Team Description 2010 for Team RO-PE

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Abstract. This paper is a brief description of two versions of our KidSize robots, RO-PE-VI and RO-PE-VII, developed by the RO-PE research team of the Legged Locomotion Group in the National University of Singapore. Technical details on its design philosophy as well as the hardware and software implementation are provided. Comparisons with previous generations of robots in this series are made to highlight the various improvements in RO-PE-VI and RO-PE-VII.

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). In tandem with the growing interest in humanoids amongst therobotics research community in recent years, this project was initiated in 2001 with the aim of building a series of small humanoid robots (so far, we have RO-PE-I through RO-PE-VI and now developing RO-PE-VII) 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. Since then, RO-PE's other achievements include being ranked 4th place in the kid size soccer competiton in RoboCup 2008, with each generation of robot exhibiting greater dexterity and intelligence. ROPE-VI, which participated in RoboCup 2008 and RoboCup 2009, will be sent to play in this year competition again. In addition, RO-PE VII will be sent to play in this year competition if its development is successful. Much effort had been spent on improving the system, in terms of both the mechanical structure and its intelligence, RO-PE is set to break new grounds and set its own new high in this year's competition.

2 Specifications of RO-PE-VI

RO-PE-VI is a fully autonomous humanoid with 19 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 3.5kg and has a physical height of 57cm. The main structure of RO-PE-VI consists of mainly aluminium alloy together with motors from Robotis(RX28and RX64).Fig. 1 shows RO-PE-VI in its standing position.

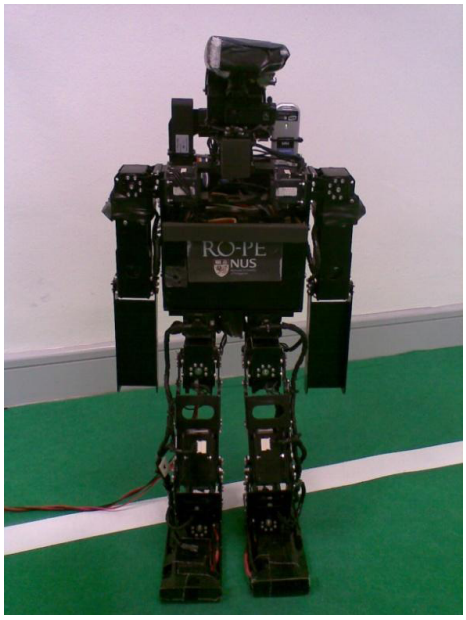


Fig.1. RO-PE-VI in its standing position.

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 Pan and Tilt camera mounted above the chest. The Pan and Tilt camera is in compliance with the recent rule changes where the field of view has to be less than 180 degrees. 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.

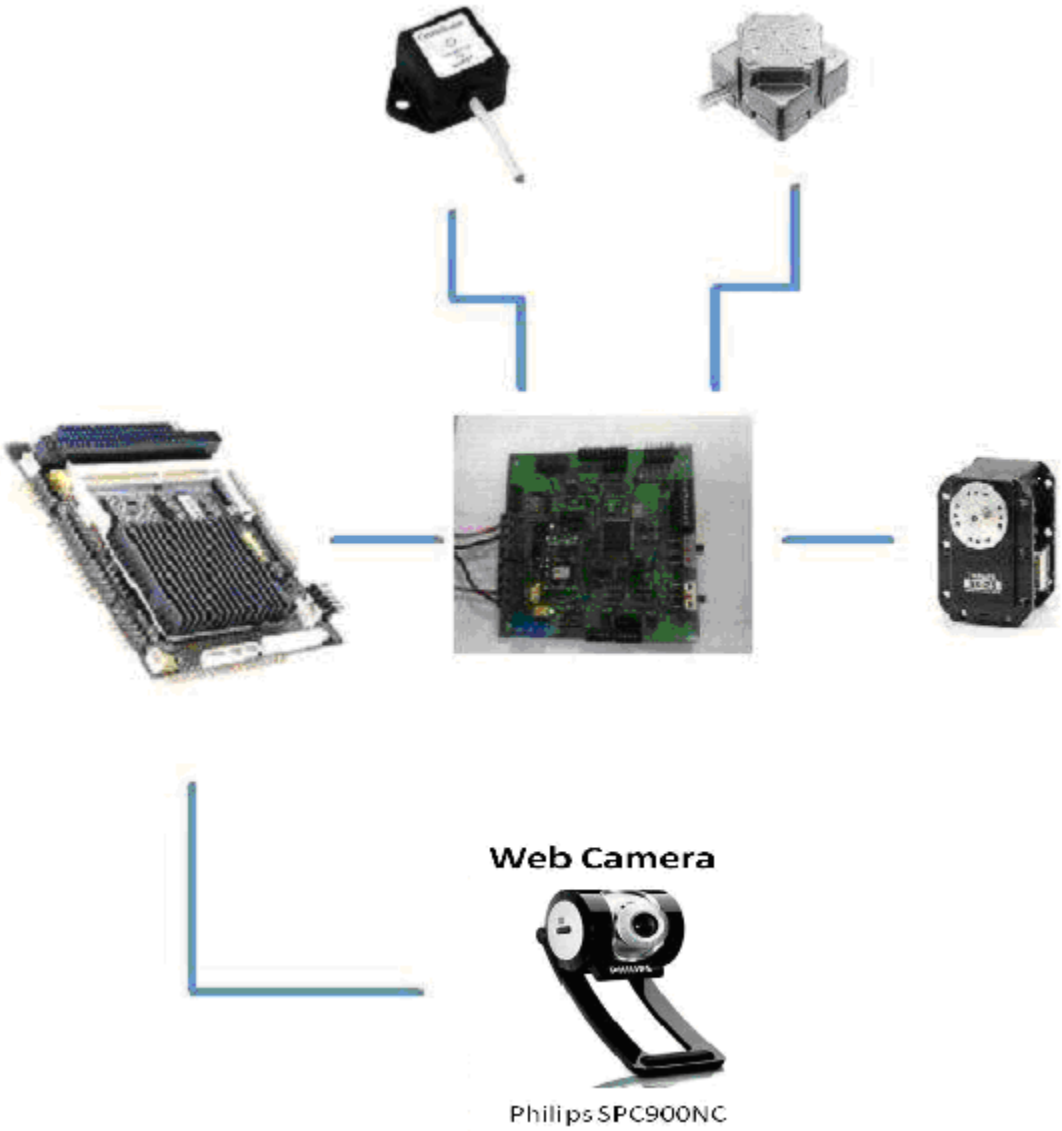
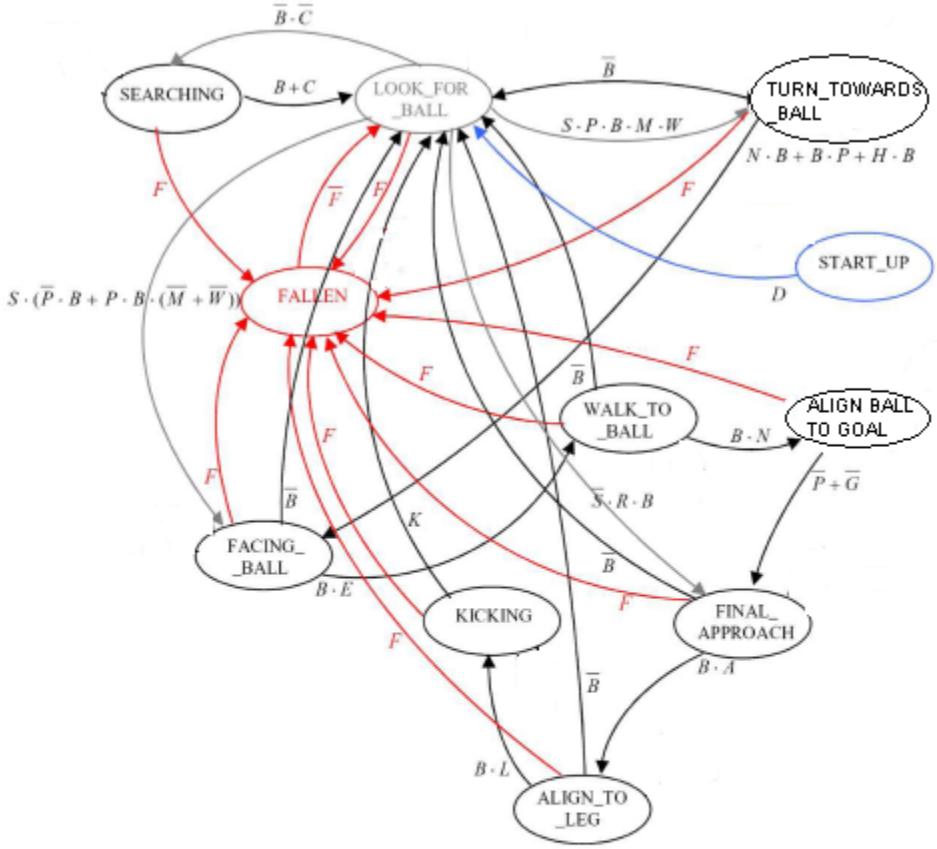


Fig. 3. Connections among components on RO-PE-VI.

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, we implemented a finite state machine (FSM) system. 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.



LEGEND

A	True if pMsg→ ballX >= X_BENT	L	True if ball is aligned to leg
B	True if ball found	N	True if pMsg→ ballR < R_UPRIGHT
C	True if ROPE is at the centre of the field	M	True if ball distance required for WALKTURN_TO_BALL Is satisfied
D	True if dip switch is down	P	True if goal found
E	True if ROPE is facing the ball	R	True if ball is in the region required for FINAL_APPROACH
F	True if ROPE has fallen	S	True if ROPE's body is straight
G	True if ROPE is facing the goal	W	True if angle required for WALKTURN_TO_BALL is satisfied
H	True if ball is in between ROPE and goal and that all 3 are collinear		
K	True if kick is complete		

Fig. 4. Finite State Machine.

4 Specifications of RO-PE-VII

RO-PE-VII is a fully autonomous humanoid with 20 degrees of freedom.It has six degrees of freedom on each leg. It weighs 3.3kg and has a physical height of 58cm.

The main structure of RO-PE-VII consists of mainly aluminium alloy together with motors from Robotis(RX28and RX64).RO-PE VII basically have the same software with RO-PE

VI, the only different is the hardware. RO-PE VII adopts a parallel structure so that the foot is always parallel to the ground when the hip and knee pitch joints are varied. Fig. 5 shows RO-PE-VII in its standing position.

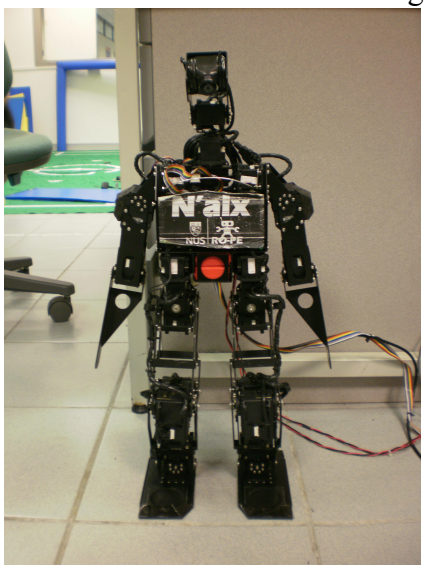


Fig.5 RO-PE-VII standing position.

5 Conclusion

Significant improvements are made in the latest generation robot of the RO-PE series. These include the pan and tilt camera system as well as a Finite State Machine 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.

References

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