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Music Hugging Robot Based on Arduino

Yuankun Dong[1, *]

[1]Beijing Guangqumen Middle School, Beijing, China
**Corresponding Author*

Abstract: *Depression is the most common depressive disorder and is also prevalent worldwide. People with depression may experience symptoms such as depressed mood, anxiety, delusions, malaise, and may even develop suicidal tendencies or behaviors. This paper expects to provide a new approach to depression counseling using robotics. With the increasing importance of robots in human life, people are beginning to pay attention to other capabilities beyond their traditional intelligence, such as empathy. Based on the field of emotional service robots, this paper designs and manufactures a service robot that can play soothing music and provide warm hugs to patients with depression, using Arduino microcontroller as the control core, and C++ programming and mechanical design techniques. The music hugging robot combines artificial intelligence with humanistic care to heal patients with music and hugs, which can alleviate patients' depression to some extent. It is believed that this technology can provide intelligent assistance to counselors and their related personnel.*

Keywords: *depression, robot hug, music*

1. Introduction

1.1. Origin of the topic

The author's grandfather had depression and gradually recovered after a period of active treatment, so the author understands the pain and misery of depression patients. Many students around the author showed symptoms of depression in the high-pressure academic competition at other stages of advancement, such as ninth grade. When the author felt depressed, the author would choose to listen to soothing music to reasonably vent his emotions and would also long for warm hugs from family and friends. Therefore, the author wanted to use technology to combine the two and provide depression patients with the help they can.

1.2. Research Background

Prolonged depression can lead to dysfunction and therefore requires aggressive treatment. However, the social discrimination against depressed people and a large amount of money and effort involved in the treatment process make most patients reluctant to seek help. Mental health has gradually become a significant social concern and an important element in the progress of national civilization. It is an essential direction for the authors to study how to provide scientific and technological support for mental health by adopting new-generation information technology. Due to this scientific significance, this paper chooses to study robotic methods and technologies geared toward mental health services, seeking to provide intelligent digital aids and tools for mental health services.

There are still many scientific problems in the field of service robotics that have not yet been fully solved, and there are also very many key technologies involved. For example:

1) A study of affective control models for multiple actuators with transition processes.

2) The Turing test method was generated by mental health services to make a service robot and try to see which counseling examiner can pass her test.

3) Research on the content of intelligent dialogue libraries for emotional service robots (teachers, doctors, counselors) with specialized knowledge education (1. direct matching of dialogue libraries; 2. establishment of dialogue patterns with machine learning, knowledge graphs, etc., after formalization of databases).

4) The methodological and technical level of artificial intelligence and artificial mental health

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services is reflected. These are important research directions for service robots and require continuous research on them.

Sensing technology has made it easy to convert real-world transformations into readable electrical signals with the continuous development of sensors, network technology, and integrated chip technology. Arduino Uno is a common development board in the field of technology and innovation. Arduino can interact with sensors and complete the corresponding commands based on different electrical signals to interact with the user.

Ultrasonic distance measurement module HC-SR04 is a kind of sensor that measures distance by ultrasonic technology. The module has strong anti-interference ability, a wide measurement range, and simple operation, so it is widely used in the field of measurement and mapping.

In addition, the authors have used sound playing components as execution modules. The Arduino can directly control the MP3 module to play out the programmed specified music, which is easy to operate and highly developable.

In order to achieve a lightweight design for the robot, lightweight materials were used for the filling of the hands. In practice, the authors used a polyurethane foam foaming machine to add foam to wooden rods to form foam, making the part of the robot that comes in contact with the user flexible and lightweight.

As for the arm joint, a servo is used. The servo is a position servo driver for control systems where the angle needs to be constantly changed and maintained, and the Arduino development board can easily output PWM signals with different duty cycles to control the angle of the servo rotation.

2. Program Design

2.1. Hardware Design

1) Arduino

Figure 1: Arduino

The Arduino hardware board consists of a microcontroller IC, a set of buses for connecting other circuits, several voltage regulator ICs for powering the entire circuit, and a USB for connecting to a computer. The Arduino software includes a text editor that developers can use to write and modify programs and write them to the Arduino board. This is how the authors used to program the Arduino to accomplish the control of the robot.

The Arduino board used by the authors is the Arduino Uno R3. As shown in the figure below, it has 14 digital input/output pins (6 of which can be used for PWM output), 6 analog input pins (for connecting sensors that output analog signals), a 16 MHz crystal oscillator, a USB interface, a DC interface, an ICSP interface, and a reset button. It contains everything you need for a microcontroller, and you can drive it by simply connecting it to your computer's USB port, or by using an AC-DC adapter, or by using batteries.

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2) MP3 module

Figure 2: MP3 Module

The MP3 player uses a Digital Signal Processor (DPS) to handle the task of transferring and decoding MP3 files. The DPS is responsible for the data transfer, device interface control, file decoding, and playback activities of the Walkman. DPS is able to perform multiple processing tasks in a very short time, and the process consumes very little energy, which is a distinctive feature that makes it suitable for portable players. A complete MP3 player should be divided into several parts: central processor, decoder, storage device, host communication port, audio DAC and amplifier, a display interface, and control keys. Among them, the central processor and decoder are the core of the whole system. Here the central processor authors usually become MCU (monolithic microprocessor) or microcontroller for short.

3) Servo YF-6130MG

The robot's joint prime mover is a servo motor, and it becomes a challenge to drive the servo motor to a predetermined angle. Generally speaking, the traditional control method is that the microcontroller uses the internal timer to generate PWM waves, which are sent to the servo motor signal line to complete the drive of the servo motor. It is important to note that the servo motor needs to be co-grounded with the microcontroller to achieve a pure and stable signal.

Figure 3: YF-6130MG

The rudder plays an important role in the model and automatic control. It is a set of automatic control systems consisting of a DC motor, reduction gear set, potentiometer, and control board. By sending a signal, the output shaft rotation angle is specified. Servo, generally speaking, have the maximum rotation angle, and ordinary DC motor difference is mainly in, DC motor is a circle of rotation, the servo can only turn within a certain angle, can not achieve turnover.

4) Ultrasonic sensors HC-SR04+

The ultrasonic sensor is a sensor developed by using the characteristics of ultrasonic waves. Ultrasound is a mechanical wave that vibrates at a frequency higher than that of sound waves and is generated by a transducer chip that vibrates under the excitation of voltage. It has the characteristics of high frequency, short wavelength, small bypassing phenomenon, especially good direction, able to become a ray and directional propagation. Ultrasonic probe mainly consists of a piezoelectric chip, which can both transmit and receive ultrasonic waves. The low-power ultrasonic probe mostly does the detecting role. Connected with Arduino, the distance measurement data can be read on the serial monitor.

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The SC-SR04+ ultrasonic module is selected, which has the following features:

Adopt high-end op-amp SGM324, which makes HC-SR04+ have wider operating voltage (3.3V-5V)

Smaller operating current (3mA) at the same measurement range

Software and hardware fully compatible with the current HC-SR04

Figure 4: SR-04

2.2. Software Design

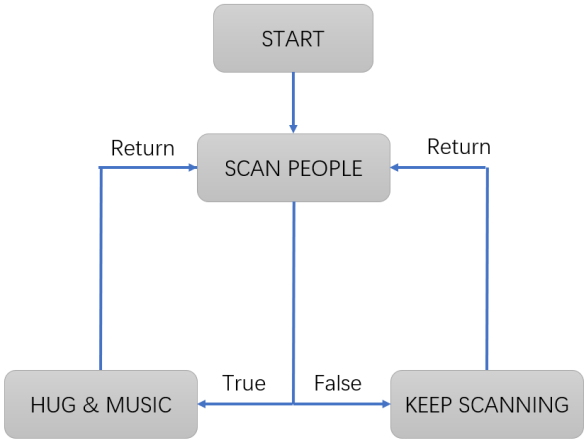

Figure 5: Software

The basic logic link of the program is: control the ultrasonic module for real-time scanning, and when the distance is closer than 10cm for a certain time (to avoid misreading), the robot controls the servo movement, and the joints move inward for hugging and use MP3 for hugging at the same time.

The logic of the program is relatively simple to judge, and the main work lies in the calling and control of sensors and actuators. Where the ultrasonic module is transmitted using the I2C protocol, the I2C (Internal Integrated Circuit) is created to provide a simple way to transfer digital information between the sensor and the microcontroller (e.g., Arduino). The MP3 module has an independent controller, which plays according to the stored content of the SD card and only requires Arduino to power it. The servo module is controlled by Arduino outputting a 50 Hz PWM wave with a corresponding pulse width of 0.5ms-2.5ms, corresponding to 0 °to maximum degrees of the servo.

2.3. Production process

First of all, the author followed the instruction and drew the floor plan using AutoCAD software, cut out the required wooden boards with a laser cutter, cut aluminum, and gold materials, and used these materials to build the upper half of the robot's body. Then the tiller box was drawn with AutoCAD to carry the tiller and assembled and spliced with screws and nuts. Two servos made shoulder joints, two servos made elbow joints, and connected with wooden sticks to make two arms. By programming, the hugging action was realized. Next, the author added ultrasonic sensors and MP3 modules under the guidance of the teacher to achieve automatic hugging and playing music when the distance is within 10cm. Finally, a layer of soft padding was applied to the periphery of the arm, filled and fixed with a bubble gun, and finally, a suit was applied.

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2.4. Finished product display

Figure 6: Product Display

3. Conclusion

In the end, the authors combined the knowledge of mechanical design and embedded development to create a robot that helps depression patients regulate their emotions through hugs and music. The robot is made of light wood panel and aluminum gold material, and the whole body is light. Equipped with ultrasonic sensors, it can realize automatic hugging by approach. It is believed that robots can be very helpful for depression patients to relieve their anxiety. At the same time, as a group of teenagers, actively expressing concern for depression patients can also guide experts in the field of robotics to develop more effective emotional service robots. The authors always believe that robotics can serve humans well and accomplish things that are not possible for humans.

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