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Fabrication of the kinect remote-controlled cars and planning of the motion interaction courses

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Abstract

This paper describes the fabrication of Kinect remote-controlled cars, using PC, Kinect sensor, interface control circuit, embedded controller, and brake device, as well as the planning of motion interaction courses. The Kinect sensor first detects the body movement of the user, and converts it into control commands. Then, the PC sends the commands to Arduino control panel via XBee wireless communication modules. The interface circuit is used to control movement and direction of motors, including forward and backward, left and right. In order to develop the content of Kinect motion interaction courses, this study conducted literature review to understand the curriculum contents, and invited experts for interviews to collect data on learning background, teaching contents and unit contents. Based on the data, the teaching units and outlines are developed for reference of curriculums.

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1. Introduction

After Microsoft launched Kinect gesture sensors and the SDK, the Kinect motion technology has been combined with PC to apply new man-machine interface to daily life field, such as education, medical care, entertainment, sports, demonstrations and many other innovated applications. In most past applications, virtual objects in software are operated by Kinect gesture controllers via gesture action, such as roles of body controlled video games. In recent

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years, applications of control hardware in Kinect gesture technology have increased. The Kinect remote controlled car discussed in this paper is an application example.

Kinect remote controlled cars are derived from commercial remote toy cars. In the car body, Arduino control panel and interface control circuits are installed to control rotating direction of front and back motors of the car (Chang, Chen, & Hung, 2011). XBee wireless communication modules are installed to receive control signals from PC terminal. In combination with PC, Kinect gesture controller, XBee wireless communication modules, Arduino control panel and interface circuits, Kinect gesture sensors can extract skeleton information to fulfill movement and direction of the toy car, forward, backward, left and right.

In the future, many industries will need many tech talents who are familiar with the gesture control technology. We also plan teaching contents of the motion interaction, and provide reference for the relevant curriculums.

2. Implementation of Kinect remote control car system

Action of Kinect remote controlled cars is to use Kinect sensors to detect motion information, and convert it into control commands. Next, the computers send commands to Arduino control panel via XBee wireless communication modules. Next, the interface circuit drives motors for direction control. The hardware architecture of the Kinect remote controlled car is shown in Figure 1: comprising PC, Kinect sensor, XBee Explorer, XBee wireless communication module, Arduino control panel, interface circuit and actuating device (motor), and the description is as follows:

![Fig. 1. System architecture of Kinect remote controlled cars](image)

2.1. Kinect sensors

As shown in Figure 2, the Kinect sensor consists of three camera lenses, and in the middle there are common RGC color camera lens which can be used to identify identification or facial expression features of users. It can be also applied to augmented reality game and video calls; the left and right camera lenses are 3D depth sensor consisting of infrared transmitter and infrared CMOS camera (Filipe, Fernandes, Fernandes, Sousa, & Paredes, 2012). Kinect mainly uses 3D depth sensor to detect user motion. Kinect has the tracking function where the motor base can rotate with movement of focusing (Dutta, 2012). In addition, Kinect also has built-in array microphone system consisting of four microphones, provides noise function, and eliminates noise after radio comparison.
2.2. Arduino control panel

Arduino is an open microcomputer control panel. Due to low price, easy-to-use software development tool and rich network resources attract many engineers and interactive designers to design various novel and interesting interactive devices. Arduino UNO control panel in installed in Kinect remote controlled car (Ngheim, Auvinet, & Meunier, 2012). Eight-digit ATMEGA328 micro-controller is used as core, which provides 14-digit I/O terminal and 6 comparison I/O terminals, and supports USB data transmission. The users can connect different electronic devices on digit I/O terminal.

2.3. XBee wireless communication module

XBee is wireless communication module of Digi firm based on IEEE 802.15.4, with working voltage of 3V. During use, X-CTU software must be performed to set XBee module parameters (Raheja, Chaudhary, & Singal, 2011). The point-to-point data transmission is used between PC and the Kinect remote controlled car. The parameter setting is shown in the Figure 3. The set Id of Xbee module of transfer terminal and receiving terminal is the same, and the baud rate is set to 9600bps. DOUT pin of XBee module on the Kinect remote controlled car is connected to RX pin of Arduino, and DIN connects TX pin. After detection of control gesture of users, Kinect sensor converts it into control command through programs. XBee wireless communication module of PC terminal sends the control command to XBee wireless receiver module connected to the Arduino control panel. At last, Arduino control panel drives the motor of the toy car according to the received control command to fulfill the action.
2.4. Interface circuit

The interface circuit core is L293D control core in which two H-Bridge circuits are arranged for control of rotation direction of front and rear DC motors (Xia, Chen, & Aggarwal, 2011). The power supply shall separate MCU from motor to prevent instability of circuit work.

2.5. Kinect motion control process

Kinect application program can set Kinect sensor parameters through NUI Library, and extract sensor information, including: colored image information, depth image information and audio information (Frati & Prattichizzo, 2011), as shown in Figure 4.

![Diagram of Kinect motion control process](image)

### Table of Control Actions

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<tr>
<th>Action</th>
<th>Description</th>
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The control programs of remote controlled car are based on C# language. C# is an Object Oriented High-Level Computer Language launched by Microsoft based on (Yen, Suma, Newman, Rizzo, & Bolas, 2011). NET frame. The control programs define human skeleton nodes by the Kinect sensor as control command of remote controlled cars through Kinect sensors for direction control of remote controlled cars (Norman, Dale, & Bret, 2011). The control actions of the remote controlled cars are summarized in the following table:
Table 1. The control actions of the remote controlled cars.

<table>
<thead>
<tr>
<th>Gesture</th>
<th>Action of remote controlled cars</th>
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</thead>
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<tr>
<td>Lift left hand</td>
<td>Forward</td>
</tr>
<tr>
<td>Lift right hand</td>
<td>Backward</td>
</tr>
<tr>
<td>Extend right hand horizontally</td>
<td>Turn right</td>
</tr>
<tr>
<td>Extend left hand horizontally</td>
<td>Turn left</td>
</tr>
<tr>
<td>Put down your hands</td>
<td>Stop</td>
</tr>
</tbody>
</table>

3. Course planning

As interactive motion technologies are applied and needs of talents increase, most of universities and technical colleges lack the curriculum planning based on Kinect interactive motion technology. Thus, we conducted expert interview survey to collect learning background, textbook contents and units of the curriculums, and formulated the course units and syllabus based on the collected data. The course is experiment teaching. The course contents can be divided into theory and experiment, which can be described as follows:

3.1. Theory: introduce Kinect sensor, embedded microprocessors, and basic architecture and principle of C# language.

3.2. Experiment: The experiment includes:

- Control the tilt angle of Kinect base: use a simple method to connect application programs with Kinect sensor, and change Kinect sensor tilt angle through Kinect SDK standard library.
- Audio signal processing: identify and record the audio locations, voice recognition and voice synthesis.
- Colored image signal processing: learn color image stream processing and application.
- Depth stream processing: understand format and application of depth stream.
- Apply skeleton tracking function: obtain human skeleton coordinate information, and send the skeleton information to the application programs for advanced application.
- Serial communications for PC and embedded controllers: PC connects embedded controller through USB port. After conversion, it is connected with the two I/O PINs which is used as signal transfer pin (Tx) and receiver pin (Rx) to achieve serial communications.
- Switch ON/OFF light: Kinect voice recognition function is combined with embedded controller to control light switch.
- LED light display control via gesture: It is divided into different gestures. Kinect sensor detects movement positions of users’ arms, calculates spatial coordinates and controls several LED light display.
- Hand gesture controls rotation and rotating speed of motors: Different gestures are used to sense Kinect sensor to send human skeleton information to control rotation direction and speed of motors.
- Gesture remotely controlled toy cars: Kinect sensor uses different gestures for direction of remote controlled toy cars.

4. Conclusion

Application and development of Kinect motion technology have been gradually penetrated into daily life, and have better perspective. The interactive course design and Kinect remote controlled cars can make students learn structure and working principle of Kinect sensors, PC control program design, signal transmission, interface circuit design, and embedded controller design technology to train students’ abilities of integrating systems, and train professional talents who are familiar with Kinect motion control.
References


