EROS TEAM

Team Description for Humanoid Kidsize League of Robocup2013

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Abstract. This paper describes the design and the development of robot EROS (EEPIS Robot Soccer). The developed design includes mechanical construction system and the system of EROS's software platform. The mechanical part is designed to get faster movement and to get higher and more stable robot body shape. The software system is developed to have layer-based structure. The development of this model is aimed to get faster computational performance in term of real time system. The platform of this robot is prepared for joining the competition of Humanoid Robosoccer 2013 in Eindhoven.

1 Introduction

After going back from the competition of Humanoid Robosoccer League 2012 in Mexico, EROS robot directly participated the competition of Humanoid Robosoccer League in Indonesia. In that competition, EROS successfully became the winner and got a chance to participate the qualification process of Humanoid Robosoccer League 2013 in Eindhoven.

The research and the development of EROS are entering its third year. EROS 2.0 is a platform developed for EROS 2. EROS 3 is the earlier de-

adfa, p. 1, 2011.

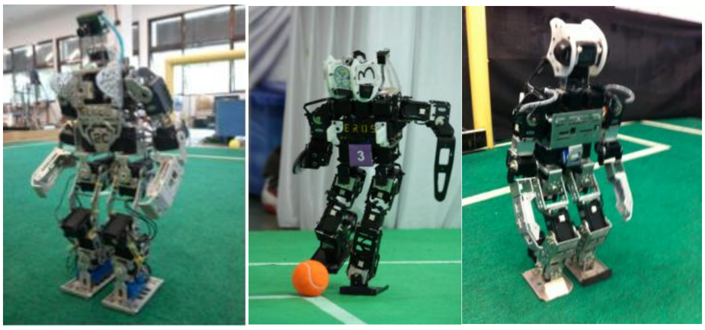
velopment platform and is applied to the third generation of EROS or EROS 3. In this phase, the development is done to increase the movement speed and the performance of the computational system.

The result of the observation done in Mexico shows some flaws of EROS. Based on some fights during the competition, in which EROS fight teams with the same ability and power, EROS seemed to be sluggish, slower, and powerless in executing the ball to the goal gather of the competitor.

Another problem evaluated from the competition is the computation of the vision system. EROS 2 executes computation in order to recognize color based objects like ball and goal gather one by one. The computational speed of the vision system in EROS is high enough, so that currently, the development is done so that EROS can recognize more than one object in one captured image.

1.1 EROS 1

This robot was the first generation of EROS developed in 2011. This robot had a dimension of 42 cm. The actuator at each joint used servo motor of dynamixel AX-18. All motors were controlled by using system of CPU board CM-700 planted ARM STM-32 processor. The vision sensor in this robot used CMU-CAM3 camera and ARM-STM32 board processor.



(a). EROS 1 (b).EROS 2 (c). EROS 3

Figure 1. The generation of EROS

1.2 EROS 2.0

EROS 2.0 is the second generation of EROS robot developed in 2012. This robot had dimension of 45cm. The mechanical construction resembled robot Darwin OP with servo motorDynamixel MX-28. This robot was equipped with camera Logitech HD-910 as the vision sensor. To control all servos, EROS used controller board of CPU ARM Cortex M3. This controller communicated with the main CPU Intel ATOM Z530 through serial port of RS-232. The camera was connected to the main CPU through USB port.the walking speed of this robot was about 28 cm/second and was still able to counter balance the competitor robot.

1.3 EROS 3.0

This robot is the third generation of EROS and the development of the earlier version 2.0. The height of the robot 50 cm with the total weight of 4 kg. The development was done by changing the mover in the leg using servo motor MX-64. The leg part has 12 DOF and all of them use MX-64. Meanwhile, the other eight joints, hip, arm, and neck still use servo Dynamixel MX-28. The walk speed of EROS 3.0 is 36cm/second. This robot can kick ball as long as 6 meters and could be even more. The controller of all of the servo use microcontroller based CPU board ARM Cortex M4. This CPU communicates with al servo by using multidrop communication system at TTL level. The communication with the main CPU is using serial port of RS-232. The main CPU of the robot still use Intel ATOM Z530. The main CPU functions as computational processor from software system of EROS 3.0. The more detailed discussion about the system software is explained in the other part of this document.

The camera used is Logitech HD-910. This camera is connected to the main CPU though USB port. The recovery is done to generate speed in recognizing objects in the soccer field like ball and goal gather. The platform software developed for vision system is aimed to get object perceptions. The lighting factors was solved by combining color based and object based recognition system. With unlimited color combination and identified objects, at time image capturing, the robot can identify and recognize more than one object.

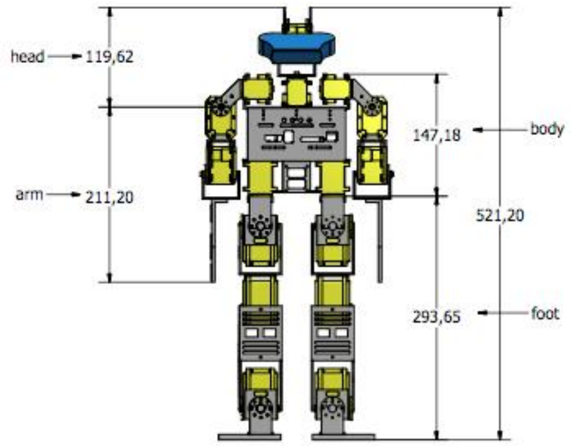


Figure 2. Mechanical layout EROS 3.0

The platform software of EROS 3.0 is also planted in EROS 2.0. In preparing for Humanoid Robosoccer League 2013, EROS team will come with 4 humanoid robots. They are two EROS 3.0 robots with platform software of 3.0, and two EROS 2.0 robots with platform software of 3.0.

2 The Electronic-System Design

The electronic system consists of sensor hardware, actuator and system processor. Figure 3 shows the scheme diagram of the electronic system applied to EROS 3.0. The sensors used include accelerometer, gyroscope. To keep the balance of the robot when moving, the system sensor will transmit information about the elevation of the robot body, acceleration, and how powerful the foot steps on the floor. Besides inertial sensor, the electronic system is also equipped with camera Logitech HD-910 as the vision sensor. This sensor will work to generate data of the captured image.

Figure 3 shows that the second processor functions to handle inertial sensor and the controller of actuator movement. This processor communicates with the main processor through serial port of RS-232. The processor uses the architecture of ARM Cortex-M4. This processor functions to handle the system of robot movement as the basic movement of human. The main processor is using Intel ATOM Z530 2GHz.

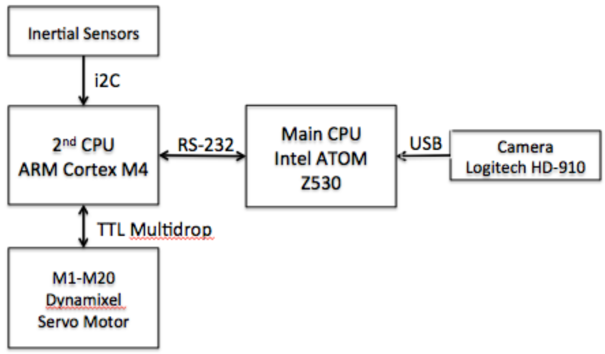


Figure 3. The block diagram of EROS 3.0's hardware system.

There was a weakness in the second processor that is the communication done using the main processor sometimes buffered. The data received and transmitted was frequently late. This caused the movement of the robot stopped. Buffering can be solved well if the processor has enough memory space to store data, and also the speed in reading and writing the data. There are two communications have to be handled by the second processor. The first is Full Duplex Communication with all actuator and inertial sensor. The second is the communication with the main CPU. The handling of information received from the main CPU by this processor must be responded as fast as possible. Whereas, the processor must also handle kinematic movement of the robot and transmit commands to the entire connected actuator. In EROS 3.0, increasing the second processor capacity becomes important. ARM Cortex M4 has higher frequency speed and amount of memory than does ARM Cortex M3 which is used in EROS 2.0. Besides that, by using MX-64 as actuator, the robot's speed increases. To keep the stability of the robot movement when walking fast, it needs faster processor response than that of the former.

3 Platform Software EROS 3.0

Generally, the design of platform system of EROS 3.0 can be seen as parts communicating one another. Besides that, the platform of EROS 3.0 as an entity of communication application using applications other than EROS or even EROS that can be implemented to the other robots. Communication among parts is done by using Inter Process Communication known as IPC. Whereas, the communication among application is using self defined protocol system through communication media of wireless WIFI 802.11g. Basically, these parts work independently and internally and respond all information related to those parts themselves through IPC. The information are in a storage called IPC PIPES. Figure 4 explains high-level design and parts of platform software of EROS 3.0 which each part is connected.

The vision part functions to process all data captured by the camera. The information resulted is transmitted to IPC PIPES continuously. Game controller in the part functioning to process information transmitted by referee box application. This part provides information about status of the competition at that time. The strategy part process all information and information successfully generated from information stored in IPC PIPES. The strategy processes and generates a decision which will be responded by tactical part. Tactical part translate it into action. Information about the action executed is responded by kinematic controller. During the battle, the Player Coordination module communicates among robot and process all information received.

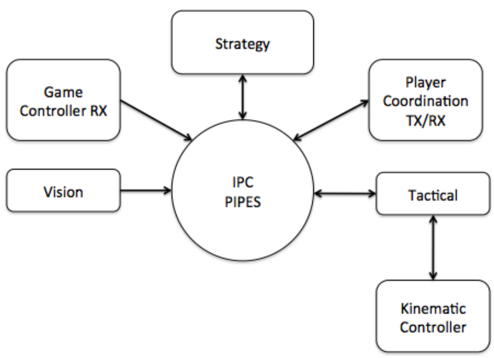


Figure 4. High-level design of EROS 3.0

Some basic functions of EROS 3.0 are functions already implemented in EROS 2.0. That function is rearranged based on the model developed in the recent platform. This arrangement is done to generate a universal platform for the future. Figure 5 is the model of EROS 3.0 platform layers. The model is developed based on the functional elements of a football player.

Figure 5.Model of EROS 3.0 platform-software layers.

The ground-most layer is the function as human. This function is closed to the tactical part and more frequently communicating with hardware part. The function components in the human layer include the basic movement of a human. The next layer is the player. Player is a human who has an ability of at lest a basic movement in playing soccer. For example, a football player can dribble a ball, throw ball, and so forth. Above the player layer is AI component. This part consists of the thinking ability of a football player. The function of determination is function acts to decide a mission which will be executed at that time. For example, a decision to kick ball or to dribble ball through the competitor robot is decided by this function.

The upmost layer of this platform is the soccer game. This layer works with function which is the information status of the game.

4 Conclusion

Until the current state of its development, EROS has experienced changes in the model of its platform software structure. With the platform-software structure model and its mechanical posture, its ability in recognizing and tracking ball becomes faster. The implementation of layer-based platform software can ease the platform development in the future.

5 Statement of Willingness for Participation

By considering the development process of EROS 3.0 robot done recently, if EROS team is stated to have passed the qualification by the committee to participate Humanoid Robosoccer League 2013, We happily welcome and are willing to participate in the Humanoid Robosoccer 2013 in Eindhoven on Jun 2013. Moreover, EROS team is also committed to delegate one team member to be one of the judges in the competition that will be conducted in the Humanoid Robosoccer 2013.

6 References

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