. If the dc current is large (usually greater than 1A), there are two ways to measure the

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value of the target current. The first method is to use the hall current sensor to convert the original large current into the corresponding small current signal and then detect it. Another way is to use a cheaper shunt to reduce the large current according to a certain proportion and then measure it. However, this method has the disadvantage of low accuracy in measuring the current, so it is more suitable for occasions with lower requirements for measuring accuracy. The pv current to be monitored in this system is the input current of the 3kW pv inverter and the dc current generated by the amorphous silicon solar panel. The maximum value is about 15A. Therefore, the method of sampling resistance obviously does not meet the actual requirements. After comprehensive analysis according to the actual monitoring requirements, this project adopts the hall current sensor to monitor the photovoltaic current[23].

(4) Photovoltaic voltage monitoring module

Normally, when the dc voltage is small, the dc voltage will be measured directly by means of receiving the amplifier behind the shunt resistor. If the dc voltage is large, the hall voltage sensor is often used for measurement. This system need to monitor the pv voltage is 3 kw photovoltaic inverter dc input voltage, the maximum value of about 550 v, for such a few hundred volts dc high voltage measurement with the method of partial pressure resistance obviously does not conform to the actual situation, comprehensive analysis, the hall voltage sensor is ideal measuring scheme, and can satisfy the requirement of accuracy and efficiency at the same time[24].

(5) Ac current monitoring module

The ac current to be monitored in this system is the output current of the 3kW photovoltaic inverter with a frequency of 50Hz and a maximum value of about 15A. Generally speaking, there are two measurement methods to obtain the value of the target current for a large ac current. The first method is to use the hall current sensor to reduce the original large current to the corresponding small current in a certain proportion and then detect it. Another way is to use the ct to reduce the original large current to the corresponding small current in a certain proportion. As the current transformer has more advantages in terms of price compared with the hall current sensor in the aspect of ac current detection, and the accuracy is relatively high, which fully meets the design requirements of the system, the current transformer is chosen in this project[25].

(6) Ac voltage monitoring module

The ac voltage to be monitored in this system is the output voltage of the 3kW photovoltaic inverter. In this system, it is the grid-connected voltage of the photovoltaic power station. The theoretical value is 220V and the frequency is 50Hz. Similar to the ac current output by the inverter, there are usually two ways to measure the value of the target voltage for such a large ac voltage. The first method is to use the hall voltage sensor to reduce the original high voltage to the corresponding low voltage in a certain proportion before the detection. Another way is to use the voltage transformer to reduce the original high voltage to the corresponding low voltage in a certain proportion. Similarly, after comprehensive analysis, on the premise of fully meeting the measurement accuracy, voltage transformers have more advantages in terms of price compared with hall voltage sensors in ac voltage detection, so this topic chooses to use voltage transformers to monitor grid-connected voltage.

3. Experiments

3.1 Components of the Experimental Photovoltaic Power Generation System

Different photovoltaic systems may differ slightly in their components, but in general, a typical photovoltaic system typically contains the following important components:

(1) Photovoltaic cell: it is composed of small square and round semiconductor thin films that can generate voltage and current under sunlight.

(2) Photovoltaic module: photovoltaic cells are made into sheets and placed between two packaging layers. (the upper layer is a transparent glass overlay, and the lower layer is the encapsulating base)

(3) Panel: composed of one or more modules fixed together. (usually interchangeable with modules)

(4) Photovoltaic array: composed of one or more panels connected by cables to provide a certain value of voltage and fixed on the bracket structure.

(5) Charging controller: equipment used to regulate the voltage of the battery.

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(6) Accumulator: a device for storing photovoltaic direct current (DC) in a chemical manner.

(7) Inverter: an electrical device that converts direct current (DC) into alternating current (AC).

(8) Load: including dc load and ac load, including devices, motors and ac-dc power generation equipment.

3.2 Experimental Environment

The main components of ANTPILOTFORGSM wireless data collector are: portable microcomputer, GSM special test phone, GPS global positioning system (with external antenna), high speed digital sweep receiver, serial port extension card and interface cable, new integrated on-board power supply system and other accessories. The above parts are all installed in a test instrument box to facilitate test engineers to collect and test data. The portable microcomputer is designed to install ANT Pilot for GSM test software for testing and ANT for GSM background analysis software for data processing. As a professional test computer, its configuration is shown in Table 1:

Table 1: Test computer configuration table

Model	CPU	HDD	RAM	According to	Battery	Floppy drive	Interface
Basic IBM series	PIII200 above	More than 10g	More than 64 MB	More than 12.1	Standard cell	Optical drive, floppy drive interchange	necessary
Recommended IBM series	PIII866 above	More than 20g	More than 256 MB	More than 14.1	Standard cell	Optical drive, floppy drive interchange	necessary

3.3 Experimental Steps

The system of the utility model comprises a tracking system controller, a monitoring computer, a communication module, a communication base station and a mobile phone. The beaded system is connected with the monitoring computer through the controller, and the monitoring computer communicates with the mobile phone through the communication module, a communication base station:

The tracking system controller is connected to the monitoring computer via a 485 bus. The monitoring computer is connected to the communication module through interface 232.

Tracking station manager via mobile phone send instruction to the GSM communication module of SMS, monitoring computer monitoring software will message read, to the text content analysis, and then through the 485 bus to the tracking system by the controller to send corresponding instructions received tracking system controller, and perform the instructions, and make skin feed to the monitoring software, monitoring software after receiving the feedback, feedback information through the communication module with skin cell phone sent to the administrator, See Figure 3.

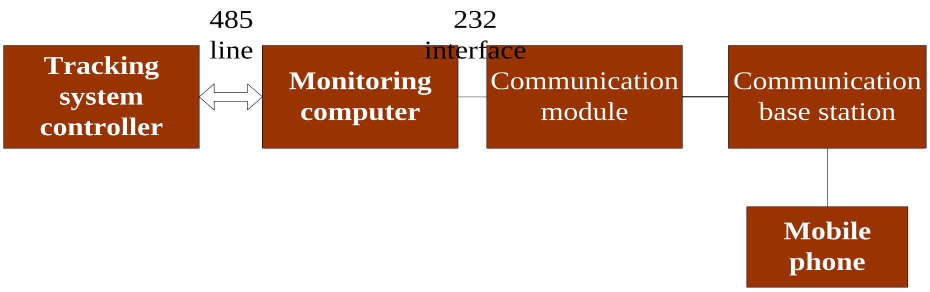


Figure 3: Schematic diagram of the module structure of the utility model

4. Discussion

4.1 Debugging Data Analysis

(1) Ac voltage test results

In order to verify the accuracy of the monitoring system, the power generator is used to generate stable 220v ac and 200v dc and test them. 50 data are selected and compared with the actual results. See Figure 4.

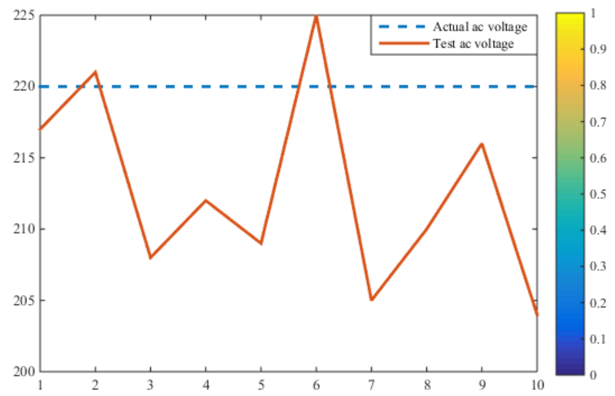


Figure 4: Comparison diagram of ac voltage test results

In Figure 4, the blue dotted line is the 220v stable ac signal output after the photovoltaic voltage passes through the inverter, while the red solid line represents the ac voltage curve detected by the system. By comparison, it can be seen that the error between actual data and ac signal measured by this system is relatively large, which may be caused by the limited accuracy of the voltage transformer adopted, or by the defect of the algorithm for calculating the effective value of ac signal, or by the low accuracy of the algorithm resulting from the limited amount of sampled data, resulting in a large error.

(2) Photovoltaic voltage test results

As shown in Figure 5, the dotted blue line represents the 300v stable dc signal generated by the dc voltage generator, while the solid red line represents the dc voltage curve detected by the system. The comparison shows that the actual data are consistent with the dc signal measured by this system.

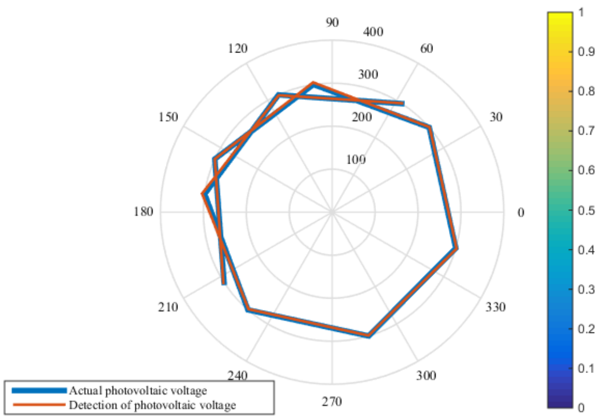
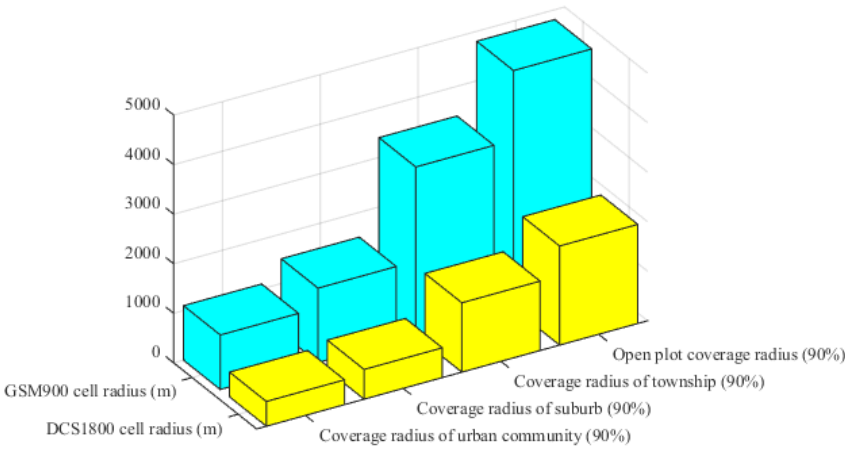


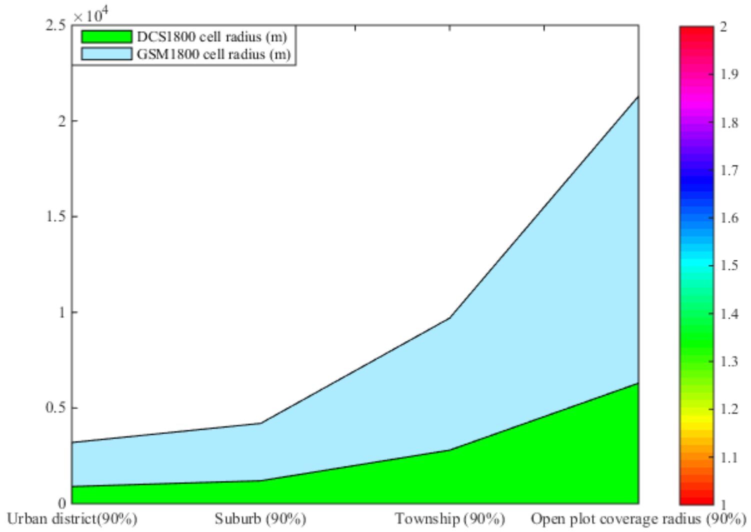
Figure 5: Comparison diagram of photovoltaic voltage detection results

4.2 GSM Wireless Communication Network Site Planning and Optimization

Currently, the GSMl800 is generally considered to be co-located with the existing GSM900 base station, but additional stations should also be considered where the strong field coverage is weak and interference is present. Station is set at 112l in the same address in the high-density area. The GSM900 base station is close to each other, and the coverage area of the two base stations is easy to approach, which is basically no problem. If the GSM900 station is located at a larger common site, the coverage will be similar to concentric circles. The boundary between the inner circle of GSMl800 and the outer circle of GSM900 will result in more switching, and the traffic absorbed by GSMl800 will also decrease when traffic is evenly distributed. In order to make GSMl800 absorb higher traffic, it should be considered to reduce the station distance. According to the actual situation of our country, the gsm900/1800 common station distance in the high-density area is best set at around 400m according to the terminal station distance according to the long-term planning, and around 500m if there are difficulties. According to the actual situation and the requirements of GSMl800 to absorb traffic, different layouts can be selected. Those with the conditions should complete the network step by step so as to achieve the best operation quality. The additional GSMl800 site to be completed should be considered in advance for coverage prediction and interference analysis.



(a) Indoor environment



(b) Outdoor environment

Figure 6: 900m /1800M GSM wireless network coverage

See Figure 6. In a network with complete coverage, more than 80% of the switches are PBGT switches, and the real number of switches caused by signal level or signal quality deterioration is not too much. Therefore, ho-margin, an important parameter affecting PBGT switching, can also control the dual-frequency switching to some extent. In addition, ho-margin is also an important parameter that determines the order of candidate cells for switching. In the dual-frequency network with common address construction,PBGT calculation is unfavorable to GSMl800 cell, mainly because the loss of 1800M signal is greater than that of 900M signal. Therefore, in order to increase the GSMl800 cell to become the target cell of PBGT or to rank high in the list of switching candidate cells, the ho-margin value of the GSMl800 cell can be reduced or even reduced to a negative value, while the ho-margin value of the GSM900 cell can also be increased. The switch then begins to tilt toward the GSMl800 cell. At the same time, under certain circumstances, we can consider canceling PBGT switching between different frequency levels. In conjunction with other parameter measures, host the phone on the GSMl800 network as much as possible.

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5. Conclusions

With the speeding up of the national economy informatization process, with the improvement of people consumption level, the mobile communication business, the data rate and so on various aspects have a qualitative requirements, in the next few years, with 4 g licences issued, wireless mobile communication network optimization work is more important, there will be more people into this work. The research and implementation of this paper has certain reference value for the optimization of mobile communication wireless network.

This paper focuses on the optimization of GSM wireless network. In the study of wireless communication, on the basis of principle and road test software, through the method of theory with practice, apply theory knowledge to practice, in strict accordance with the telecommunication operators work rules and regulations and the process of its implementation, for shenzhen mobile communication company network quality assurance provided hardware guarantee and the increase of the users. Currently, 90% of the solutions and Suggestions provided to mobile operators through practical work have been adopted. And provided some reasonable Suggestions.

Participated in the formulation of the optimization scheme of GSM wireless network, including the test comparison of unicom network G, C network, mobile network G and PHS network, analyzed the reasons for the poor network quality in detail, and proposed specific implementation measures to improve the network quality. At the same time, the summary of network quality, network receiving field strength and TA value of mobile G network is summarized to give a clear view of network coverage and network quality of each area and cell of mobile company. After a series of system debugging analysis, found some problems and defects in the system, including component performance, PCB design defects, data processing algorithm deficiencies. On the basis of these found problems, the system is constantly improved, and the overall performance of the system becomes better and better.

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