Team Description 2011 for Team RO-PE

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Abstract. This paper is a brief description of RO-PE-VI, our KidSize robot. Technical details on its design philosophy as well as the hardware and software implementation are provided. Comparisons with previous iterations of our robot are made to highlight the various improvements.

1 Introduction

RO-PE (Robot for Personal Entertainment) is an ongoing humanoid robot project by the Legged Locomotion Group (LLG) from Control & Mechatronics Lab (COME Lab) of National University of Singapore (NUS). This project was initiated in 2001 with the aim of building a series of small humanoid robots which acts as a test bed for research in bipedal walking and artificial intelligence.

Results of our RO-PE research team have thus far been very good. In 2004, RO-PE-II made its maiden appearance in the RoboCup humanoid league. It was ranked 5th overall and 2nd in the H80 Category, among 13 participating robots. We ranked 4th place in the kid size soccer competition in RoboCup 2008, with each generation of robot exhibiting greater dexterity and intelligence.

2 Specifications of RO-PE-VI

RO-PE-VI is a fully autonomous humanoid with 20 degrees of freedom. Like many other robots [1,2], it has six degrees of freedom on each leg, anything less than that would deny the robot from achieving some basic human movements [3]. It weighs 3.5 kg and has a height of 57 cm. The main structure of RO-PE-VI consists of mainly aluminium alloy together with servo motors from Robotis (RX28 and RX64). **Fig. 1** shows RO-PE-VI in its standing position.

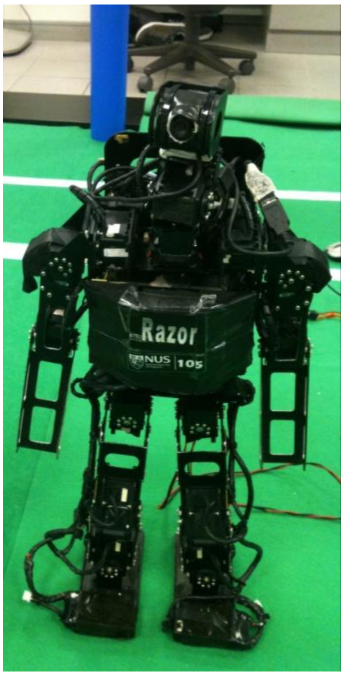

Fig. 1. RO-PE-VI in its standing position

For a robot to be fully autonomous, it has to contain its own processing unit and sufficient sensors to identify the surroundings. The primary sensor for RO-PE-VI is the one “pan and tilt” camera mounted above the chest. The camera is in compliance with the 2010 rule changes regarding the camera configurations allowed. **Fig. 2** shows the components on RO-PE-VI while **Fig. 3** shows the connections between these components.

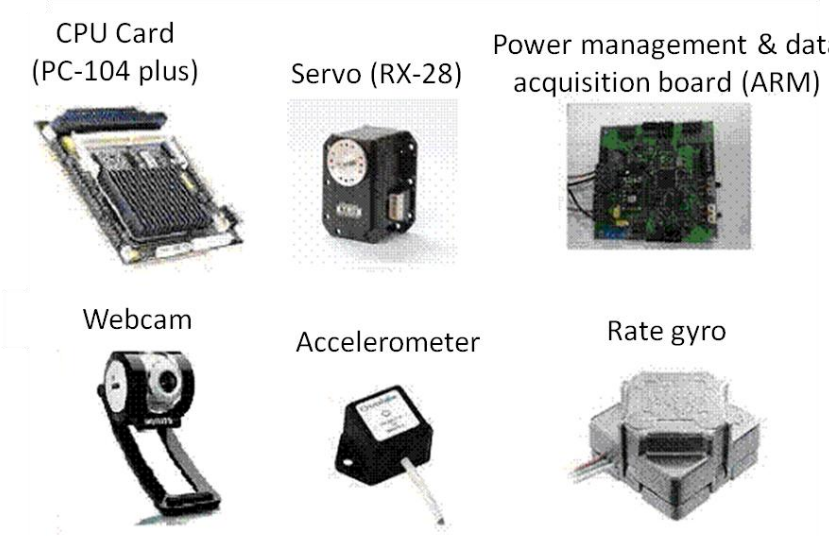

Fig. 2. Components of RO-PE-VI

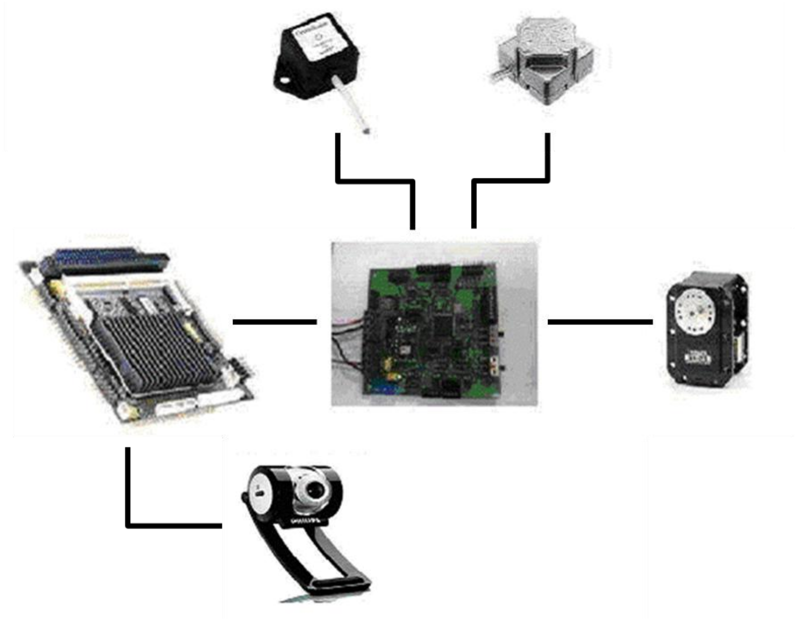

Fig. 3. Connections between components on RO-PE-VI

3 Software architecture for RO-PE-VI

RO-PE VI is a humanoid built by the LLG as a platform for research on multiple areas. These areas include mechanical design, machine vision, walking gaits generation and motor control. During competitions, ROPE VI frequently went into deadlocks and had to be removed from the field for resetting.

To improve the decision-making system, a finite state machine (FSM) system has been implemented. FSMs have high degree of predictability. Given a set of inputs and a known current state, the state transition can be predicted, allowing for easy testing. This helps programmers to debug new functions more effectively. The structure of FSMs makes further expansion of the current program easier as the programmer only needs to declare a new state and add in the state transitions later. Furthermore, FSMs can be represented easily with the use of state transition diagrams, aiding new developers in the understanding of the flow of program. **Fig. 4** shows the state transition diagram of ROPE VI.

Unlike its predecessors, RO-PE-VI employs a new type of actuator that is able to feedback to the computer system several states of the motor, which include the motor’s position and torque. RO-PE-VI’s movements are controlled with the help of this information. A new user-friendly program which enables the independent control of every joint was also developed.

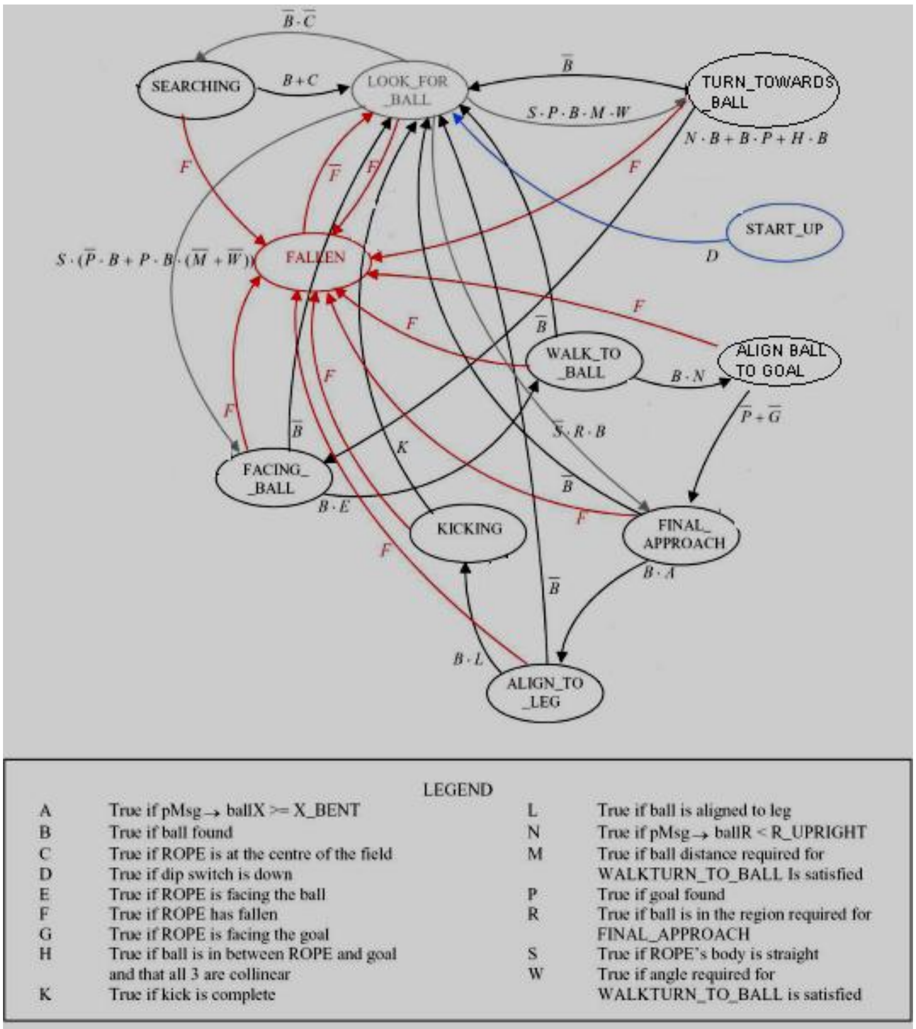

Fig. 4. Diagram for Finite State Machine

4 Improvements

This year, Monte Carlo Localization has been implemented to achieve robot self-localization [4]. Work is being done to adapt robot decision-making to this new functionality. Robot motion has also been improved, particularly in strength of kicking and stability of walking.

5 Conclusion

Significant improvements have been made on the existing system. With the help of position and torque feedback provided by the program, calibration and movement control is greatly simplified. The reduction in time consumption of these activities will allow for more focused and in-depth research and development in other interesting and important aspects of humanoid engineering.

6 References

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