Unbounded Designers Teen & Kid Size Team Description Paper

Humanoid League ,Robocup 2018 ,Montreal ,Canada

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Abstract: This document is a brief summary of research studies on Teen Size and Kid Size Humanoid Robots by Unbounded Designers team of the Islamic Azad University of Isfahan from Iran, to participate in RoboCup 2018, Montreal, Canada. This team has formed up and started its research activities in 2015., aiming to design an open-source platform for kid size and teen size Humanoids. This report gives a summary of our hardware design activities, such as Mechanics and Electronics, and software design tasks, such as Motion Algorithms, Machine Vision, and Localization, and innovative ideas of the team to improve and complement prior research in further works.

Keywords: RoboCup 2018, Humanoid Robots, Open Source Platforms, Electronic Design, Mechanic Design, Motion Algorithms, Image Processing, Localization

1. Introduction

Unbounded Designers Team formed up with an essence of research and development in the Islamic Azad University of Isfahan in 2015 and in addition to its activities in Information Technology and Artificial Intelligence, started its research in humanoid robots. In 2017, this team became champion of Iran Open 2017, in Teen Size Humanoid league. Also, the team performed well in RoboCup 2017, Japan and RoboCup-ap2017, Thailand.

Fig.1 UD team member

Currently, we are implementing our ideas and innovations in order to improve previous algorithms and designs and prepare for participation in RoboCup 2018, Canada.

Unbounded Designers has focused on three main areas:

I) Usage of innovative Force sensing resistor (F.S.R) method, in order to keep more balance

II) Improvements on Image Processing algorithms

III) Better robot behavior in game environment and improved intelligent strategies

2. Hardware and Electronics

Our platform is a fusion of Baset Pazhooh Tehran's commercial platform for teen and kid size, and Unbounded Designers platform designed in 2016. In our new design, we have tried to solve previous

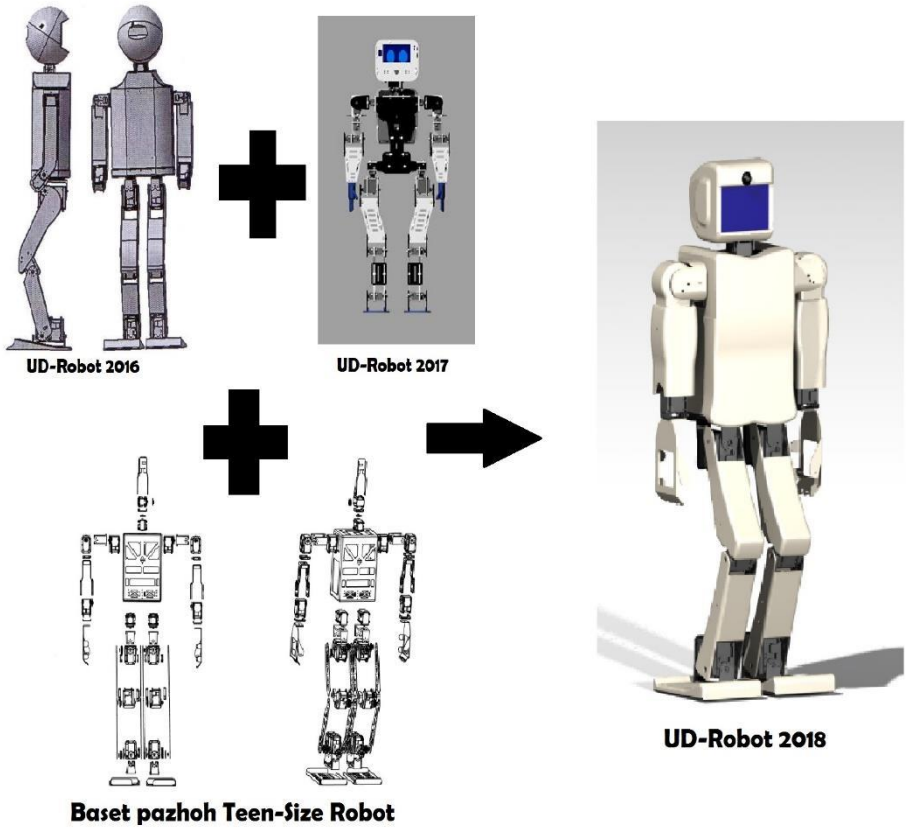

Fig.2 The Designed Robot

design's problems. Hence, the final design is complementing the aforementioned two.

The designed robot (Fig. 2), has the size of 85cm, 6 degrees of freedom for each foot, 3 degrees for each hand and 2 degrees for the neck, and is in accordance to 2017 rules[2]. In this design, MX-28, MX-64, and Dynamixel MX-106 motors are used to provide the torque needed for walking, jumping shooting and etc.

For RoboCup 2017, Montreal, Canada, the Unbounded Designers team will use a commercial Baset Teen-Size [1] platform.

Table-1 describes the characteristics of two platforms.

	Baset Pazhoh Robot	UD-Robot
Height	84	85
Weight	6.3	6
Camera	Logitech C905 640x480 @ 30 fps	Logitech C905 640x480 @ 30 fps
DOF	20DOF	20DOF
Actuators	Dynamixel MX-106 & MX-64 & MX-28	Dynamixel MX-106 & MX-64 & MX-28
Processing Unit	QutePC-3000 (QPC-3000) [3], 2 GB DDR3 memory, 64 GB SSD	Intel NUC7I7BNH-/X1D [4], 2 GB DDR3 memory, 64 GB SSD
OS	Windows 8.1	Windows 8.1
Battery	Li-Po 11.1 V – 5000mAh	Li-Po 11.1 V – 5000mAh

Tabel.1 Robots Information

For better balance control of the robot during a move, our team uses an IMU with 9 degrees of freedom. Raw data for this IMU is provided by an RMG-146 sensor and is developed by one of the team members. This IMU is available in the market under the name GN-MPU[5].

Also, our team uses Force Sensitive Resistors (FSR) [6] in the robot's foot to improve balance control. These resistors are very cheap and are easy to set up, and makes it extensively convenient to use. 8 resistors are used in each sole and the pressure is equally distributed to ensure dynamic and continuous balance in various moves.

Fig.3 Force Sensitive Resistor

Besides, we designed a board to connect motors, sensors and etc. to central mini-computer. This board has two RS-485 connectors, one for motors and the other for IMU and other sensors, and its goal is to collect information from sensors and motors. We also use an ARM processor for processing raw data of gyroscope and accelerometer and a power divider, which divides battery power into different parts. This board connects to a mini computer and exchanges information through USB.

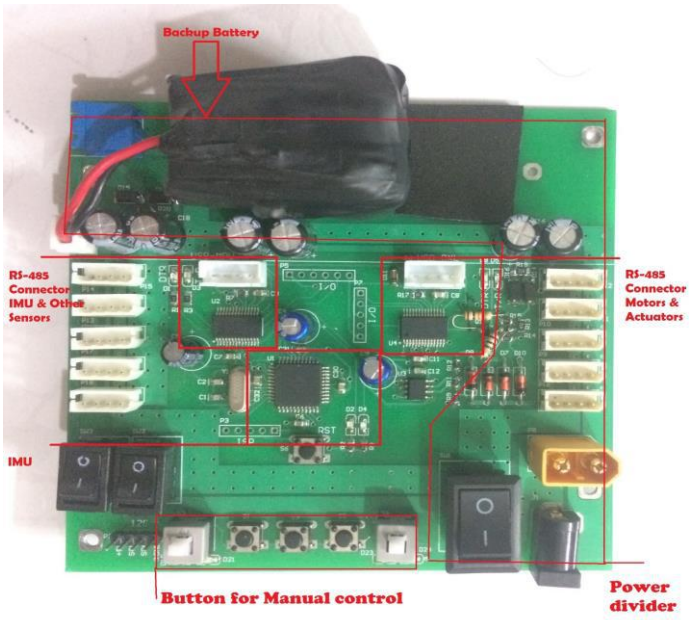

Fig.4 Controller board

(Fig. 5) gives an overview of electronic connections in Unbounded Designer's robot.

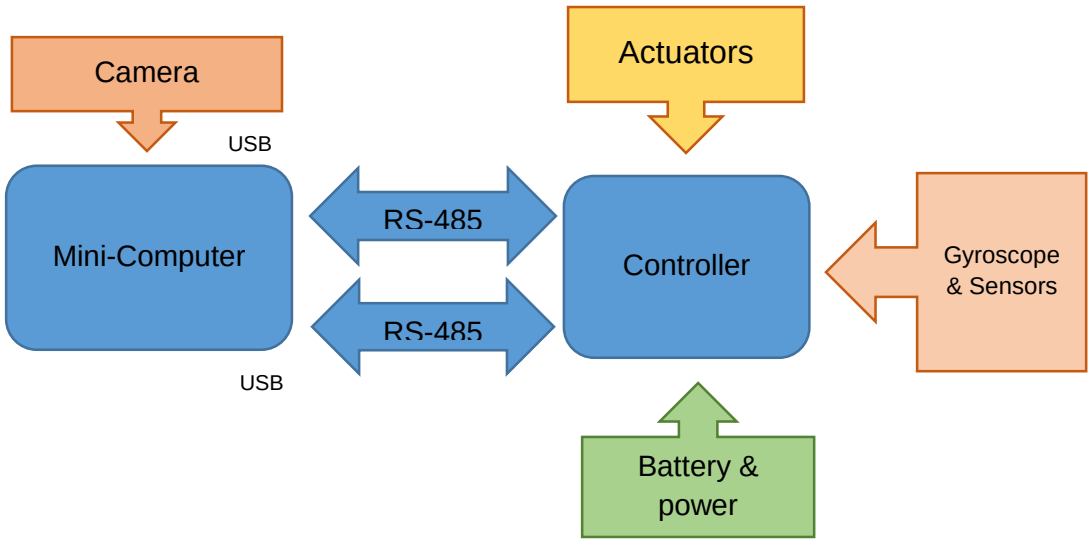

Fig.5 UD-Robot Device Connection

3. Software

1.3. Motion & Control

Currently, our main and most important concern is a dynamic and fast walk. After investigating different methods and algorithms by Baset Teen-Size [1], MRL-HSL 2017[9], Nimbro 2017[8], Nimbro 2014[7] and AUTman[10], we decided to use an Omni-direction based method that can process with different speeds and has been created and developed by Baset Teen-Size [1]. The major improvement of this module is using a trajectory learning approach that was trained on NAO robot in simulation [11]

In this module, hands are used to increase dynamic and speed, and to prevent any decrease in stability. In addition, we slightly modified this module and added a balance control system through force sensitive resistors to improve the performance of this module.

2.3 Vision Module

For Image Processing and Vision, the Unbounded Designer team uses a 25 fps camera. After reading related works of other teams, specifically Baset Teen-Size [1] and even adult size[12], we followed an initial idea, which is very simple and primary. We use modules provided in OpenCV[14], to convert RGB image to HSV to divide colors better. Then, HSV channels are separated and after applying each color range on channels and composition of result channels, Green and White color ranges are available. By finding Green color contour, every part out of Houghcircles is removed to decrease noise and error. Now, the algorithm can detect ball and middle circle candidates. Finally, to remove false results, white and green area percentages of each circle is calculated and the biggest circle with 50-70 white area

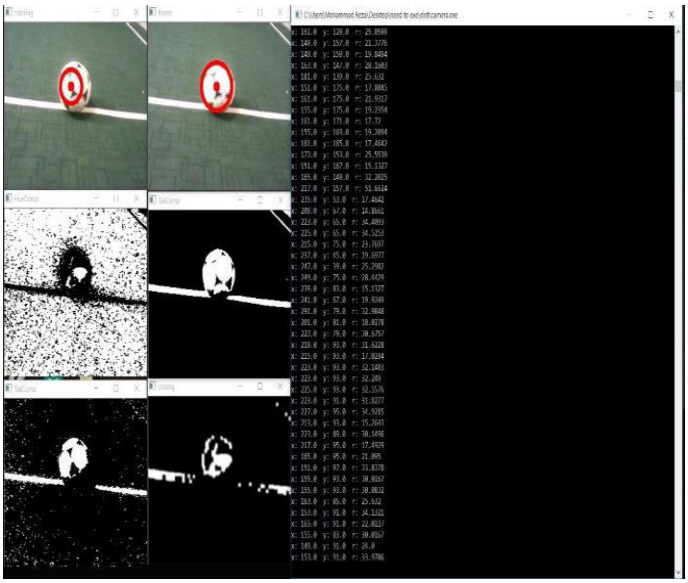

Fig.6 , Image Processing

percentage and with a radius larger than the threshold, is indicated as ball. The middle circle is detected in the same way.

We are working to perform specific changes on the idea to decrease error rate and in the next stage, to train the robot to detect the ball.

3.3. Localization

After investigating various methods of other teams used for localization problem, our robot performs the algorithm described here, which is based on results of the method used in AUTMAN 2013[10] and Baset Teen-Size [1]. We use Kalman Filter, and robot's longitudinal distance from its goal line, latitudinal distance from goal and orientation are denoted respectively by x, y, z. To get more precise information about robot's position, we use visual features and compass(?), in a way that center circle and sidelines, in addition to compass data and IMU, indicate robot's current position relative to original position. Our main problem with this method is that if by any accident, the robot loses its position, we have to move it to the original position. We are trying to solve this problem.

4. Conclusion

This document is a brief summary of research studies on Teen Size and Kid Size Humanoid Robots by Unbounded Designers team. This team is supported by the Islamic Azad University of Isfahan and hopes to introduce its final open source design to market. Also, we try to develop principles and algorithms in motion control, image processing, localization and etc., under the support of the Islamic Azad University of Isfahan.

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