Team Description Paper: Adult-Sized Robot for 2018 RoboCup Humanoid League*

Kuo-Yang Tu, Hong-Yu Lin, Che-Ping Hung,
and Zi-Xuan Li
Institute of Electrical Engineering,
National Kaohsiung First University of Science and Technology,
No.1, University Rd., Yanchao Dist., 824 Kaohsiung City, Taiwan (R. O. C.)
Email: tuky@nkfust.edu.tw
Team home page: http://humanoid.nkfust.edu.tw/F229/
Video: https://youtu.be/qVX19XoPg7k

Abstract. Team NKFUST participated adult-sized humanoid league since 2010 RoboCup at Singapore for many years. In recent years, we focused on different kinds of adult-sized humanoid design for 2016 RoboCup at Germany and 2017 RoboCup at Japan. In this year, we concentrate our experiences of adult-sized humanoid robot design for an agile humanoid with strong joins based on more sensors in body. Hopefully, we can get good performance in 2018 RoboCup at Montreal.

Keywords: Adult-Sized Humanoid Robot, Agile Walking Gait, Inertia Motion Unit Sensor, Force Sensor, Center of Pressure (COP).

Introduction.

Humanoid robot is an interesting research in recent decades. In recent, small-sized humanoid is popular, and commercialized, but adult-sized is still a research challenge. Intelligent Robotics Laboratory at National Kaohsiung First University of Science and Technology focuses humanoid robot research for many years. We developed many different kind small-sized humanoid. In recent years, we face the big challenge of adult-sized humanoid robot. On 2010, our adult-sized robot participated RoboCup humanoid league competition at Singapore. We captured lots of key points to improve the implementation of adult-sized robot. Therefore, we were successful to build Aaron for RoboCup 2016, and got ONE score point during the match of RoboCup 2017.

* This research was supported by Ministry of Science & Technology, Taiwan, Rep. of China under grant MOST 105-2221-E-327-031-.

Over 20-year history, RoboCup is successful to promote robot research, especial humanoid robot. In every year, the organizers of RoboCup upgrades competition rules for the boosting of humanoid robot research. The annual competition, RoboCup, becomes a popular and exciting activity for researchers and expert.

For the humanoid competition in RoboCup, stable walking gait, computer vision, etc. are the fundamental function of adult-sized robot. The adult-sized humanoid robot to have stronger joins and more sensors is designed and implemented. We believe NKFUST adult-sized humanoid robot will have good score in the game of 2018 at Montreal.

Mechanical Design

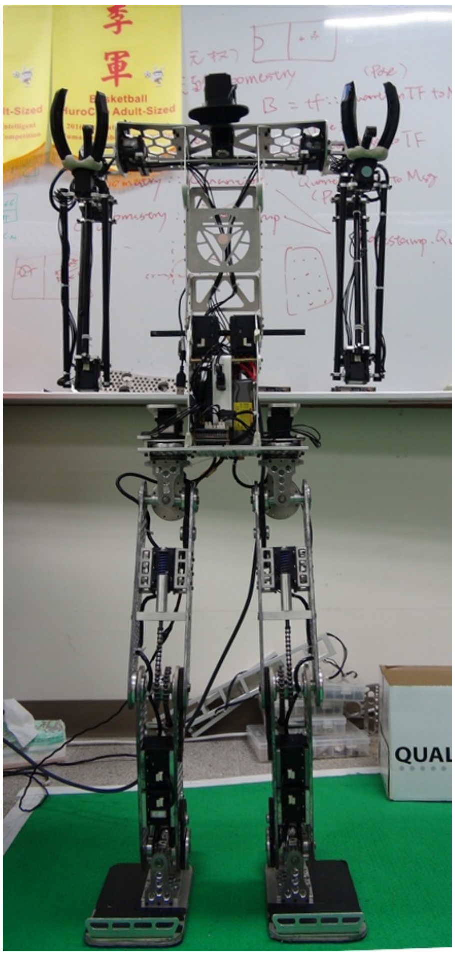

Fig. 1. NKFUST humanoid Structure

The idea of NKFUST structure is come up from our experience in the research of small-sized humanoid robot. The mechanical model of NKFUST humanoid are shown in **Fig. 1**. We install lots of extra gears and spring on each leg's joints as shown in **Fig. 2**. The extra gears are designed against heavy body and the springs are designed to have agile walking gait. In addition, as shown in **Fig. 3** the force sensors are installed on the foot bottom for Center Of Press (COP) of humanoid robot during walking. And **Fig. 4** shows the X and Y locations estimated by force sensors during moving the humanoid robot. **Table 1** is the specification of NKFUST humanoid.

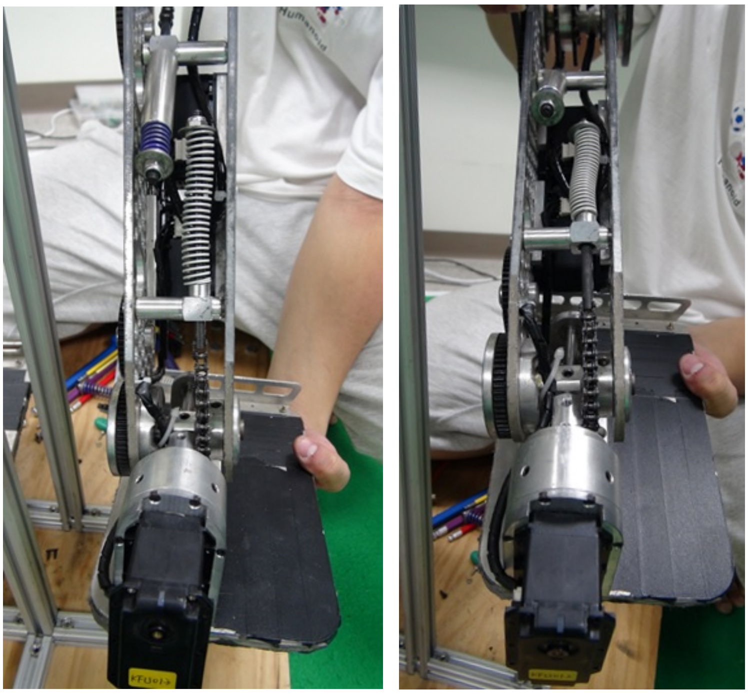

Fig. 2. The detail photo of NKFUST humanoid ankle. As shown in the photo, the extra gear and spring are design for the ankle join to have stronger torgue.

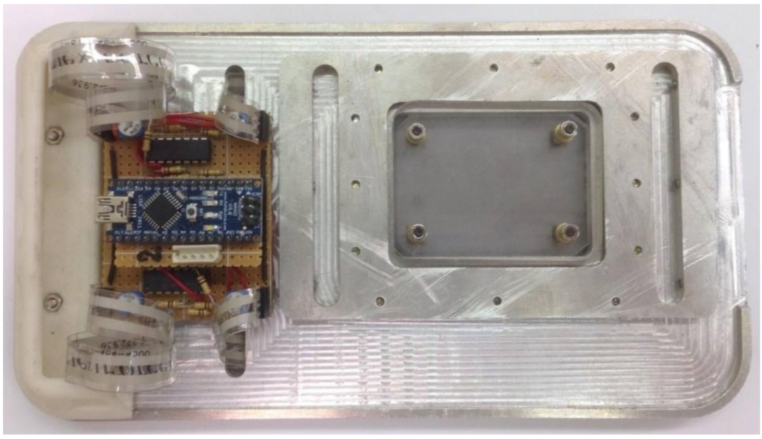

Fig. 3. The force sensors and circuit is installed on the foot bottom.

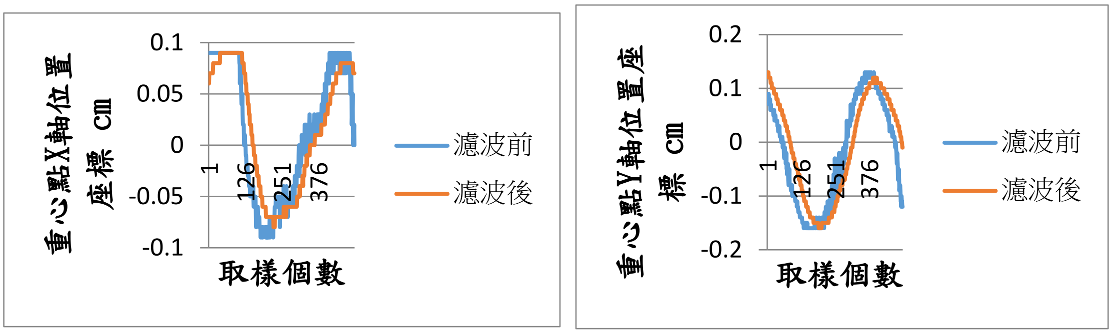

Fig. 4. The Center of Press (COP) estimated by the single of force sensors.

Table 1. NKFSUT Humanoid Specification.

Height(cm)		130	
Weight(kg)		15	
DOF	Leg	12	
	Arm	10	
	Head	2	
Servo		Robotis MX106	
		Robotis MX64	
		Robotis MX28	
Sensor		Gyro	MPU-6050
		Acceleration	
Control System	Main Controller	PICO 880	
	Motion Controller	86duino One	
Walking Speed		9 meters/minute	

Control System

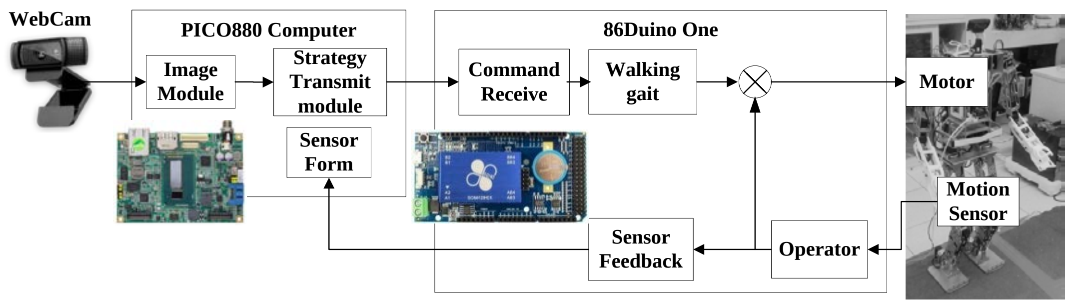

Fig. 5. The control system block of Aaron.

In our design, the control system of NKFUST humanoid consists of two boards as shown in **Fig. 5**. One is PICO 880 for computer vision process and strategy command, and another is 86duino for motion control and sensor feedback. PICO

880 can catch the image from webcam, and send strategy commands according to different game. Then the motion controller 86duino will receive the command for servo motor control and adjust walking gait based on sensor feedback.

Software System

The robotics control system is a complicated system consisted of many different kinds of hardware. For example, the control hardware of our adult-sized humanoid robot is consisted of main controller PICO 880, motion controller 86duino One, servo motors, and motion sensors. The communication and intrgration of the hardware messages for the humanoid robot control are a tough work. Therefore, Robot Operating Systems (ROS) is designed and implimented for the tough work. The main feature of ROS are:

1. Peer-to-peer processing architecture design,
2. Open source,
3. Multi-language support. ROS support computer languages such as Python, C++, Java.

Fig. 6 is the software architecture of ROS.

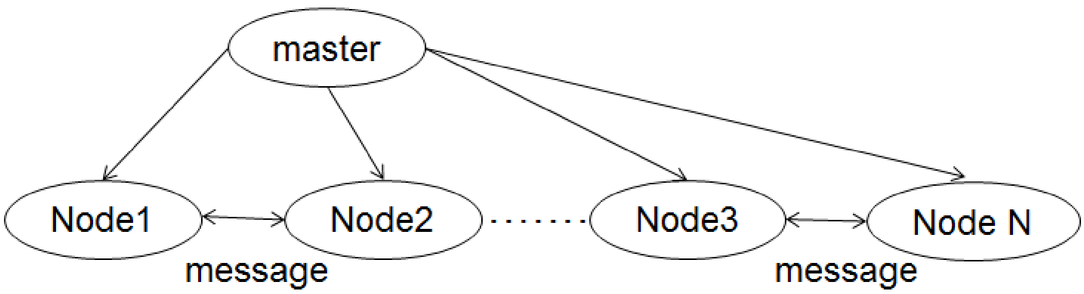

Fig. 6. The software architecture of ROS

To desgin for ROS, the operation system of Pico880 makes use of the Linux-Ubuntu 14.04. Fig. 7 shows the software architecture of our robot control system. As shown in Fig. 7, the nodes are developed by Python or C++ computer languages. The topic is a activ means of communication, and the service is a passive means of communication. Actually, every node can be published and subscribed for sending value to the topics and getting value from topics.

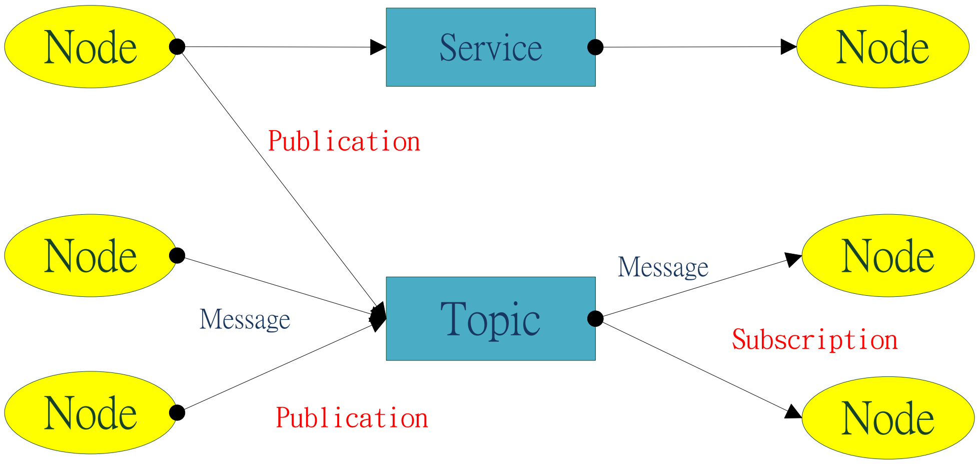

Fig. 7. The Software architecture of our robot control system based on ROS.

Conclusion

RoboCup is a fantastic competition. It's a chance we can make the AI robot by ourselves and sharing different knowledge with the other team which come from the whole world. We participated 2016 RoboCup and 2017 RoboCup, and were preparing for 2018 RoboCup 2018. We believe we will have good performance in 2018 RoboCup at for Adult-sized humanoid league.