Autonomous Control of a Humanoid Soccer Robot: Development of Tools and Strategies using Colour Vision

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Masters Abstract

Humanoid robots research has been an ongoing area of development for researchers due to the benefits that humanoid robots present, whether for entertainment or industrial purposes because of their ability to move around in a human environment, mimic human movement and being aesthetically pleasing. The RoboCup is a competition designed to further the development of robotics, with the humanoid league being the forefront of the competition.

A design for the robot platform to compete at an international level in the RoboCup competition will be developed. Along with the platform, tools are created to allow the robot to function autonomously, effectively and efficiently in this environment, primarily using colour vision as its main sensory input.

By using a 'point and follow' approach to the robot control a simplistic A.I. was formed which enables the robot to complete the basic functionality of a striker of the ball. Mathematical models are then presented for the comparison of stereoscopic versus monoscopic vision, with the expansion on why monoscopic vision was chosen, due to the environment of the competition being known. A monoscopic depth perception mathematical model and algorithm is then developed, along with a ball trajectory algorithm to allow the robot to calculate a moving balls trajectory and react according to its motion path.

Finally through analysis of the implementation of the constructed tools for the chosen platform, details on their effectiveness and their drawbacks are discussed.

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Chapter 1: Introduction

1.1: Project Background and Objectives

Robot soccer is a new area of research to further development in robotics. The humanoid leagues are a new area of advancement in the game, with the objective to have a fully autonomous humanoid robot team capable of competing with the world's best by 2050 [Behnke et.al. 3][Burkhard et.al.][Kitano et.al.]. The development of a humanoid soccer robot team is a goal of the Mechatronics department at Massey University.

The appeal of humanoid robotics is that a humanoid robot can be used to carry out tedious and dangerous tasks that a human would normally be required to perform. Industries like construction could use the robots to perform tasks that would be considered life threatening [Inoue et.al.]. Humanoids could also be used in the entertainment industry to serve humans with their close resemblance to humans making them more readily accepted [Bekey].

The first objective of this project is the development of a soccer robot platform using off the shelf components, which will be able to compete in a robot soccer competition. The robot platform, and external devices, will have to be researched, and the appropriate devices chosen.

The control of the robot through vision will be the main focus of this project. A set of tools will be developed using colour vision that will aid the A.I. (Artificial Intelligence) of the final autonomous robot design.

The first tool will be a basic A.I. based on a point and follow routine. The aim is to use the camera as a pointer for the body of the robot to follow. Through this routine's implementation it is the goal to have a robot that has the basic cognitive ability to perform the required tasks to score a goal in a game of soccer, therefore enabling the robot to function autonomously.

The second tool that will be developed is a monoscopic depth perception algorithm. This added depth perception will not only allow the robot to predict the distance from the robot that an object is located, but allow subsequent calculations to be performed which will enable the robot to determine the trajectory of the ball's travel when in motion. The new information received by calculating the ball's trajectory will enable improvements in the overall A.I. of the robot.

1.2: Research Publications

Refereed Conference Proceedings

- B.J. Rielly, O. Diegel, C.L. Kang, M.J. Read, J.R. Zyzalo, J. Potgieter, W.L. Xu, "A Mechatronics Approach to Autonomous Control of a Humanoid Robot", 13th ENZCon, University of Canterbury, Christchurch, New Zealand, November, 2006.

- C.L. Kang, O. Diegel, B.J. Rielly, M.J. Read, J.R. Zyzalo, J. Potgieter, W.L. Xu, "Humanoid Biped Robots: Walking and Balancing using Natural Dynamics, ZMP, and Gyroscopic Sensors", 13th ENZCon, University of Canterbury, Christchurch, New Zealand, November, 2006.

1.3: Thesis Layout

Chapter 2 will introduce robot soccer the RoboCup in particular, along with its requirements, and regulations. It will give provide background on humanoid robots that are being developed for the RoboCup and for other applications in the real world. Finally it will discuss the equipment that will be used for the robot platform being developed for this application.

Chapter 3 will go into the mechatronic systems produced and go over the choice between monoscopic and stereoscopic vision for this project. Chapter 4 outlines the distance and direction calculations that are used and leads on to trajectory calculations in chapter 5.

Chapter 6 discusses the results that were achieved through this project and finally chapter 7 outlines the future work presented by the project and the conclusions reached.