Chapter 9
Design and Implementation of BIOLOID Humanoid Robot

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ABSTRACT

Research in humanoid robot design and implementation is quite challenging due to the complexity of the system and multiple objects involved. Stability, gait generation, navigation and object detection and recognition are all key factors in the humanoid robot design. Researchers in humanoid robot design has put dramatic efforts on one aspect and made assumption on many other aspects. Humanoid robot research involves challenge issues of stability of motion, body movement, navigation, in addition to the issues of path generation, object detection, collision avoidance in the wheeled robots. Rooted from the previous experimental study of wheeled robotics systems, the research project of BIOLOID humanoid robot was started on Fall 2013 and supported by Title III Strengthening Grant Program (HBGI) (DAAD17-02-C-0113). In this paper, we give an overview of the project design and implementation of BIOLOID humanoid robot, including hardware architecture, firmware design and device management, in an overall perspective research work of the motion planning of humanoid robots. In addition, a wide discussion of the issues we faced and challenges of research work is presented, with the results of the current on-going progress. This work will cover the overall hardware architecture, model based system design and behavior analysis using a systematic approach. The work is implemented on a soccer game scenario with a goalie and an offender role. This project has demonstrated a successful development process of collaborative humanoid robotics on a complex research and education platform of BIOLOID using a software engineering approach.

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INTRODUCTION

Research in humanoid robot design and implementation is quite challenging due to the complexity of the system and multiple objects involved. Stability, gait generation, navigation and object detection and recognition are all key factors in the humanoid robot design. Researchers in humanoid robots design has put dramatic efforts on one aspect and made assumption on many other aspects. Humanoid robot research involves challenge issues of stability of motion, body movement, navigation, in addition to the issues of path generation, object detection, collision avoidance in the wheeled robots. We give an overview of the project design and implementation of BIOLOID humanoid robot, including hardware architecture, firmware design and device management, in an overall perspective research work of the motion planning of humanoid robots. In addition, a wide discussion of the issues we faced and challenges of research work is presented, with the results of the current on-going progress. This work will cover the overall hardware architecture, model based system design and behavior analysis using a systematic approach. The work is implemented on a soccer game scenario with a goalie and an offender role.

Motion planning of bipedal robot design and implementation requires the complex process of computing kinematic behaviors in a sequence of fine steps automatically. This is a necessary and fundamental capability for all legged robots to realize the fully autonomy. Motion planning is useful in other robotics related areas such as human-robot interaction, human-operated robots (remote controlled, computer aided design, etc.). Control structure of humanoid robot can be difficult and painfully slow due to the mechanism with many joints of electrical and mechanical concerns other than programming and software issues. In this paper, we selected Bioloid GP, a middle sized humanoid robot with advanced design of actuators and gears where networking communication is integrated, in addition to the high resistant aluminum materials.

The BIOLOID GP humanoid robot is widely adopted in academic and industry for research and educational aspects due to its simple human like interface design, highly integrated gears and flexible multiple programming platforms. BIOLOID GP is currently the top level design kit in humanoid robot products of the company (Other than it, DARWIN is the most advanced kit but with more than four times cost over GP version). As one of the best humanoid robots on the market, BIOLOID GP program is supported by two platforms (through the RoboPlus software which is the default program used or in Embedded C) and easily to be coded and analyzed (Figure 1).

Bioloid robots can be programmed in an integrated package named Roboplus, a software and hardware configuration environment. Roboplus comes with three different applications that are used to control the humanoid robot – RoboPlus manger, RoboPlus task, and RoboPlus motion (Figure 1). The RoboPlus manger is used to manage the status of the robots system, such as firmware, dynamixel motors, and sensors. It can also be used to change the default setting of the robotics system. This section give the user the option of applying different setting such as change dynamixel id, infrared sensor setting, and other external port setting. RoboPlus task is used to operate the BIOLOID humanoid robot; it can be seen as the brain of the robot. This is a functionally languages that uses graphical blocks the user uses to program the humanoid robot action. The blocks have several commands like if, if else, button count, and My_id. This is way the sensor can be set within the program, to execute the action through the Humanoid robot. The third piece of software is RoboPlus motion that is used to build the motions for the humanoid robot. Each tiny motion which turn into a series of action to create one full motion that the Humanoid robot execute. The motion is executed through the Roboplus task based on the user programming each decision in.