An Indoor Position Mechanism with Infrared Base Stations for Smart Mobile Devices

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ABSTRACT: The positioning and creative value-added applications have been used widely in our life, such car navigation, travel guide, etc. The global positioning system (GPS) is used mostly for outdoor applications. However, at an indoor environment, the GPS signals cannot be received well. The Wi-Fi or RF position technologies are used for indoor location applications mostly, but the estimated position is unstable and the position accuracy could not be accepted actually. This paper proposes an indoor position mechanism with IR base stations for smart mobile devices. The major components, IR base station and IR receiver, are design and implemented. Users can plug our IR receiver dongle into the headphone jack of their smart phone. The IR transmitter is directional and the receiving area is narrow. When a user stands under a certain IR base station, the ID of the IR base station is encoded into IR signals. The IR signals are received by our IR receiver dongle, and translate to audio signal. Finally, the user's smart phone records the audio signal from the headphone jack, and the ID of the IR base station is decoded. The current position would be decided. In our test result, the ID of IR base station can be decoded well.

1 INTRODUCTION

With the development of consumer electronics and communication network technologies, the positioning and creative value-added applications have been used widely in our life, such car navigation, travel guide, etc. The global positioning system (GPS) is used mostly for outdoor applications. However, at an indoor space, the GPS signals cannot be received well. The Wi-Fi or RF position technologies can be used for indoor location applications, but the position accuracy could not be accepted actually. Due to the RF characteristics, the received signal is variable and unstable. The current position point shown in the screen would drift. Moreover, the present smart phones are very powerful and provide several peripheries. Unfortunately, the build-in GPS, WiFi and Bluetooth could be used for indoor high-accuracy position estimation.

This paper proposes an indoor position mechanism with IR base stations for smart mobile devices. The major components, IR base station and IR receiver, are design and implemented. In our system, the users can plug our IR receiver dongle into the headphone jack of their smart phone. When the IR signals are received, the smart phone can decode the original IR signals with audio signal processing. Finally, the current position would be decided. In our test result, the ID of IR base station can be decoded well.

2 BACKGROUND

Infrared communication is the use of infrared technology to transmit signals in a wireless communication technology, the connection does not require an entity, simple to operate and achieve relatively low cost, and it is widely used in portable data communications equipment, such as: remote control ... etc.

Infrared Data Association (IrDA, Infrared Data Association) set up and establish a unified infrared communication standard in 1993, published in 1994, called infrared IrDA 1.0 SIR (Serial Infrared, serial infrared protocol) specification for an asynchronous, half-duplex infrared communication via the serial data waveform pulse compression and optical signal waveform received electric pulses extend this process to achieve encoding and decoding infrared data transmission. (HAAKE, J. et al. 2014)(PO-WEN, L. et al. 2012)

In our system, the simple components of IR LED and IR Receiver are used in our system. The sample rate of the IR receiver is 38kHz, and the IR wavelength is 940nm.

3 SYSTEM DESIGN

3.1 *System architecture*

Our System architecture is illustrated in Fig. 1. The major components are IR base station and IR receiver. The IR base station is identified by the 48-bits media access control address (MAC address), such as Ethernet MAC address. The IR base stations are deployed on the ceiling and broadcasting its base station ID frequently. Due to the narrow angle of IR directional transmission, the IR receiver area can be limited in a small range, e.g. 40cm to 80. The IR receiver area is dependent on the ceiling height.

The IR receiver is design as dongle for smart phones. The dongle can plug into the headphone jack of smart phones easily. The IR transmitter is directional and the receiving area is narrow. When a user stands under a certain IR base station, the ID of the IR base station is encoded into IR signals. The IR signals are received by our IR receiver dongle, and translate to audio signal. Finally, the user's smart phone records the audio signal from the headphone jack, and the ID of the IR base station is decoded. The current position would be decided. In our test result, the ID of IR base station can be decoded well.

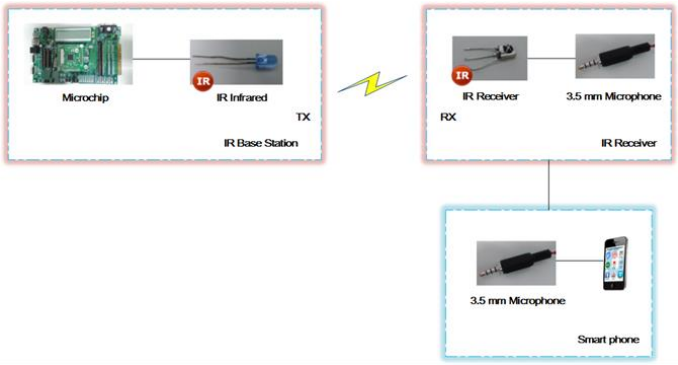

Figure 1. The system architecture.

3.2 *IR base station*

In the IR base station, the device is developed by a Microchip development board (APP1632) (ELMEDANY, W. M. et al. 2010). The simple circuit of IR transceiver is design and implemented shown in Fig. 2. The base station is identified by the 48-bits media access control address (MAC address), such as Ethernet MAC address. The base station ID is broadcasted per 1 second frequently.

The IR signals are produced by a Microchip microprocessor. 12 characters are produced within 1 second. The encoding MAC code is to use the negative edge of a 200μs and a 400μs positive signal edge signals are combined into one signal, shown in Fig. 3; and a negative edge signal a positive edge signal 200μs and 200μs constitute a total of 800μs two signals to signal 0, shown in Fig. 3. The MAC address is combined from 0 and 1 signals. The oscilloscope castrated signals of the complete MAC address are shown in Fig. 4.

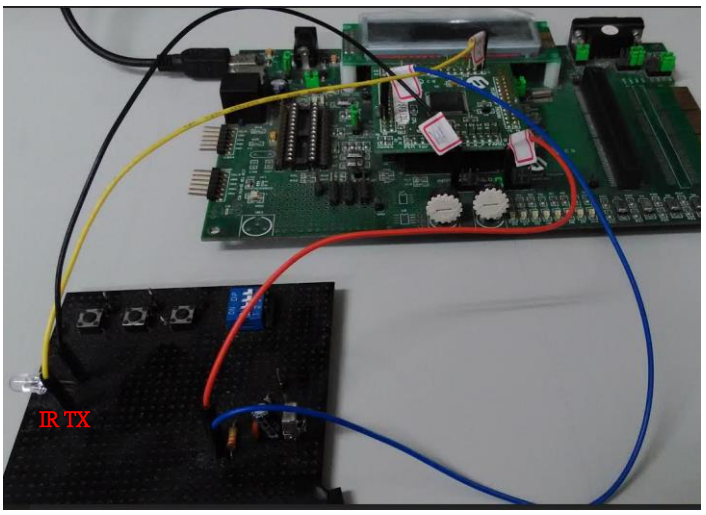

Figure 2. The prototype of IR base station

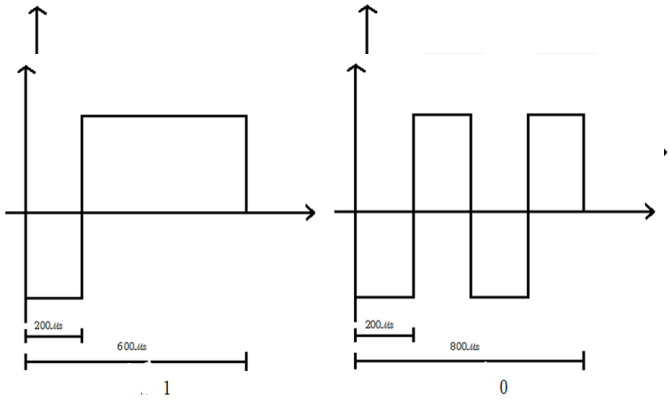

Figure 3. The signals of 1 and 0.

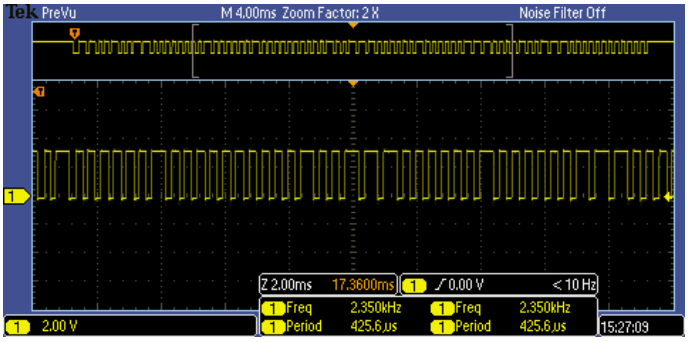

Figure 4. The complete MAC address captured from IR base station.

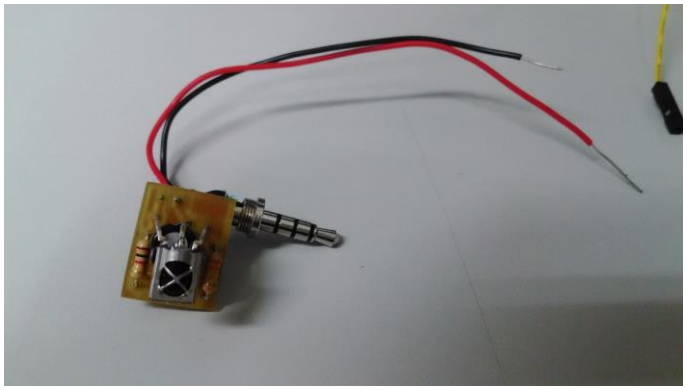

Figure 5. The prototype of IR Receiver dongle.

3.3 *IR Receiver*

The IR receiver is design for smart phones shown in Fig. 5, and the circuit is illustrated in Fig. 6. It is a small line-in dongle and connected to the smart phone with the headphone jack. The phone app of sound recorder and decoder is performed. The IR signal is recorded to sound data. Consequently, the sound data is decoded to the 48-bits IR base station ID. Finally, the smart phone can recognize the mobile device is located in which area of IR base station.

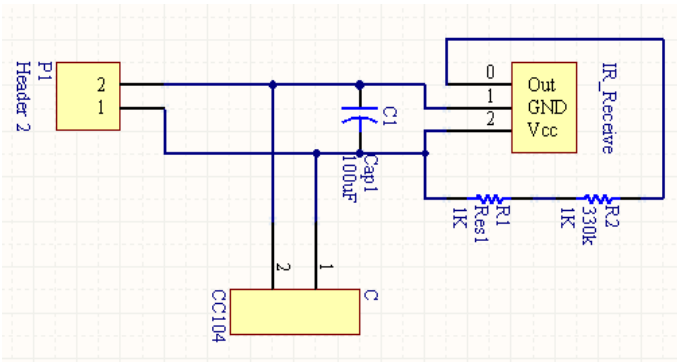

Figure 6. The circuit of IR Receiver dongle.

3.4 *Audio signal processing*

The part of the IR Receiver will transmit signals through the receiver will sound way to deliver value to the intelligent mobile devices, value after decoding receiver receives audio data, use the audio data will be analyzed infrared signals, in the sampling part of the sampling rate to 44100Hz, the sample size is 16bit, single-channel recording, and the data file is set to PCM (Pulse Code Modulation) lossless file format, so that the audio signal data maintained at optimum level and the original audio data access down to analyze file to WAV (Waveform Audio File Format) file format access music, so the sound quality present the best state, facilitate the reduction of audio data than the right. Figure 7 shows the recorded audio data signals.

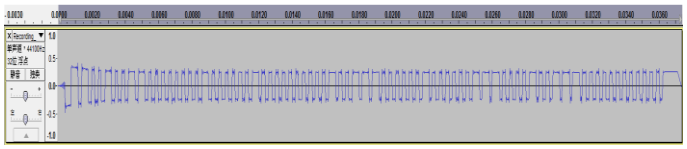

Figure 7. The recorded audio signals from smart phone.

In this experiment, the MAC code transmitter signals the complete coding of 1010, 1100, 0010, 0010, 0000, 1011, 1000, 1000, 1110, 0101, 1100, 0000 Fig. 7, this coding through hex conversion of AC: 22: 0B: 88: E5: C0, by this way can be a complete analysis of all of the MAC code out, use this method allows users to clearly understand all of the MAC code decoding.

4 SYSTEM TEST AND PERFORMANCE EVALUATION

4.1 *Receiving distance*

In the receiving distance test, we observed the relation of the receiving distance and received signal strength. The receiving distance is between the IR base station and the IR receiver dongle. The receiving distance is test with 0.5m, 1m and 1.5m. The test result is shown in Fig. 8. The x-axis indicates the receiving distance, and the y-axis means the receiving strength of the IR signals. The receiving signal strength is decreasing with the distance increasing. In the test result, we can observe that 1.5m is the acceptable distance. If we need support high ceilings environment, the IR transmitter power should be fine-tuned or the higher power IR LED should be replaced.

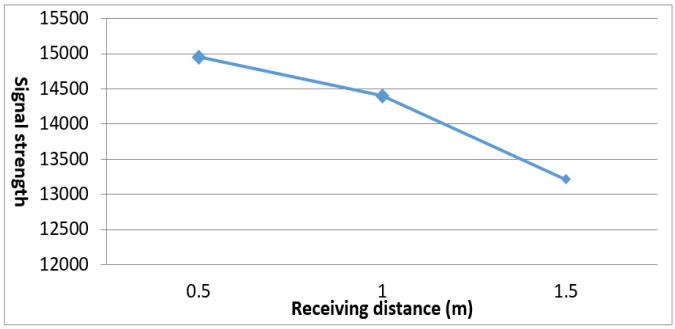

Figure 8. The relation of the receiving signal strength and the receiving distance.

4.2 *Decodable ratio*

The relation of the receiving distance and decoding result is shown in Fig. 9. The y-axis indicates the receiving distance, and the x-axis means test times. The orange bar means the times of decoding failure, and the blue bar indicates the times of decoding success. In the result, we can observe that the IR is affected by the environment easily, such as receiving distance, light, etc.

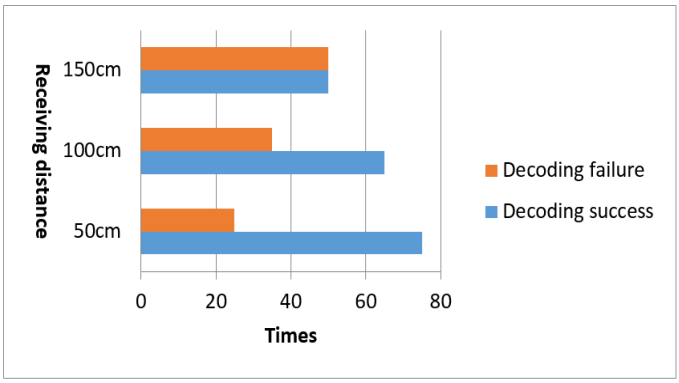

Figure 9. The relation of the receiving distance and decoding result.

5 CONCLUTION

This paper proposes an indoor position mechanism with IR base stations for smart mobile devices. The major components, IR base station and IR receiver, are design and implemented. Users can plug our IR receiver dongle into the headphone jack of their smart phone. The smart phone can indicate that it locates in which IR base station.

The indoor position mechanism was approached. In our test, if the mobile device moves into the IR area, the IR base station ID can be decoded well. In the future, several IR base stations should be deployed at each hot area. The value-added position applications could be approached, such as indoor navigation for museums and markets.

6 REFERENCE

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