Real-Time Interaction System of Human-Robot with Hand Gestures

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Abstract

With the declining birthrate and the aging population, the shortage of labor has become more obvious. Therefore, the teleoperation of the robot as the substitute of human labour have become popular. In this study, an application of real-time gesture-based human-robot interaction is proposed using a Kinect sensor for elderly care. By employing gesture-based teleoperation of robots, demands, and conditions of the elderly such as sudden falling and the abnormality can be quickly recognized. The robot used in this study, iRobot Create, is a popular mobile robot for indoor usage which will recognize the following gestures: right-hand raising, left-hand raising, right-hand waving, and left hand waving, in corresponding to the control the robot's moving forward, backward, right turn, and left turn, respectively. Experimental results shown that the four types of gestures can be recognized by the iRobot Create with human gestures captured by the Kinect sensor. The corresponding actions in real-time were realized through the designed gesture-based remote human-robot interaction system. The experimental results are also can be seen from the Youtube channel.

Keywords: gesture recognition, teleoperation of robot, elderly care

Introduction

In recent years, as the population decreased, many problems have begun to arise, such as wage increases due to insufficient labor. Fewer elderly people can be accompanied by an aging society. Robot technology has appeared to support the work required by simple and repetitive labor. Hence, more companies are investing in robot researches and manufacturing. Robotics researches have become one of the most important future trends in an aging society. Robot technology has gradually developed from industrial applications to diversified professional fields. The robot can be seen everywhere in life such as in the medical and nursing industries. Yet, there is also a lot of room for the development of robotics. Nowadays, the lack of medical resources becomes serious, especially in the caring manpower. It is difficult for nursing workers to concentrate on the rehabilitation of multiple patients at one time. In this aspect, the caring robot can be designed to accompany and take care of the elderly. Robotics seems to provide a resolution for the shortage of caring people at home, hospital, and nursing institute. Hence, a real-time human-robot interaction system using hand gestures is proposed in this study. iRobot Create [1] is a programmable circular robot. It can easily load a variety of programs and reflect the user-designed results. Kinect sensor [2] was originally used for Xbox 360. The Kinect sensor integrates games into the home entertaining lives in an amazing way. When the player stands in front of the Kinect sensor, the Kinect sensor automatically detects the player's movement and presents the movement data to a corresponding screen according to the player's posture. One can experience the gesture-control method of waving hands and feet. In this study, the Kinect sensor is integrated with the iRobot Create robot in real-time according to human gesture instructions.

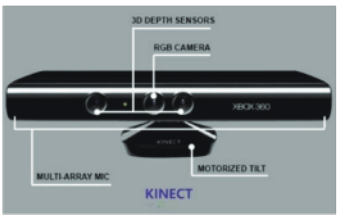
Methodology

The basic caring for the elderly or patients gives patients the assistance they need for a long period. Therefore, human-robot interaction methods allow robots to assist the elderly or patients in real-time at home, hospital, and nursing institutes. However, it takes time to observe the daily actions of patients to coordinate with the writing of the program for caring robots. It might consume a lot of manpower and time for the development of human-robot interaction methods. From the above point of view, three main functions are designed for the real-time human-robot interaction system using hand gestures.

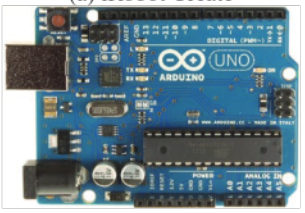
1. The robot can react to human actions by employing the Kinect application [4][5]
2. Basic actions required by the user's instructions can be performed by using iRobot Create.
3. Let the actions of iRobot Create match human needs

A. Development environment and tools

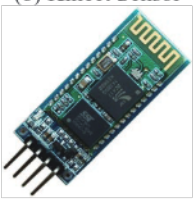
(a) iRobot Create



(b) Kinect Sensor



(c) Arduino UNO board



(d) HC-06 Bluetooth module

Fig. 1 Hardware used in this study.

Figure 1(c) shows the Arduino UNO board. Arduino is a microcontroller development board based on ATmega328P. It has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog input pins, 16 MHz crystal oscillator, USB connection, a power jack, ICSP connector, and reset

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button. They are connected to the computer with a USB cable or use an AC-to-DC interface card or battery to power it and start using it. In this study, Arduino UNO uses PIN10, PIN11, 5V, and GND to connect with iRobot Create, as shown in Fig. 2. Arduino UNO board is then used to control iRobot Create [3].

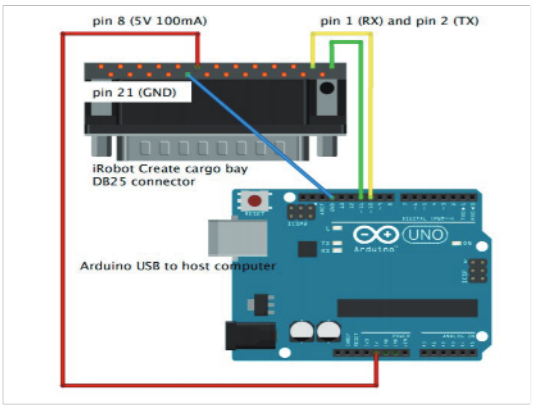

Fig. 2 Schematic diagram of the connection between Arduino UNO and iRobot Create.

Figure 1(d) shows the HC-06 Bluetooth module. The HC-06 allows original equipment to get rid of the cables and realize wireless communication within 10 meters. Then, the Bluetooth module and the development board are connected to the power supply and then paired with the computer to start communication. Figure 3 shows a schematic diagram of the real-time human-robot interaction system using hand gestures.

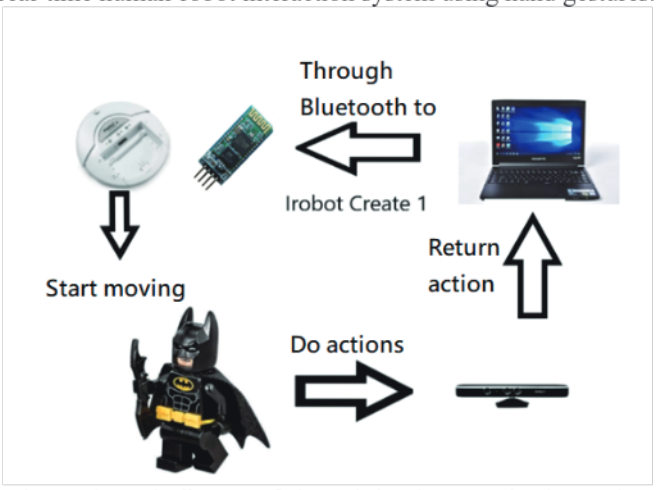

Fig. 3 Schematic diagram of the real-time human-robot interaction system using hand gestures

At the beginning, the target person acts against the Kinect sensor. If the Kinect successfully receives the action of the person, it returns a specific signal to the computer representing the value of the computer keyboard pressed, and the computer then corresponds to the different keyboard values. The instructions are sent from Bluetooth to Arduino UNO via the HC-06 to drive iRobot Create for different actions. Figure 4 shows the operation flow chart of this iRobot control system, which is written in C language in Arduino UNO.

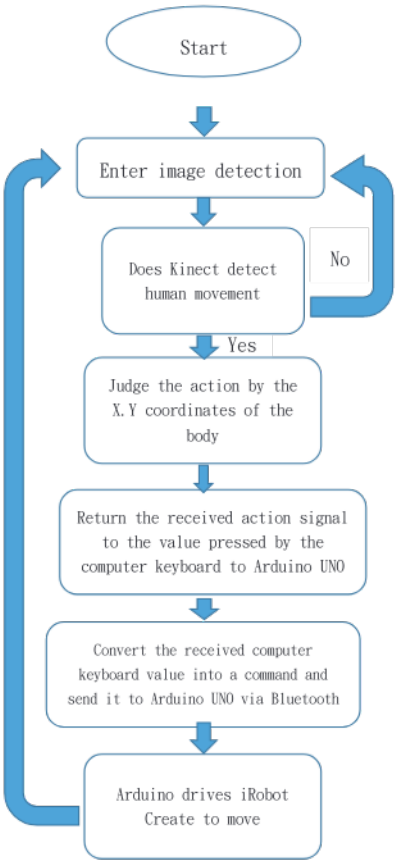

Fig. 4 The operation flow chart of the iRobot control system.

Figure 5 shows the flowchart of the gesture recognition system using the Kinect sensor.

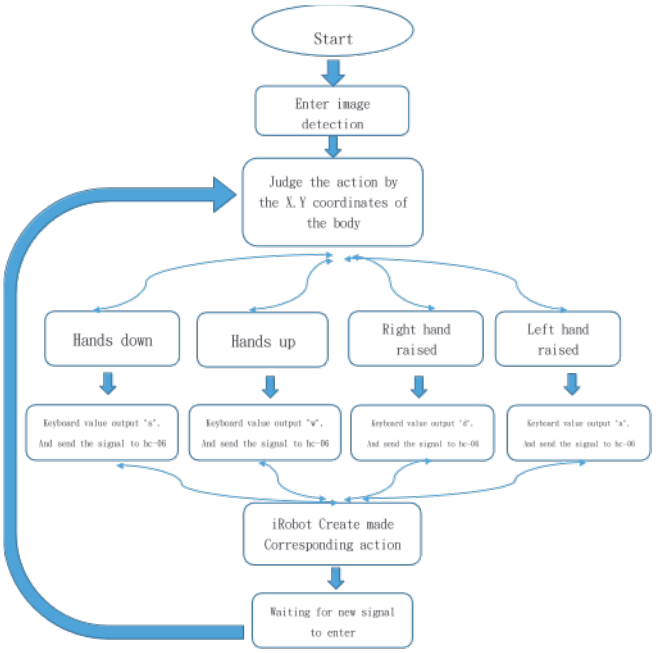

Fig. 5 The flowchart of the gesture recognition system using the Kinect sensor.

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Experimental results

A. Results

Figure 6 shows the result of raising the right hand and making the iRobot Create to turn right.

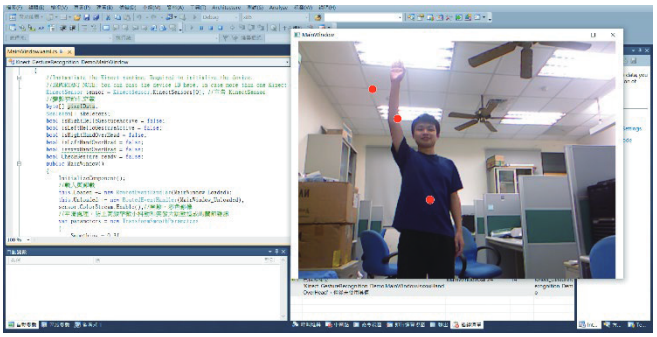

Fig. 6 The instruction to raise the right hand to make the iRobot Create to turn right

Figure7 shows the results of raising both hands to make the iRobot Create to move forward.

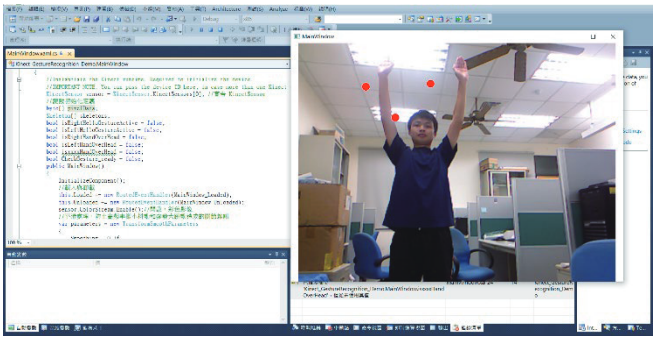

Fig. 7 The instruction for raising both hands to make the iRobot Create to move forward

Figure 8 shows the result of raising the left hand to make the iRobot Create to turn left

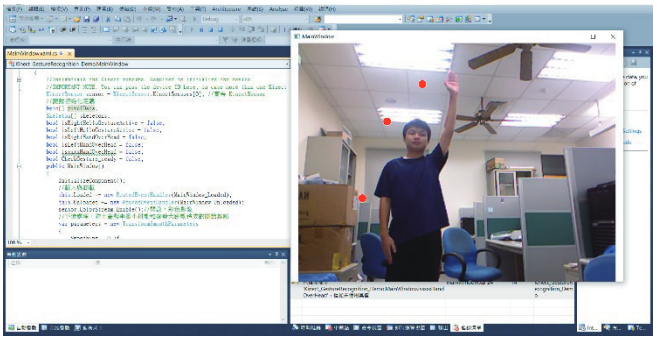

Fig. 8 The instruction to raise the left hand to make the iRobot Create to turn left

Figure 9 shows the result of putting both hands down to make iRobot Create to stop moving.

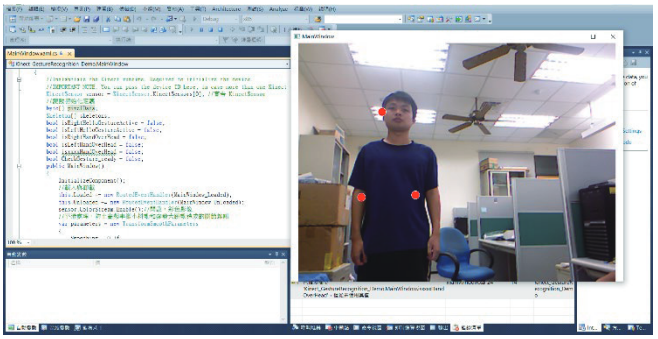

Fig. 9 The instruction to put both hands down to make iRobot Create to stop moving.

The video of the developed real-time human-robot interaction system using hand gestures will be placed on the Youtube channel as well.

B. Difficulties encountered and solutions

In the beginning, a HC-05 is purchased during the Bluetooth connection test, but it fails no matter how the connection is made. Various methods are tried for a month and the Bluetooth communication still does not work. Finally, the HC-05 is replaced with an HC-06, and the Bluetooth communication was successfully connected after a few trial and error.

Conclusion and future work

This study provides a preliminary idea for using robots to help the elderly or patients overcome the lack of nursing manpower. The designed system can reduce the workload of nursing and social workers and overcome medical manpower for a society with limited manpower. Similar concepts of robotics can be applied to other areas, such as education and entertainment. There is relatively little information on controlling the iRobot Create using Arduino UNO. Thus, Arduino is used to control the iRobot Create in C language. The gesture recognition system with a Kinect sensor required C# programming language using Microsoft Visual Studio. The designing process and system integration developed the real-time human-robot interaction system using hand gestures.

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