Robot Contest for Innovative Development in Education Technology

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***Abstract*—Robotics has taken on a multifaceted role with outstanding development such as in the development of robotic technology and automation, medicine, and industry. This research aims to encourage students to practice their skills in science, technology, engineering, and mathematics. It results in practice, analyzing and solving problems, and working together as a team. They will also be able to participate in a robot contest to find a Thailand representative for the upcoming Asia Pacific robotics competition. Researchers and students from the Department of Electrical Education, Faculty of Industrial and Technology Education, King Mongkut's University of Technology Thonburi under the team "MODFIRE@FIET" joined the robot competition from 2013 to the present. Each competition will evaluate the performance of the robot with a unique criterion. This results in the student's commitment to develop a robot to work effectively under the circumstances. The team has developed the knowledge of robotics and automation and controls the main work with Arduino. Each contestant will have two robots, a Manual Robot and an Automatic Robot. Both of these robots have different designs, structures, and mechanisms from generation to generation, under the rules of the year to reduce the system crashes. Our team is focused on designing robots with a simple and appropriate mechanism to carry out the mission. In the future, the researcher aims to provide the robot as part of the development of teaching and learning for students. Let them know, analyze, and further their knowledge to apply to technology.**

***Index Terms*—ABU robocon, robot competition, robot education, innovative in education**

I. Introduction

Asia-Pacific Broadcasting Union: ABU is an organization that is set up to compete in robotics using a robot based on the NHK Robocon of Japan. The objective is to develop knowledge and ability to "produce" associated members of the Asia-Pacific Broadcasting Union (ABU) continually. The robot production of university students to compete in the ABU Robocon of Japan has been supported by the company since 1988. Later in 2002 it was renamed to ABU Robocon and still involves organizing a robot contest every year. Participating countries will come from around Asia, about 20 countries or about 1,000 teams [1]. For ABU Robocon, the idea is to expand the program internationally, leading to the development of youth in the Asia-Pacific region. Various promotions lead to the development of knowledge skills, and creative ability, including the introduction of various technological innovations applied to the design and construction of robots to be used in the competition [2]. From this concept, it resulted in having ABU Robocon. The tournament is held every year. Countries that are members will rotate to be a host. For the role of the host country, often the competition rules reflect the culture of the host. Recently in 2018, the Asia-Pacific Broadcasting Union (ABU) has designated Vietnam (the official name is The Socialist Republic of Vietnam) to host the ABU Robocon 2018 competition under the name "Shuttlecock Throwing" [3].

Researchers agree with the spirit of competition management, focusing on ABU Robocon as a target for creating robots with innovative technologies. From the ability of senior students to the younger generation is a limitless development. Due to the fact that the competition was evaluated it is understandable that attitudes to getting attention to ABU Robocon are evident. The researcher will introduce the robot system to develop the application as a teaching style in the classroom [4, 5] to facilitate the learning of learners in electronic, magnetic, and mechanical technology innovation [6]. It is also the basis of software development to publish to next generation learners.

II. How to Design a Robot

In the design of robots to participate in ABU Robocon robots, there will be rules that change every year.

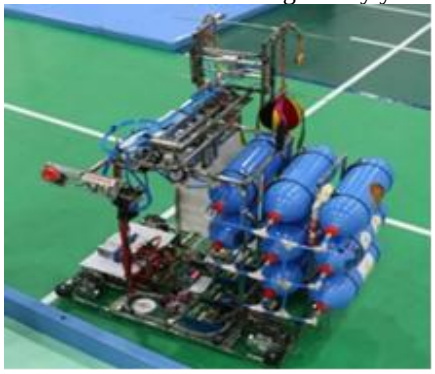

Figure 1. Exhibits the appearance of a hand-built robot.

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This year, 2018, Vietnam will host a competition. The concept is of developing a robot from the Vietnamese folk game called "*Throw the ball*". The competition will be a competition between two teams. Each team will have two robots, manual robot and automatic robot. The team that made *Rong Bay* before or the team that scored the most in three minutes will win [3].

For design and development robotics to participate in this competition, it is divided into two parts: hardware [7, 8] and software [8, 9]. Each section has the following details:

A. Hardware Design

1) Manual robot

For the design of the hand-held robot, it is possible to move from the beginning and then to pick up the ball to send to the robot automatically and move back to pick up the golden ball and then send it to the robot automatically again. It is precisely designed in the following way:

- The part of the forced robot to use the joy box is the robot controller. It is because the X box is an analog system, it can be used to force the robot to move slowly or quickly. They can be forced to move in a narrow way which is difficult to do automatically.
- For the wheel, it will use four wheels of maximum because it's better than the Omni wheels. It can move in four directions and is easy to tighten by hand. As a result, the robot moves to the desired point precisely.
- The drive motor board can drive an 80A type H bridge to control the DC motor. The voltage is 24V and the speed is around 500Rpm. It can adjust the speed of rotation of the motor to slow or fast for moving robot as required [10].
- The pneumatic cylinder (pneumatic system) is used for stretching or shrinking to catch the ball and to rotate the top mechanism of the robot to send the ball to the robot automatically and rotate back to its original position.

Figure 2. Outlines the appearance of the auto-generated robot.

- A control system of Arduino Due Boards works with all the microcontrollers of the device and is used with the joy of the X box in the manual robot [11].

The completed hand-held robot will look like Fig 1.

2) Automatic robot

The automated robotic design accepts normal balls and gold balls from the robots and then throws the ball in each designated zone. The normal throws in the throw area 1 (TZ1) or in the throw area 2 (TZ2), and gold balls throw in the throw area 3 (TZ3).

It is designed to allow automatic robots to move from the pickup point to the various zones. Arduino dues the main control for all devices. The details of the design are as follows.

- The automatic robot movement will use the microcontroller program to control the automation by pressing the keypad to run.
- The wheel section uses Omni wheel for four wheels to move. It is an easy to design automotive system in order to move the robot to the point where it is precisely.
- The drive motor board can drive 80A motor with type H bridge. It controls a DC motor voltage 24V, speed 500rpm. The speed of rotation of the motor allows the robot to move slowly or quickly [10].
- The encoder section is used to control the rotation of the motor to check the movement of the robot and automatically stop in the waiting position of the robot.
- The infrared sensor section is used to check the distance from the robots.
- The limit switch is used to check when the limit switch is touching the edge of the field.
- Sections of Line Track Sensors are used for forcing automated robots to stop and rotate in position with the ball thrown into the ring. This will work alongside the limit switch.

Figure 3. Show the delivery of the robot from manual robot to automatic robot.

- Part of Linnaeus is used to adjust the pitch of the ball in each ring, which has the different height of the pole [12].
- The pneumatic cylinder (pneumatic system) is used to pull the wood and throw the ball into the ring. This affects the robots' ratings. Therefore, it must work precisely. It is also used to rotate the base of the robot automatically, resulting in

reduced mobility. It also includes the ball to keep still. Do not let the ball swing before throwing the ball.

- Arduino due board is the main control of all devices in the robot [11].

The completed automatic robot is shown in Fig 2.

B. Software Design

The development of the program to control the work of both robots will begin with the development of the program to control the four-wheel motor of the two robots to move in 8 directions [12, 13].

Next, it will be the part of the robotic arm control system for the robot arm to control the clutch range of the manual robot and then send it to the robot automatically. As shown in Fig 3, the automatic robot will have sensors to detect whether the ball has been received. If received, the robot automatically moves to the throw zone (TZ1) or to the throw zone (TZ2) to throw the ball to the ordinary ring. If normal balls pass through the normal ring, it will be considered, and the robot can do the next mission to pick up the gold only when the team can score from the regular ring in the TZ1 and TZ2 areas at least once. When the first mission is accomplished, the robot automatically moves back to wait for the gold in the receiving zone (CRA). Then the robot moves to the loading area to pick up the golden ball and sends it to the robot automatically. After the robot automatically receives the golden ball from the robot the robot automatically moves to the 3rd throw zone (TZ3) in order to throw gold balls to the gold ring. If the gold ball passes through the ring, it will be considered. If the gold medal passes through the gold ring and goes down on the gold medal (GC), it will be considered a winner of the "*Rong Bay*" (*Dragon Fly*) competition and the match ends.

C. Example of Software Design

Examples [14] of programming a robot to do some of the tasks are:

Case 1: The robot moves automatically from its start point to the catch point (CRA) to point 1 (TZ1) as shown in Fig 4.

Case 2: Automatic robotic movement from the TZ1 throw zone to the TZ2 throw zone to throw the ball to the normal ring as shown in Fig 5.

TZ1 area1

```
void Area1(int encode) {
 if (step == zone1_step1) {
        if (digitalRead(om) == 1) {
              move.Backward(0, 200, 200, 0);
        } else if(digitalRead(RLIMIT1) == 1 &&
              digitalRead(RLIMIT2) == 1)
        {
              move.Backward(0, 50, 50, 0);
        }else
        {
              reEncode;
              step = zone1_step2;
        }
        } else if (step == zone1_step2) {

        if (currY <= 6000 ||digitalRead(om) == 0 )
        {
             updateEn_Y();
             move.Backward(100, 255, 255, 100);
        }
        else
        {
              step = zone1_step3;
              //reEncode;
              move.Stop();
        }
        }
}
else if (step == zone1_step3) {
        static byte re = 0;
        if(re == 0)
        {
              reEncode;
              re++;
        }
        updateEn_Y();
         if (digitalRead(om1) == 0 ||
          digitalRead(RSENSOR)
           == 0 ||digitalRead(RSENSOR1) == 0) {
        move.Backward(100, 100, 100, 100);
        }
        else if(digitalRead(RSENSOR) == 1 &&
             digitalRead(RSENSOR) == 1)
        {
              move.Stop()
              step = zone1_step4;
              reEncode;
        }
  }
```

Figure 4. Application of robot program (TZ1).

TZ2 area2

```
void Area2() {
        static int f = 0;
        static int ff = 0;
        static int fff = 0;
        static int ffff = 0;
        static int gg = 0;
        if(step == zone2_step0)
        {
              LEDOFF;
              move.Stop();
              Wire.beginTransmission(44);
              Wire.write("c");
              LEDON;
              Wire.endTransmission(44);


              Wire.requestFrom(44, 1);
              char c = ' ';
              if (Wire.available()) {
                    c = Wire.read();
              }
if (c == 'c') {
              LEDOFF;
              reEncode;
              line = none;
              zone = zone2;
              step = zone2_step7;
              timing = 0;
        }
}
else if (step == zone2_step1)
{
        static int flag = 0;
        if (f == 0)
        {
              reEncode;
              f++;
              timing = 0;
        }
        if (currY <= 3500)
        {
              updateEn_Y();
              if (currY <= 1000)
              {
int val = map(currY, 0, 1000, 80, 250);
        move.Backward(val, 0, 0, val);
```

Figure 5. Application of robot program (TZ2).

TZ3 area3

```
void Area3() {
static byte f = 0;
static byte ff = 0;
static byte fff = 0;
static byte a = 0;
if (step == zone3_step1) {

        if (f == 0) {
                reEncode;
                f++;
        }
        if (currX <= 17500) {
                updateEn_X();
                if (currX <= 2000) {
        int val = map(currX, 0, 2000, 80, 255);
        int val1 = map(currX, 0, 2000, 20, 120);
        move.MoveTrackRight(val, val1, val1, val);

 } else if (currX <= 15500) {

move.MoveTrackRight(255, 120, 120, 255);
                } else if (currX <= 17500) {
                LEDOFF;
                int val = map(currX, 15500, 17500, 255, 75);
                int val1 = map(currX, 15500, 17500, 120, 10);
                move.MoveTrackRight(val, val1, val1, val);
        }
        } else {
        move.Stop();
        step = zone3_step2;
        timing = 0;
}
} else if (step == zone3_step2) {

updateEn_X();
if (digitalRead(LEFTLINE2) == 0 && digitalRead(LEFTLINE3) == 0 &&
digitalRead(LEFTLINE1) == 0&& digitalRead(LEFTLINE4) == 0
&& currX <= 30000 && a == 0) {
        move.MoveTrackRight(75, 10, 10, 75);
        } else {
```

Figure 6. Application of robot program (TZ3).

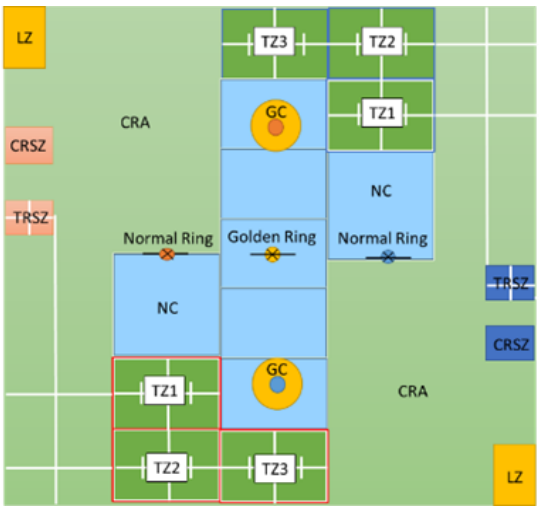

Figure 7. Competition field (plan view).

Figure 8. The shape of the balls.

Case 3: The robot moves automatically from the throw zone to the 3rd position (TZ3) in order to throw gold balls to the gold ring. If the gold ball passes through the ring it is as shown in Fig 6.

The area of the throw zone and the shape of balls are shown in Fig 7 and Fig 8, respectively.

III. Robot Test

For the robot test, the design is divided into two tests: tested with a simulated field and real field. For the simulated field, the environment is very close to the real field. Manual robots and automatic robots can work together perfectly by throwing a regular ball from the throw area 1 (TZ1) and the throw area 2 (TZ2) through the ordinary ring. The results show that the automatic robot can throw both poles and can throw the gold ball from the area of throwing ball 3 (TZ3) through the ring successfully. They can also be thrown into the gold cup (GC) 9 times from the 10 tests. The mission ends within the time limit. For the problems that our team encountered, the problem at the beginning of the test is the problem of the paper pulp used to make the ground is not the same thickness. This causes the robot to move with some rhythm. However, the team members can completely resolve this issue and test the system to be stable until the competition.

Figure 9. The real situation for competition ABU Robocon 2018.

Testing the robot in the real field (test run) before the match, our team had some problems due to the color of the ground which was not dry. Also, the pitch is slightly different from the rule, so the motor cannot move to the specified position during the first phase of the test. However, the team modified the robot by adjusting the Limit switch to be lower and reduce the speed of the robot. The solution to these problems is to fix the actual page. Once these problems have been resolved, the robot can move and complete the mission in the real field.

For the real situation that can be recorded in the ABU Robocon 2018, shown in Fig. 9.

IV. Results and Discussion

The robot we created took part in the ABU Robocon Robotics Competition 2018 to find a representative of Thailand to compete in Vietnam. The result of the match was that in the first match, the team's robots were able to defeat the team from the match as tested. The second match of the team encountered a problem during the match on the field, which resulted in the automatic robot being unable to work as expected due to the Limit switch.

This is a function of the edge of the field to stop and rotate the robot and throw the ball during the fracture. The robot cannot go to the mission successfully, so it loses. When the second match ended, the team hastily brought the robot back to the robot stop to change the limit switch and do the test runs with the full system again. Therefore, the robot was working normally. In the final match, which is very important to the finalists, our robots were ready to go down the field.

During the match, the team faced the problem of manual robots being unable to work as expected. Due to the manual robots having heavy duties during the test run through the race day, the gears in the motor controlling the movement of the robot were broken. The manual robot cannot move to send the ball to the automated robot automatically, so it lost. The problem is we sometimes cannot control the robot. But one thing we got from this competition and the previous one was friendship between matches. These are more valuable than awards. The friendship between the teams participating in the exchange is an exchange of ideas, knowledge, skills and experience [15]. These experiences cannot be found in the classroom and will be relayed to the younger generation in order to develop the robot innovation in the next year to be better.

V. Conclusions

By encouraging students to practice their skills in science, technology, engineering and math it resulted in practice, to analyze and solve problems, and work together as a team [16]. They also had the opportunity to participate in a robot contest to find a Thailand representative for the Asia Pacific robotics competition [17]. Then students have the knowledge to do robotics both in structural design and programming, including the knowledge that has been applied to the robot. It is a team event involving practice and learning to plan. It also creates experience for students and teachers in a robot competition with different entrants. The things that have been learnt could also be applied to life.

Conflict of Interest

The authors declare no conflict of interest.

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