LIKE A HUMAN : Proposal of the next stage of RoboCupJunior Soccer

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Abstract

The international rule of RoboCupJunior Soccer challenge is being improved every year for aiming better achievement of providing authentic learning for kids worldwilde. Recently we are worried about that the shape and mechanical part of the soccer robot in the international competition looks not so improved past few years. But the technology that used in the robot becomes latest and high without understanding details inside. This paper shows one alternative approach to address participants to be aware of RoboCup landmark and encourage them to pursue new idea to solve issues to achieve our goal. Basic idea of this proposal is to improve the rule both according to our goal and making more simple but adding difficulty by nature. We also show some practice based on this proposal in Japan.

Keywords: RoboCupJunior Soccer, Proportion of the robot, Center of gravity, Authentic learning

1. Motivation of this Proposal

At the start point of the RoboCupJunior, we try to figure out what is the goal of RoboCupJunior. Of course RoboCupJunior shares the goal of RoboCup itself and supports to be able to achieve the goal from the point of views of education, especially in primary and secondary grades education. We know that the RoboCup activity is one of the 'Landmark Project' such as Apollo mission. RoboCup Soccer has the mission, "By mid-21st century, a team of fully autonomous humanoid robot soccer players shall win the soccer game, comply with the official rule of the FIFA, against the winner of the most recent World Cup."(See RoboCup. So we RoboCupJunior also share this mission and have to break down to junior level subgoals toward it. But when we look back over the past few year's changing of international rules, we had good progress for achieving RoboCup mission such as Soccer B new field that has while lines instead of walls. But on the other hand, also not so good changing for avoiding not well controlled violent robot, such as the weight limitation and power limitation of the kicker. It seems that current direction of soccer rule's changing is little bit confused. In the human soccer, there is no limitation of player's weight or muscle power. This kind of rule looks just for the robot player, cannot share with human players. In this paper, we would like to recall the nature of the mission of RoboCup and propose the new rule items that aim to give RoboCupJunior participants more educational questions to encourage pursuing with their own ideas by themselves.

2. Basic Concept of the new rule

Core ideas are following 2 changing to make the robot more 'unstable' so participants should think more carefully and need not just new technology but more ideas to construct their robot and control system.

1) Changing the size and proportion of the robot to make more unstable, more slim and tall shape like a human.
2) Restricting the position of the center of the gravity to make more unstable, more higher like a human.

In this report, we introduce detailed policy of changing rule, sample implementation, and show some demonstration of the robot implementation and the game play in Japan.

3. Core definition of the new rule

When we think about the nature of the proportion and weight distribution of the human body, current proportion

(See Fig.1 left) and weight limitation, lightweight ≤ 1.1Kg and Open ≤ 2.4Kg in the Soccer rule is definitely not same as human. Biggest differences are 1) footprint of the robot is too wide rather than the human and 2) center of gravity of the robot is too low. For those reason, the robot is so stable that teams can easy to make much stronger attacking robot by choosing bigger battery, more powerful motor, more powerful actuator for the kicker. Followings are illustrating how to improve the rule to address the nature of making the robot can play with human more closely.

3.1. Size/Proportion of the robot

First of all, compare with the proportion of the human body, the footprint of the robot should be more narrow rather than the height. And shape should not be so different from the human body. Fig.1 shows Japanese, male, 20-24 years old, average size of each part in the human body. According to this proportion, we decided the first version of the size/proportion of the robot as the right figure of Fig.2.

First of all, basically the bottom footprint area is reduced and make more slim. On the other hand, because of the limitation of participant's using technology especially currently most teams using wheels for robot movement, the bottom footprint shape is not like human foot. But important thing we have to keep like human foot is to make the area of the footprint is quite same as human's. So the right figure in Fig.2 shows the 15.0cm width and 7.0cm depth rectangle.

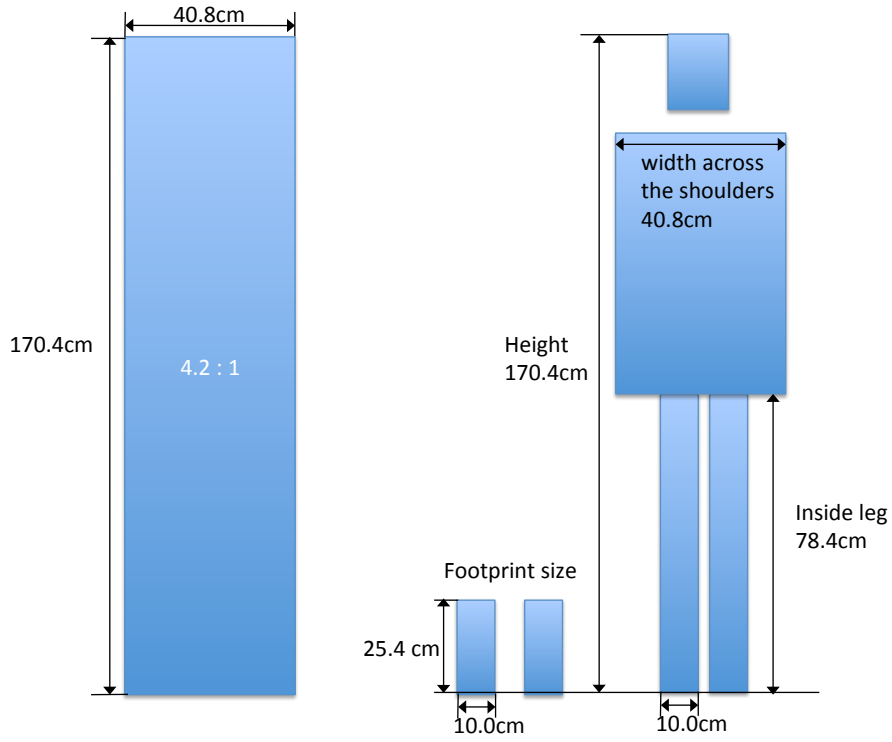

Fig.1 Japanese (20-24 years old, male) average size of each part in the human body (METI 2007)

Second thing we have to think is the proportion of the width and the height of the robot. According to human, the ratio is about 4:1 approximately. If the height stays 22.0 cm as same as current rule, the width should be about 5 cm. So we finally decided the size of depth of footprint as 7.0cm. If we change the height more tall, it becomes more suitable. That depends on the participant's technology and the size of the field, if make the field size more wide, it would be able to make more tall.

And more, the right figure of Fig.2 shows much wider area in upper of the body. That depends on participant's technology. Their robots use not so small elements. And more, that shape and proportion depends on the limitation of center of gravity showed below. Along with new limitation of center of gravity of the robot, in most case participants have to think the position of heavy elements in their robots. Motors and batteries are one of the most heavy elements, but the motor may be stay lower part, so most of other main parts have to put in upper part.

So this new rule of the size/proportion makes the room for those stuffs.

Third thing we have to think about is the kicker and the dribbler. In the future participants would has enough technology to make 2 legs robot, we would not have to care about the specific kicker mechanism. Until changing the situation, we have to continue to take care of participant's needs of using kicker and dribbler system. For the dribbler, if all parts of the dribbler are inside the rectangle, it is regal. Related to this, limitation of the depth of the ball capturing zone is same as current rule, 3.0cm or less.

On the other hand, all parts of the kicker should also be inside the rectangle except the kicking part. Only kicking part can extend 3.0cm maximum, but the linked part of the kicking part should be 3.0cm or high. This is for avoiding the kicking part becoming the third leg to balance the body of the robot like Fig.3.

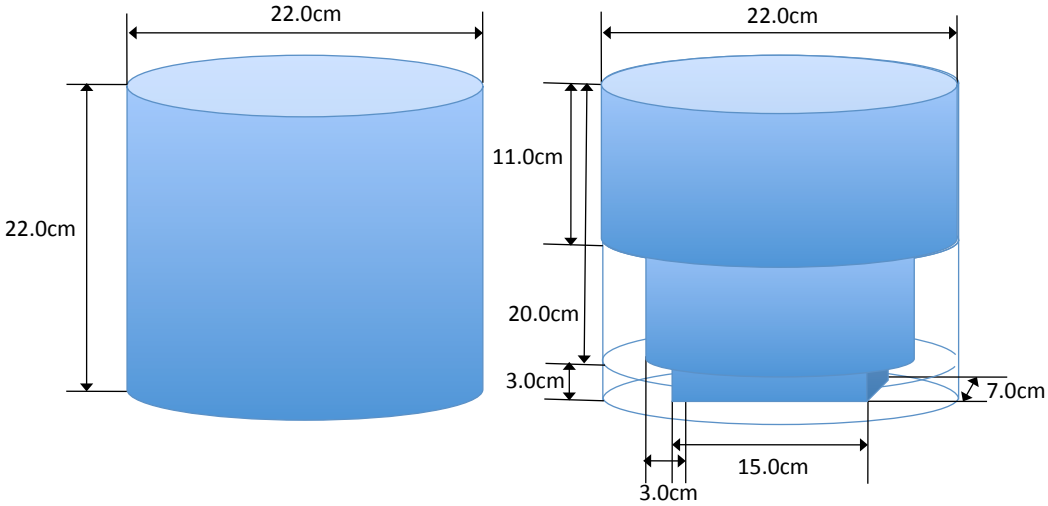

Fig.2 Size/Proportion of the robot for new rule

3.2. Limitation of center of gravity

Human male's center of gravity is approximately 56% height from the ground and female's is little bit low but upper from the center of the height (Susan L. Roberts 2005). Add new rule "Center of gravity should be at the center of the height or higher like Fig.4.

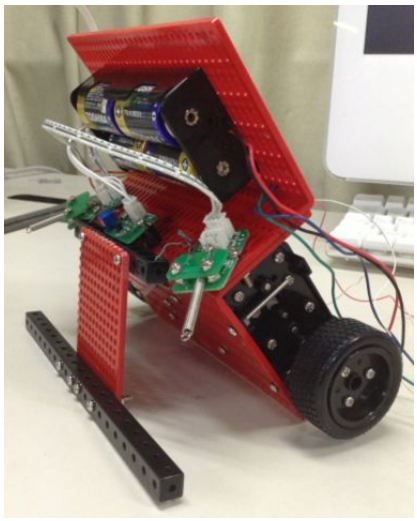

Fig.3 The kicker issue

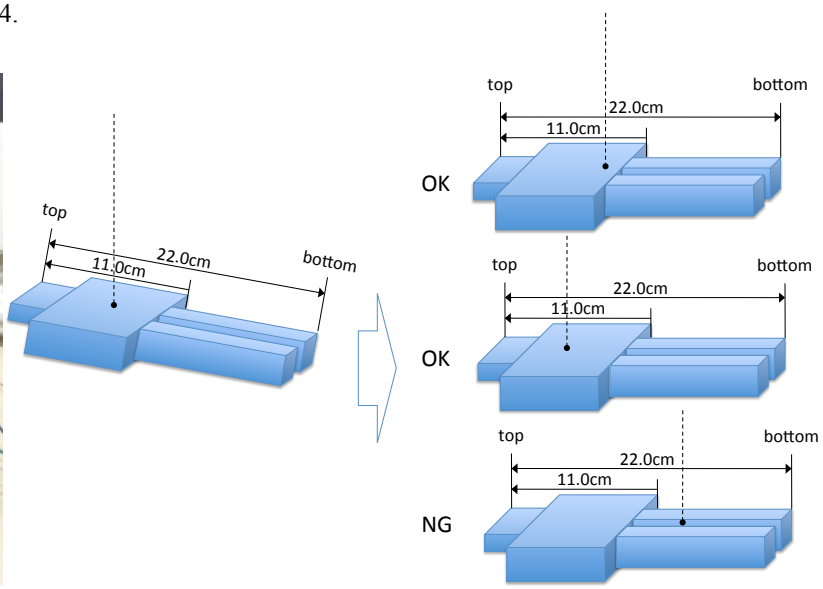

Fig.4 Limitation of the center of the gravity

3.3. Removing other limitations

Instead of changing the size/proportion of the robot and adding the limitation of center of gravity, remove the weight limitation and the power limitation of the kicker from the rule. By nature, those limitations come from the aim of avoiding so strong attacking root. But by changing above two points, participants have to control so

carefully that spontaneously they decide to reduce the speed and control delicately. We already found some evidence in our practical research.

4. Practice of Japanese students

During Sep 2012 to June 2013, we try to use this new rule in some educational activities. One high school student made original robot based on the commercial kit according to this new rule. Fig.5 shows two types of robots, one has the kicker system. Unfortunately the footprint of this robot is little bit different from the new rule in Fig.2. The width of the bottom footprint is almost 20cm because of this student's less skills and known technology. But this robot is still enough unstable as aimed. This robot used the Arduino compatible controller board and programmed by C++ language with Arduino IDE. This student had experience of making the soccer robot according to current rule and first of all, this student tried to program usual way. But soon he found that it was impossible to control even just move forward without control the speed gradually. He did not know about the principle like PID control, but he tried to find the better speed at the starting point and at the stopping point and programmed 3 steps speed control routine. Finally he succeeded to realize the basic motion like forward, backward, left and right turn. For kicking system, this time he could not finish his software to realize kicking motion.

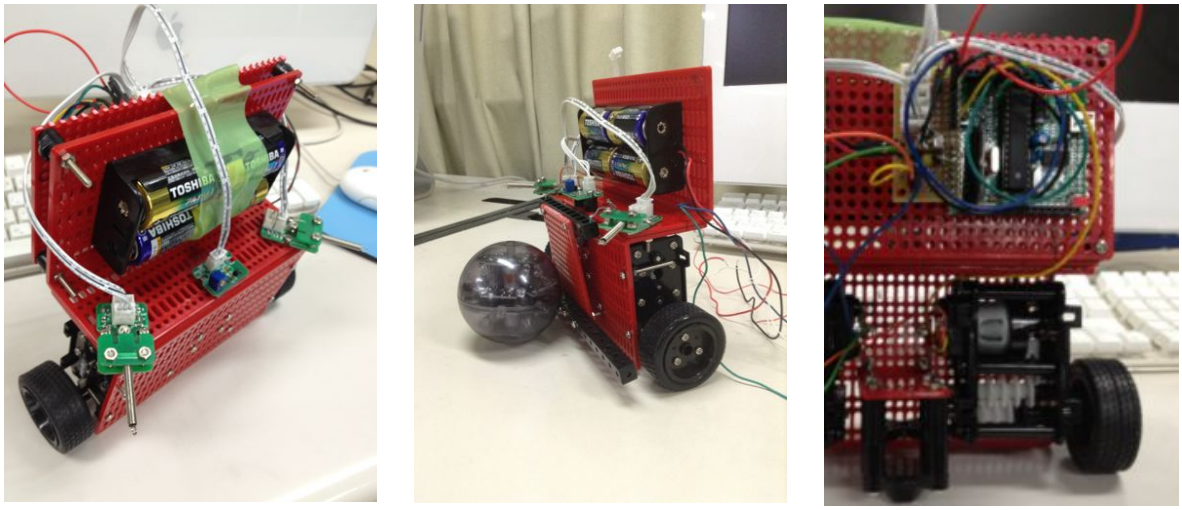

Fig.5 Original robot based on the commercial kit

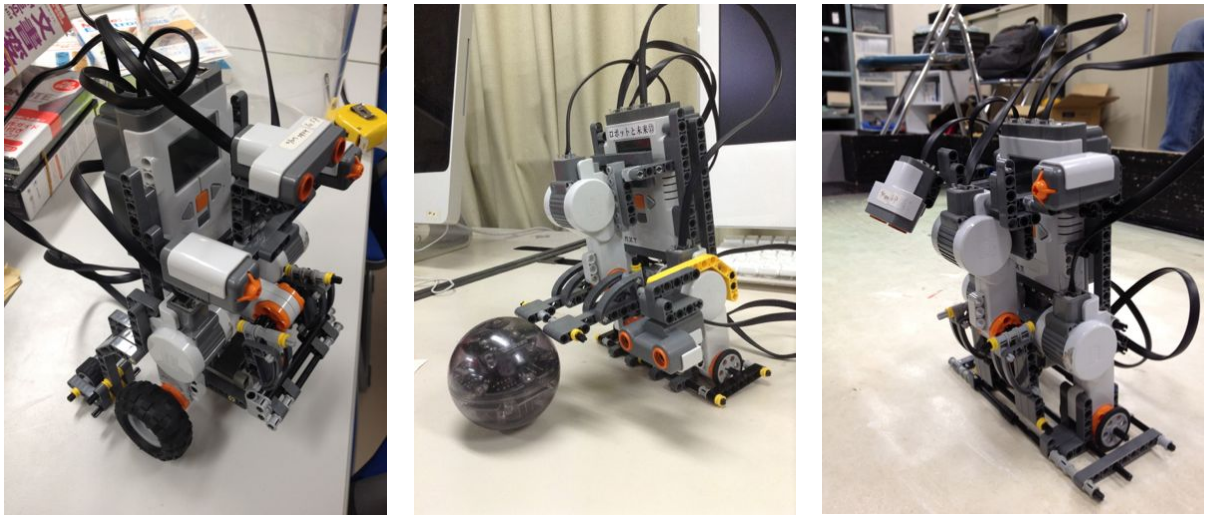

Fig.6 students made LEGO NXT based robot

On the other hand, 4th grade to 6th grade elementary school 3 students tried to build their robot according to this new rule with using LEGO NXT kit. All students of this group could not make the model by themselves so we

gave them the example model (Fig.6) and instructed them like “First of all, make your model by seeing this example but may not make strictly same shape. All students made almost same shaped robots as the example, and programmed by using Robolabo software. Those students also finally could control the robot by changing the speed gradually. And more, when use the kicker, they found the idea of avoiding fall over the robot by add the motion of go back a little after kicking.

Fig.7 Compete the soccer game with 4 robots

Finally those 2 groups came together to do the competition like Fig.7. All robots did not move so aggressive but more excited by watching well thought ideas for controlling the robot more stable.

5. Discussions and Conclusion

During our some practical research, we found the possibility of changing the rule as proposed to reduce aggressive motion. And more this change give them the opportunity to think not only just making the robot, but also focus on the human motion much carefully. But we have to continue to test following topics.

1) Try to have practical activity for more variety of students. Especially we have to test to higher age students with high skills and knowledge.
2) Try to gather many models students made and find the possibility of the flexibility, freedom of the implementation. Also have to find the variety of materials that effects of controlling the position of center of gravity. If students would be able to get the material that is very high specific gravity easily, they could make more stable robot easily.
3) Try to find the path to make the 2 legged robot not only adopting the rule but also finding the possible way of learning technologies related to 2 legged robot by students themselves. For example we should thing about the difference of the speed between wheel robot and 2 legged robot, but it is not good to separate the league for each by each because making many leagues goes to complicated running of the competition.

We hope this practical research help to improve RoboCupJunior activity especially Soccer challenge and give participants more opportunities to learn more scientific and authentic.

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