Research on LED Advertising Display Wireless Control System Based on MT6589

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Abstract. Aiming at the problems of wired control and database updating in LED display applications, a wireless advertising control system for LED advertising machines with low-cost, easy-to-update database and remote control is given. The system is based on the Cortex-A7 MT6589 chip of the ARM microprocessor and uses Wi-Fi communication technology to build the wireless transmission peripheral circuit module and the IEEE802.11b protocol. It uses the RP-SAM interface that comes with the development board to match the Wi-Fi function of the connected mobile client, which realizes wireless control and high quality display of LED advertising display. The mobile client’s design of software is realized by Phone-Gap technology. The system is reliable in structure, low in hardware cost, convenient in software control, and satisfies the basic requirements for users to conveniently use it.

1. Introduction
LED displays have many advantages, such as high brightness, bright color, large contrast, low power consumption, and easily being assembled in the display field. Today, LED dot matrix advertising displays are used in all walks of life, but it inevitably would be found some obvious problems. Especially in the way of controlling and transferring information, the cable transmission control systems need much investment that the high maintenance costs and its inconvenience by users have been unable to meet the needs of various industries. It can be seen everywhere that LED advertising displays in large shopping malls and public institutions are too low in pixels to display high-definition. There are thick cables and optical fibers, which not only increase the weight and cost, but also easily cause obstacles in communication [1]. Conventionally, LED displays usually use a single-chip microcomputer as a micro-controller. When the amount of display data is large, it is limited by the size of the clock frequency. Owing to the low frequency during the scanning process, the display effect is unstable obviously. There are many limitations on single-chip wired transmission control systems. So the high-density wireless transmission control system of the MT6589 chip with Cortex-A7 architecture has its outstanding advantages [2]-[5].
In order to meet the remote control of the LED advertising machine, a part of the GMS module is installed in the LED advertising machine control system. The wireless control of the LED advertising machine control system is realized by the wireless data transmission of the 3G/4G network card. Another parts use ZigBee, Bluetooth and other wireless communication technologies that are connected to the host computer [1]. Because the data transmission based on the CMCC's GPRS/GSM communication network, in addition to charging communication costs. It will bring additional costs.
ZigBee communication technology data transmission rate is low, which can not meet the transmission rate of LED advertising machine with high pixel density; Bluetooth technology’s problems are that the power consumption is large and the transmission distance is short, and the network size is small [2], [5]. Taking into account the ubiquitous mobile phone being used everywhere, and coming with WiFi wireless connection function, LED advertising machine system uses Wi-Fi wireless communication technology. It can be better adapt to the market environment.

2. Overall system design

This system uses the Cortex-A7 architecture MT6589 as the core chip. Through the Phone-Gap technology, the designed mobile phone operating system platform is used to find the hardware ID number or IP address of the MT6589 chip for establishing a connection. After the connection is established, the signal is sent to the Wi-Fi on the development board. Then, the signal is received by the Wi-Fi module. It is transmitted to the MT6589 chip control terminal via the internal transmission control serial port, and then drives the LED display module. Considering the resource utilization of the development board, the PC can be directly implemented connection with the LED display module through the Ethernet when necessary. The overall design of the system is shown in Figure 1.

![Figure 1](image)

**Figure 1.** The overall design of the system

3. Hardware design

The LED advertising machine wireless control system is implemented by Media Tek's MT6589, which uses the quad-core ultra-low-power processor Cortex-A7 and Imagination Technologies' Power VR Series 5XT graphics processor (GPU). The Cortex-A7 processor has a main frequency of 1.2GHz, which supports 1080P video decoding, and HDMI. The hardware circuit can be basically realized by building related peripheral circuits on the development board [7]. Compared with the current control system's heat dissipation, low power consumption and cost budget, the platform is the current price/performance ratio. The hardware structure of the control system is shown in Figure 2.

![Figure 2](image)

**Figure 2.** Control system hardware structure diagram
3.1. Wi-Fi module

The title is Wi-Fi, also known as EEE 802.11b. It is a short-range wireless transmission technology that supports wireless signals connected to the Internet in hundreds of feet [4],[6]. This system adopts Sinan Union SNIOT603 Wi-Fi module, which integrates micro-controller and 802.11b/g/n, 2.4GHz wireless RF transceiver chip, including RP-SAM, UART, 2C, PIO, DIO, CM, etc. The interface can be simulated and programmed with the emulator. The mobile client platform opens the Wi-Fi setting for searching, and the connection with the Wi-Fi module is established. The related data is transmitted and fed back. Then, the MT6589 internal data register receives the data transmitted by the serial port and buffers the data transmission in the SDRAM. Figure 3 shows the interface between the Wi-Fi module and the MT6589. The communication between the Wi-Fi module and the MT6589 can be completed with only four wires.

![Figure 3: Interface diagram of Wi-Fi module and MT6589](image)

3.2. SDRAM memory module

With the rapid development of the information age, the traditional small-capacity, slow-processing static memory has been unable to solve the problem in today's multimedia networks. The problem of large amount of data transmission and high bandwidth consumption must be solved. In the process of processing high-speed signals and large-capacity data storage, Synchronous Dynamic Random Access Memory (SDRAM) is the first choice for cached data, due to its low cost, high density, and high read/write data rate. For storing the device, this system uses SK Hynix's HSTQ4G63AFR chip. The chip has 8 zones inside. A single zone can store 64M*8bit data. Its total storage capacity can reach 512M*8bit, which the clock frequency can reach up to 1600MHz, and the working voltage of the system is 3.3V. Two SDRAM are used in the design, and data can be stored and read by ping-pong operation, which can process data at high speed [8]. In this control system, SDRAM is used to store various texts, pictures, audio and video data, which provides enough space to save and run temporary files. It is convenient for the program to call at any time.

3.3. Flash configuration module

The MT6589 not only supports the common serial and parallel standard configuration modes, but also supports the Serial Peripheral Interface (SPI) configuration mode. Because the flash memory is much lower than the cost of the master MT6589 controller of this design, In traditional flash memory, Flash does not need UV light to erase memory. The control chip design software can eliminate data by using it. It can be used repeatedly. Therefore, SanDisk SDIN8DE2 is used as the flash memory configuration chip of MT6589 in this system, which has high capacity and small volume. It has many advantages, such as Low power consumption, simple interface, 8G of the memory, 1.2GHz of the clock frequency, 3.3V of the working voltage. Its synchronous serial bus can communicate with data at any time, with its own SPI interface [6]. The flash memory is divided into two parts for data storage, one for storing the software program design of the MT6589, and the other for storing the relevant parameters in the control card.

3.4. JTAG interface module

Joint Test Action Group (JTAG) is an IEEE standard test protocol for testing the integrity of signal communication between chips on a PCB and for fault detection of hardware circuits, as well as debugging simulations of the system. The main controllers on the market today, such as DSP, ARM,
FPGA. Those controlling chip manufacturers will reserve JTAG test ports, which is convenient for developers to simulate and debug online. The JTAG interface typically has four output lines: Test Data Input (TDI), Test Mode Select (TMS), Test Clock (TCK), and Test Data Output (TDO) [1]. In the program programming design function, the flash configuration module can be programmed through the JTAG interface.

3.5. Power circuit
In this system, MT6589 requires 3.3V DC (Direct Current), Wi-Fi module requires 5.0V DC, and other modules are 3.3V DC. According to design requirements, the system adopts input voltage of 5.0V DC, which can be directly supplied to wireless module. The AXP209 chip is selected as the DC-DC converter for DC conversion from 5.0V to 3.3V. The system power supply circuit shown in Figure 4 has the advantages of high reliability, good stability, and high output voltage accuracy. In order to make the LED advertising machine power off, the system time will not disappear. The power supply of each system of 3.3V CR2032 battery is separately set to ensure the stability of the system.

3.6. Clock and reset module
In the clock circuit of this system, 8MHz XTAL is adopted. After the frequency of the internal phase-locked loop circuit is doubled, the maximum frequency can reach 60MHz. At the same time, the PLL circuit has high frequency noise reduction, which can achieve the purification effect of the signal. It is sufficient to realize the basic requirements of scanning the advertisement screen.

The reset circuit uses the MAX811 chip, which is a power monitor device with a manual reset input pin and greatly enhances the stability of the system. As shown in Figure 5, the reset circuit normally resets the pin output level. When the reset button is pressed, the pin outputs a low level to reset the system.

4. Software design
Today’s mainstream mobile platforms mainly include IOS, Android and Windows Phone. They are not compatible with each other. There is no unified method and interface to realize cross-platform application development. If enterprises develop unified software for different platforms, it will not only cause time. And the waste of human resources will also lead to the difficulty of developing customization[10]. In order to reduce the cost of the enterprise and make it more convenient for users to use, the mobile phone client software design of this system adopts Phone-Gap technology. It can realize full platform support in various smart phone systems such as Android, IOS and Windows Phone. Through the JavaScript code of Phone-Gap technology for network programming, the mobile client performs Wi-Fi setting to connect the Wi-Fi module in the same LAN. Then, it can drive the LED control chip through software control to realize the control of the mobile client to the control system. The overall program design flow as shown in Figure 6.

4.1. Phone-Gap cross-platform framework design
Phone-Gap is a free, open source, cross-platform mobile application framework. It is based on HTML, JavaScript and CSS and supports a variety of mobile operating system development frameworks such as iOS, Android and Windows Phone. As shown in Figure 7, Phone-Gap's Web view for different platforms becomes a powerful browser that can access the local API, and the Native APIs are encapsulated in the Plugin mode to implement the web-side call to the mobile client. Each mobile operating system platform has a mobile client component, which can realize the following functions: at any time, the module is called to parse the received data, construct user excuses data, present and operate the service system on the terminal [9].

4.2. Software playback function structure design
Phone-Gap The general function of the LED advertising machine playback control software is to control and edit the information displayed on the LED advertising machine. At first, various programs are created on the mobile client, and the required content is dragged to the reduced-scale placement box displayed on the software, and transmitted to the LED advertising machine through the Wi-Fi module, and the program display preview effect can be called at any time on the mobile client. For comparison treatment [8]. The display on the advertising machine is rich in content, and can basically cover all the playing content, such as text, forms, pictures, videos, and so on. The playing software is generally composed of the following parts: content editing, program playing, and corresponding simple daily application functions. The functional structure is divided into user interface, editing, playing, and hard and software setting mode function blocks. The overall software functional structure is shown in Figure 8.

4.3. Implementation of text and picture playback functions
In the LED advertising machine playback control software, in order to enhance the dynamic effect of the information displayed on the advertisement screen and attract the attention of the public, special effects such as telescopic, gradual, moving, rotating, etc. can be applied when playing pictures and texts. Phone-Gap technology provides very convenient CSS3 animation code, such as skew-l, rotate, shadow, etc., which can display the dynamic effect of text images. When implementing dynamic
playback effects, some obvious problems are often exposed. For example, when switching pictures or preparing the next video, the playback screen will flash a large area, and sometimes the screen will appear. Therefore, the system software is designed with double Buffering technology [10], the specific operation is to vacate an area in the system's memory for use as a background canvas, allowing related programs to be modified and drawn on the canvas. After the update is completed, the canvas directly covers the background of the display screen to achieve one display.

Figure 8. Software overall functional structure

4.4. Audio and video playback functions

The audio and video program is mainly based on the Phone-Gap platform, which provides a series of APIs such as Media, File, and Network to process media files in various formats, audio and video collection, and can process various common media formats on the market, including ASF, AVI, DV, MPEG, MOV, etc. According to the actual application, implement a complete Media playback function.

5. System test

This paper has initially completed the hardware and software design part of the LED advertising machine wireless control system, including the hardware module circuit design and software-related playback functions. In order to verify whether the LED advertising machine can be used safely and smoothly at the playing site, the wireless control system testing experiment is a key link in the design process. The system test needs to complete the control of the LED advertising machine by the software on the mobile client, and check whether the related functions such as the playing of the advertising machine and the editing of the software are normal, including the following aspects, including the Wi-Fi connection test, the software interface effect test, and the program. Experiments were carried out on images and so on.

5.1. Wi-Fi connection test
The test process is as follows: the mobile client is set to set the Wi-Fi connection interface, so that the Wi-Fi module and the mobile client of the wireless control system are in the same local area network, and the Wi-Fi scanning module can generally scan multiple Wi-Fi access points, and the control system is connected. A network called XMUT-WiFi is used as an example for a mobile client Wi-Fi connection, as is shown in Figure 9. If the mobile client cannot search the Wi-Fi module network, press and hold the reset button for 3 seconds to reset the system Wi-Fi module.

![Figure9. Phone’s Wi-Fi connection interface](image1)

![Figure10. Software interface function display](image2)

5.2. Software interface effect test
The interface generated by CSS3 in Phone-Gap technology has the characteristics of beautiful display effect and high user experience. The control of the two makes the layout and color matching of the application page reach the level of the native application UI [10]. As is shown in Figure 10, the function interface implements basic functions such as system occupancy system resource, volume and brightness control, program management, and screen white balance.

5.3. Program play test
In the field application, an 800*320 full-color indoor LED advertising machine was tested, and the software program playback management interface was opened. As is shown in Figure 11, the rectangular screen of the interface is also the scaled version of the LED advertising machine large screen. The mobile client reads the picture or video and places it in the rectangular screen of the software interface to adjust the size of the picture or video playing area. The effect is shown in Figure 12.

![Figure11. Software program play management interface](image3)

![Figure12. Current test chart](image4)

6. Conclusion
Based on the MT6589 chip structure of Cortex-A7 architecture, the hardware design of LED advertising machine wireless control system is carried out.

The cross-platform software design of mobile client is realized by Phone-Gap technology. Diversified text, picture and video playback, network automatic update Time and other versatile implementations to meet the needs of the majority of users.

The final test shows that the control system runs stably and has high reliability. The display effect of the LED advertising screen is clear. The software interface is intuitive to understand, and the user operation is easy to use, which greatly meets the market demand.

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8. References
[1] Ji X, Chen M and Li Z et al 2012 Wireless real-time LED display control system based on single chip microcontroller IEEE International Conference on Computer Science & Education 951-952
[2] Song Y, Feng Y and Ma J et al 2011 Design of led display control system based on AT89C52 single chip microcomputer Journal of Computers 6 718-724
[3] Yang F, Qin X F, and Zhai L B 2015. Control system and control method for automatic adjustment of outdoor led display brightness Lecture Notes in Electrical Engineering 331 613-619
[4] Chen M C, Ciou J Y and Jhang G S et al 2016 Led image display system with mobile app control Computers & Electrical Engineering 52 1-11
[5] Liu S M and Chou Y C 2014 Color calibration for a surrounding true-color led display system by pwm controls IEEE Transactions on Industrial Electronics 61 6244-6252
[6] Cui T W, Chen H and Gao Y et al 2014 Design of LED control based on Android Electronic Measurement Technology 37 102-124
[7] Zhang S K and Peng P 2015 LED display word stock update wireless research based on LPC2103 Video Engineering 39 107-110
[8] Yi P, Iwayemi A and Zhou C 2011 Developing zigbee deployment guideline under wifi interference for smart grid applications IEEE Transactions on Smart Grid 2 110-120
[9] Friedman R, Kogan A and Krivolapov Y et al 2013 On power and throughput tradeoffs of wifi and bluetooth in smartphones IEEE Transactions on Mobile Computing 12 1363-1376
[10] Bo C, Shuai Z and Tang H 2015 Wireless machine to machine monitoring using cross-platform smart phone for district heating Wireless Personal Communications 83 1229-1250