Kwangwoon University KW-1 (Adult Size) Team Description Paper

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Abstract. This document describes both hardware and software specifications and practical functions of the humanoid robot Stepper Adult, developed by team KW as a platform for research in bipedal locomotion, robot self-localization and multi-robot cooperation. The robots will be used to participate in Humanoid League (Adult Size) of ROBOCUP 2012 Mexico City.

1 Introduction

The KW is a professional robot game team of Kwangwoon University in South Korea. Team 'KW' established in November 2006. The KW has participated in several domestic and international tournaments and received more than 100 awards in competitions. The team, ‘KW’ has a five-year accumulated robot technology. We have put a lot of efforts for the 'ROBOCUP' contest to get qualified and we also have studied Robot system which would be covered during the contest.

Briefly, we use 'FIT PC' which is easy to be equipped with robot and also processes received images. The images processed through the CAN (Controller Area Network) communication system are transmitted to interface board. As you can see from the pictures below, we have developed strong and rugged robots using the SAM-170 motor and the SAM-20 motor.

2 Overview of the System

Figure.1 is our **prototype** robot design. **This robot is not completed yet.** We **plan to upgrade** the hardware lighter and more robust. You can find more detail from the spec. table 1 at the next page.

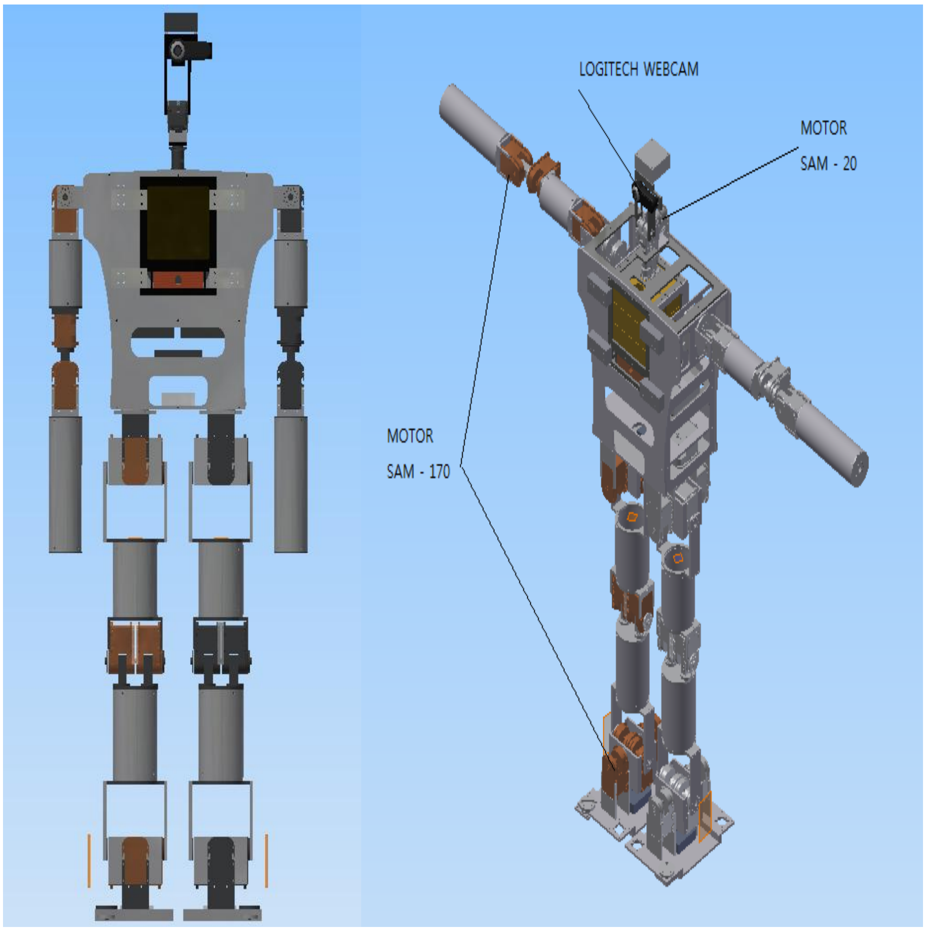


Figure.1 Unfinished Robot

SIZE	Weight 26 kg Height 152 cm Leg Height 75 cm Arm Height 60 cm Sole of a foot Height 26.5 cm Sole of a foot Width 16.5 cm
Number of degrees of freedom	All of DOF 23 DOF LEG 6 DOF ARM 4 DOF
Type of motors, Speed	SAM-170E 30 60 RPM SAM-20 3 140 RPM
Computing units	FIT PC 2I CPU : Intel Atom Z5xx 1.1GHz – 2GHz* Graphics : Intel GMA500 RAM : DDR2 1G USB : 4 USB PORT
Camera	Logitech Webcam Pro 9000 **(1600 * 1200, 720p)**
Sensors	Acc Sensor Gyro Sensor Load Cell Sensor

Table 1 Specification of the Robot

3 Robot Control System

Our robot control systems are divided into three parts.
The first part of our robot systems is 'FreeScale' which controls over 20 actuators and several sensors.
The Second part is 'FIT PC' which receives information and processes image data from pictures of match situations.
The last part is teaching system making a basic robot motion such as shooting or blocking a ball.

3.1 System Diagram

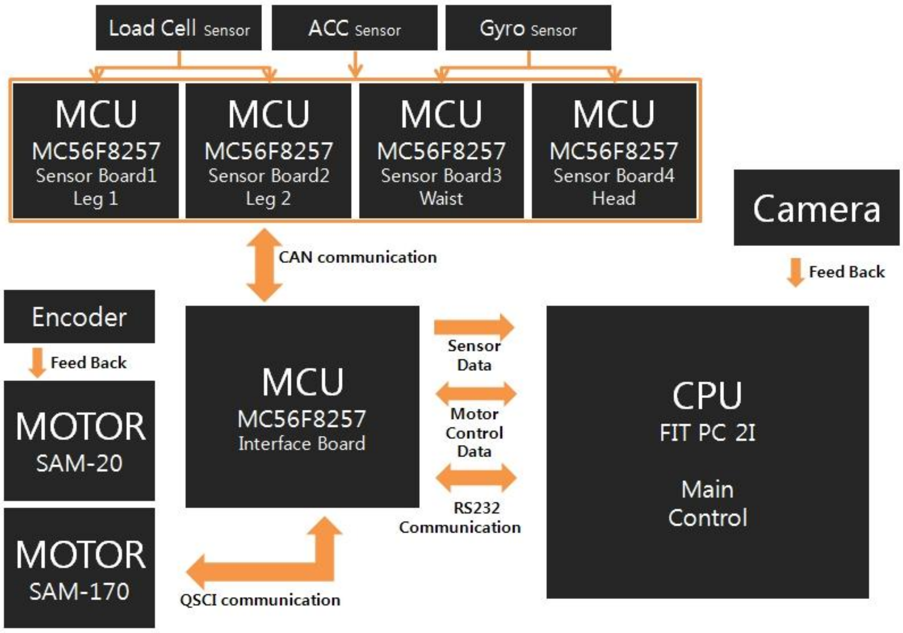


Figure.2

Figure.2 is a diagram of our robot system.
Camera data into FIT PC so FIT PC is order to Interface Board 'moving motor' then motor is moving and feedback encoder. Interface Board makes compensate from Sensor Board (1 ~ 4) data. Sensor Boards have Load Cell Sensor and ACC Sensor, Gyro Sensor.

3.2 Teaching Software

Figure.3 is a Teaching program.

The teaching program is to make fundamental motions. The motions consist of several connected slides providing that we fix specific robot body postures using different robot IDs. Then these slides reserve as data in FreeScale.

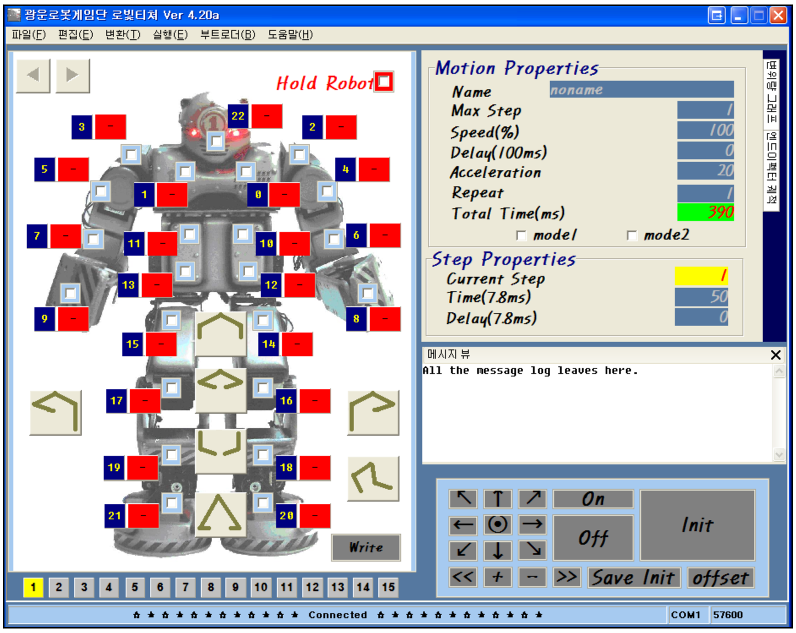


Figure.3

3.3 Firmware

3.3.1 User Function

MSCAN
The module is a communication controller implementing the CAN 2.0A/B protocol as defined in the Bosch specification dated September 1991. CAN protocol is designed to meet the specific requirements of a vehicle serial data bus: real-time processing, reliable operation in the EMI environment of a vehicle, cost-effectiveness, and required bandwidth. MSCAN uses an advanced buffer arrangement resulting in predictable real-time behavior and simplified application software. We used MSCAN communication than between Interface Board and Sensor Board.

QSCI
The SCI allows asynchronous serial communications with peripheral devices.

ADC
The analog-to-digital converter (ADC) is one dual 12-bit ADC in which each ADC converter has a separate voltage reference and control block.

GPIO
The general-purpose input/output (GPIO) module allows direct read or write access to pin values or the ability to assign a pin to be used as an external interrupt. GPIO pins are multiplexed with other peripherals on the package. The device's data sheet specifies the assigned GPIO ports and the multiplexed pin package.

3.3.2 User Firmware

We used F/W in Sensor Board and Interface Board because we want analog signal from a sensor and return to mine CPU and control SAM motors.

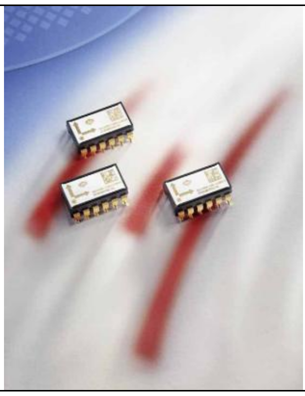
Sensor Board
Sensor Board has three types are leg, waist, head. Leg Sensor Board has four Load Cell Sensor and two ACC Sensor so take analog signal and send to Interface Board (use MSCAN). Waist Sensor Board has two Gyro Sensor and two ACC Sensor so take analog signal and send to Interface Board (use MSCAN). Head Sensor Board has two Gyro Sensor and two ACC Sensor so take analog signal and send to Interface Board (use MSCAN).

Interface Board
Interface Board is communication board so this board has two communications QSCI and MSCAN. QSCI used motor control and communication FIT PC. MSCAN used communication Sensor Board.

3.4 Sensors

We used many sensors because of Robot's seamless walking. We used Load Cell Sensors, ACC Sensors and Gyro Sensors.

Load Cell sensor	
	FC22 is that we choose to pressure sensors. We use this pressure sensor when robot walk in order to measure foot pressure. We supply this pressure sensor 5.0V.

ACC Sensor	
	We chose SCA1020 because of robot walking posture correction. ACC Sensor is supplied 5.0V.

Gyro Sensor	
	We chose ADXRS613 because of robot walking posture correction. Gyro Sensor is supplied 5.0V and 3.3V. Because of sensor output we are supplied 3.3V.

4 Image Processing & Communication

Figure.4

This is a trial picture which was taken by a test program.

We have developed a program to participate in ROBO CUP though OpenCV and GUI programs. For communication with robot, we used CAN(Controller Area Network)

Nowadays, we have developed a USART communication program to be easier to operate robots.

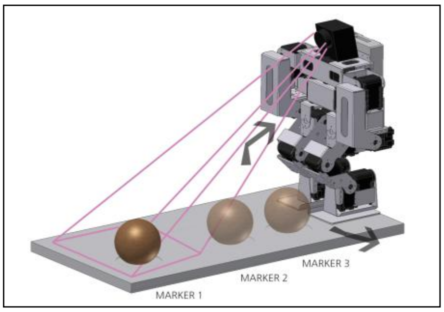


Figure.5

The Figure.5 is using algorithms which detect a exact distance between a ball and a robot with triangular functions in robot's standard.

A particular point is this algorithm that assigned 3 parts of a place where a ball put on. It is easy to find a distance between a ball and a robot faster.

5 Walking System

Approximately five years of cumulative experience and know-how through trial and error make robot's strength point which is fast and accurate walking motion.
Robot's walking motion was not fixed, it can vary by sensors and inverse kinematics.

The sensors mounted on the robot control relative values for finding a ball and keeping the ball moving fast and accurate. So robot can control the ball easily and shoot properly.

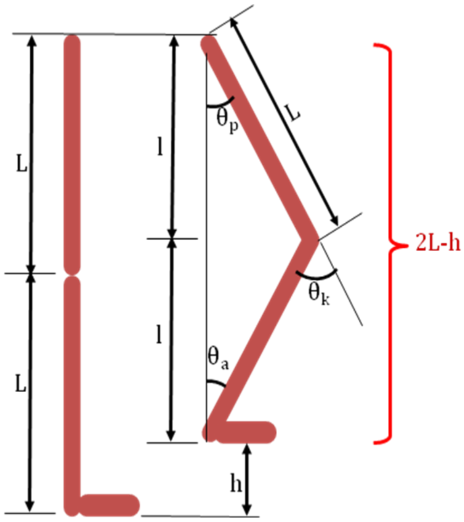


Figure.6 (Inverse Kinematics Simplify)

6 Conclusion

Our system was described in the Abstract.
Since 2006, we completed the design and built, based on our experience to try to join the 2012 ROBOCUP competition.
Higher level of robot mobility and powerful shot also accurate imaging breakthrough in tracking the movements of the robot will be able to determine.