The Production and Research for Humanoid Robot

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Abstract— **Humanoid robot that has always been a dream for humankind to develop has the external behavior of human beings, human intelligence and flexibility, the ability to communicate with people and constantly adapt to the environment. It is humanoid robot that is designed to imitate. The morphology and behaviour are from human. Generally, it has the humanoid limbs and head. We have produced the humanoid robot by CAD software and designed the robot's structures according to human. The control panel consists of CycloneⅡand MSP430.It can be achieved to control the robot dancing movements by comprehensive programming.**

Keywords— **simulation; communicate; Msp430; comprehensive; humanoid robot**

I. THE RESEARCH BACKGROUND OF HUMANOID ROBOT

It has always been one of human dreams to develop the humanoid robot, which not only possesses human intelligence and flexibility, but can communicate with people and make itself adapt to the environment constantly. Humanoid robot is designed to imitate the morphology and behavior of human. And generally, it has the humanoid limbs and head.

Humanoid robot is the most ideal robot that can interplay with people. The mode of thinking and behaving as well as appearance will be more similar to humankind. Humanoid robot which includes computer science, information technology, sensor technology, electronic technology, control theory, artificial intelligence theory, mechanical science, cognitive science, thinking science, psychology, theoretical linguistics, philosophy is widely used in the production and life. What's more, it also stands for a country's level of development of high-tech. The aim for researching is to create the advanced intelligent robot. As a new tool, it has some specific human features(like walking, sense, thinking and judging etc).In some degree, it can replace humans in particular work to serve humanity. At the present stage ,the research applications of robots continue to expand, and the research and application of humanoid robot gain the particularly widespread attention, and become the most active research focus in the field of intelligent robots.

Humanoid robot research has made breakthroughs in many areas, like the key mechanical unit, the basic ability of walking, global motion, dynamic vision. However, it's still far from the ideal requirement, the further research should focus on the aspects of the ability of thinking and learning, the interaction with environment, body structure, limbs movement and the architecture. From the current research situation of robotics and artificial intelligence, it is still hard to achieve the humanoid robot with High intelligence and high flexibility .What's more, the limitations of the understanding of human also limits the development of humanoid robots.

II. ANALYSIS OF DOMESTIC AND INTERNATIONAL RESEARCH

The research of humanoid robot began in the late 1960s,only has thirteen years' history. However, it has the rapid development. Many scholars are engaged in research in this field, and it has become one of the main directions.

A. America

In 1968, R.Smosher tried to invent a biped robot-operated machinery called "Rig", which opened a prelude for the development of humanoid robots.

B. Japan

In 1968, professor Ichiro Kato in Waseda University., commenced work on the development of the biped robot in Japan. In 1969,he invented WAP21(Waseda Auicmatic Pedipulator) plane freedom walking machine. This robot possesses six degrees of freedom, each leg has three joints that is made by the artificial rubber muscles including hip, knee and angle .It can move by joint movements which is dragged by the muscle contraction caused by exhaust and gas injection. However, this robot is not stable because of the scalability of gas. In 1971, Ichiro Kato invented WAP23 biped robot, drived by artificial mscle. It has 11 degrees of freedom, can walk in flat, slope and ladder .In 1971,Kato Laboratory developed WL25 biped walking robot with 11 degrees of freedom, drived by Hydraulic pressure. It can achieve the center of gravity moving around by legs for three-dimensional motion and body for swing around. The robot weight 130kg, height 0.9m,load

30kg,achieved the smooth dynamic walking of 15cm a stride and 45s each step. In 1973, professor Kato made the autonomous robot by deploying manipulator, artificial vision and hearing device based on WL25 robot.

In 1980, Kato developed WL29DR (Dynam's Refined)biped robot. This robot uses the control method by pre-designed the walking style, using motion analysis and repeated walking gait trajectory design of experiments to control the robot's walking motion. This robot uses quasi-dynamic walking programs that uses the single support period as static state, feet switching as dynamic to achieve the quasi-dynamic walking of 45cm a stride,9s each step .In 1984,Kato laborary developed WL210RD biped robot controlled by torque of ankle.It achieved the stable dynamic walking of 40cm a stride,1.5s each step.In 1986,Kato laborary successfully developed the WL212(R) walking robot. The robot through the body motion to compensate for any movement of the lower limbs, in the balancing effect of the body to achieve the flat dynamic walking period 30cm.

C. China

Harbin Institute of Technology began to develop the biped walking robot from 1985, based on control theory they have won Natural Science Foundation and the National "863" program support, and completed three models of development work so far.

The first model HIT2É has 10 degrees of freedom, weight 100kg, high 1. 2m, joints driven by a DC servo electrode, a static walk.

The second model HIT2Ê has 12 degrees of freedom, the structure of hip and leg is parallelogram.

The third model HIT2Ë has 12 degrees of freedom, the ankle using two motors cross structure, while achieving two degrees of freedom, the leg uses a cylindrical structure. HIT2Ë achieved the static and dynamic walking, can complete front ö underwent lateral line, turning, up and down stairs and upper slopes and other activities.

Currently, Robotics Institute of Harbin Institute of Technology and Mechatronics Engineering Department are cooperated to develop a fully functional humanoid robot HIT2Ì .This robot includes walking institutions, upper body and arm actuators, initially set at 32 degrees of freedom.

National Defense University also have done some research in this area . In 1989,they successful developed a biped walking robot which has 10 degrees of freedom, can completed the static and dynamic walking. Tsinghua University, Shanghai Jiaotong University, Beijing University of Aeronautics and Astronautics and other universities and research institutions are also invested considerable human and material resources to develop the intelligent humanoid robot in recent years.

III. Theoretical Basis For The Design Of Humanoid Robot

A. design philosophy

This work uses FPGA and MSP430 control board to communicate with each other through SPI bus .By tuning method, based on the object characteristic changes automatically tuning parameters, the control system has a stable robustness to the consolidated performance of the control system, which is used to ensure the robustness of the control state is used to ensure that the control system is safe and reliable operation. Our humanoid robot with serial peripheral interface principle, FPGA-based fast computation ability to achieve the FPGA and MSP430 communication control, the experimental results well.

B. Functions and principles

After the design freedom of the robot, based on the design by the corresponding action, using characteristics, through the setting operation, based on the operation, the robot can be self-corrected.

C. The communication with MSP430 and FPGA

SPI bus: The basic signal line of SPI bus is 3 transmission lines, called SI、SO、SCK.Transmission rate determined by the clock signal SCK, SI is the data input, and SO is the data output. The system using the SPI bus is shown in Figure 8-27,It contains a main piece and some s.Main piece issues chip-select signal-CS to control which subordinative piece should communicate. When the-CS signal of a subordinative piece active,it can receives instructions and data through the SI, and send data back to the SO. The SO end of thenon-selected piece is in a high impedance state.

IV. The Select Of Humanoid Robot Drive

A. Drive Selection

When we choose the drive motor , we use the drive servos. Servo position control is a way to provide a DC motor, and it's applied in many areas, such as model aircraft, cars, boats, etc. Because of the corresponding speed, light weight, each module can be made small, so that each joint small, reducing the overall volume. Servo uses PWM signal control, simple control, so that steering control will be addressed later. This is not to say, we chose a high response speed and driving torque servos parameters shown in Table 4.1.

TABLE 4.1

Physical	Parameter Range
Module size	20 x 40 x 38 mm
Weight	55g
Output Power	12W
Maximum speed	270°/s
Maximum output torque	12kg.cm
Angle range	0°~185°
Drive voltage	7.5V

V. THE CONTROL SYSTEM OF HUMANOID ROBOT

A. The Control Design of Humanoid Robot

The current humanoid robot control system can be broadly divided into the following control modes: centralized control, master-slave control and distributed control. Centralized control means that the system is only one processor, which can complete all information collection and control tasks. Master-slave control means that the system has two processors that one is the master controller which is responsible for the overall information gathering, planning the whole movement, to send control commands; the other is from the controller that the master controller is responsible for receiving the command and control of the underlying execution mechanism motion. Distributed control refers to the system has multiple processors, and communication between them through fieldbus real-time interactive information technology, coordination to complete their tasks. These three control methods have their advantages and disadvantages.

B. The programming based on KILE platform and Quartus-II platform

The robot introduces a designed control system framework. The framework consists of three parts: the presentation layer, business layer and data layer. What is in the service layer as a humanoid robot hardware system based on FPGA and MP430, modular design, and each module communication using the message as a coordinating mechanism, multi-threaded multi-process as a mechanism for concurrent execution, this framework has good scalability and can be recycled.

By KILE and in Quartus-II action on programming designed allows the robot to self-adjust the angle to prevent falling.

C. Program Design

1) Design

Humanoid machine master system accomplished humanoid robot motion control. Therefore, the control system does not involve too much multimedia signal processing.

2) Software Architecture

Operation of the software consists of three main parts. The first part of the system initialization includes sensors and other original features of the test as well as the software used by the variables, timers, etc. The second part of the task process, according to the sensors and flags feedback process of the task to judge and control. The third part is a part of the task is mainly the task of performing various rules, and the results fed back to the analysis section.

VI. THE HARDWARE ARCHITECTURE OF HUMANOID ROBOT

A. Overall composition humanoid robot system

Small humanoid robot system consists of the robot body, control panels and control software and other parts. Robot body parts connected include the limbs, trunk and head and so on. Robot Control Board generally uses a microcontroller as the core of embedded system to achieve.

B. Structural Design small humanoid robot

1) Joint Select freedom

The different between human beings and other animals is the most distinctive feature to achieve bipedal upright bipedal wake. This process is inseparable from the large number of human bones and muscle support. Humanoid robot system,set the number of degrees of freedom and the position assigned like simulation of human bone and muscle tissue, so humanoid robot in order to achieve stable and flexible walking humanoid robot itself is inseparable from freedom of distribution and therefore free degree configuration of the robot functions to achieve plays a decisive role. Generally the role of the lower limbs major joints DOF.

Generally humanoid robot to be able to stand steady walking, push-ups and play, because the general freedom of the lower limbs are often 5 × 2 , upper limbs and head, there are 4 × 2 +2 degrees of freedom. Figure 6.3 presents a schematic view of distribution of degrees of freedom, in which:

Head DOF assignment: the direction of the neck is a Yaw freedom, a freedom pitch direction, to achieve head rotation;

Upper DOF assignment: Shoulder 2 +2 Roll Pitch direction , the direction of the elbow a Roll,

Yaw direction of a wrist I realize arm movement;

Lower extremity DOF assignment: hip 2 +2 Roll Pitch direction, the direction of the knee I a Pitch,

Ankle 2 +2 Roll Pitch direction.

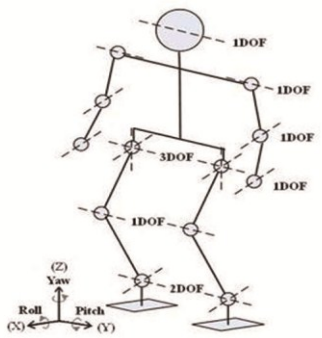

Figure 6.1 One kind of white humanoid robot by the degree distribution

If humanoid movement is set 16-20 degrees of freedom, the shoulder is two degrees of freedom; Elbow joint is one degree of freedom; Wrist one degree of freedom, the head 1-3 degrees of freedom. Hip two degrees of freedom, a freedom of the knee, ankle two degrees of freedom.

Humanoid robot system structure determined with reference to human physiology in each of the major joints of normal human activities, can be further requirements depend on the task to determine the relevant parameters associated with the movement, including the relative positions of the adjacent joints parameter limit joint movement parameters, etc.

2) Design of the overall structure and size

Overall structure and size of the design structure of the human body can refer to the approximate ratio, combined with the practical use to determine the robot's height, shoulder width, leg length, arm length, etc. Figure 6.2 shows a small humanoid robot prototype of the overall structure and size.

Figure 6.2 A small humanoid robot prototype

3) The Selection of Material

Humanoid robot connections including steering gear rack, helm, U-shaped frame, chest plate and screw nuts, etc made of aluminum as the main material because it has a low cost, the proportion of small, high intensity, good cutting performance and other characteristics, not only to reduce the weight of the humanoid robot, but also to ensure the durability of the robot. If you need to reduce the weight of a humanoid robot that can connect pieces smaller force hit parts of weight loss holes.

Humanoid robot upper body, including all the joints of the upper limbs and the head, a relatively small tolerance, lower density may also be used plastic rudder plate and plastic connectors. Robot Foot materials tend to choose aviation plastic or rubber aviation. Aviation plastic density, high strength, rigidity, dimensional stability without deformation, and transparent appearance; Aviation rubber is with stable quality, good toughness, long life, high coefficient of friction characteristics.

VII. THE INNOVATIONS FOR HUMANOID ROBOT

The robot is completely autonomous robot, through our own PCB designed and AD designed software combines FPGA and MP430 panels control system, and mechanical structure designed by CAD draws mechanical structures. Now there, on the market, are mostly good PC software, by adjusting the parameters to control the designed action. Our robot is different from them, and the actions are made by programming, written on your own function to adjust operation parameters. It is easier to modify the action from the bottom.

VIII. CONCLUSIONS

In this paper, we design the humanoid robot system, the system designed by FPGA and MSP430 communicate through the SPI Bus. By tuning method, based on the object characteristic changed by automatically tuning parameters. The control system is stable and integrated, in order to ensure that the control system performance and stability, to ensure safe and reliable operation of the control system. This design has made the following findings:

1) SPI Bus: The basic signal line SPI Bus transmission lines 3, called SI, SO, and SCK. Transmission rate determined by the clock signal SCK, SI for the data input, and SO for the data output.

2) FPGA uses its fast processing speed, collected by the three-axis gyro angle information. the data will be processed, for processing transmitted to the MSP430. MPU-6000 as the world's first integrated 6-axis motion processing components, compared to the multi-component programs, eliminating the combination of the gyroscope and accelerometer axis between the time of the problem of poor, reducing the amount of packaging space.

3) The robot introduces a layered model designed control system framework. The framework consists of three parts: the presentation layer, business layer and data layer. Wherein the service layer as a humanoid robot hardware system based on FPGA and MP430, modular design, each module communication using the message as a coordinating mechanism, multi-threaded multi-process as a mechanism for concurrent execution. This framework has good scalability and can be recycled, etc. advantages.

Finally, our robot is different from theirs, because every movements are made by the program. We write our own function to adjust operation parameters, more easier to modify the action from the bottom, to achieve intelligent humanoid robot.

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