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Development of Static Kick by NAO

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Abstract **- NAO, a humanoid robot is being extensively used at RoboCup, an international robotic soccer competition. Different universities around the world take part in it with their own NAO and their algorithms to make NAO play soccer. Right now, we have exhibited the route framework for the NAO that looks for a red ball, explore to it, and kick it to the goal post. The proposed work is approached in two ways - (1) one is similar to a penalty kick and (2) is kicking the ball kept anywhere (range of 1.5-2.0 m) in a frontal hemispherical plane corresponding to the robot. The proposed strategy utilizes information obtained from the 2 cameras mounted on the robot to locate the ball and to explore towards it after. Thereafter, it will take an image of the goal post using its upper camera and adjust its angular position with the goal post. Finally, it will take an image of the ball from its lower camera and adjust its position to kick the ball with the right or left leg whichever is nearer to the ball.**

Index Terms **- RoboCup, Detection, Tracking, Kicking**

I. INTRODUCTION

Robotics is an ever-expanding division in Engineering and Computer Science. As we start the 21st Century, innovation in this field is developing significantly, and such exponential rates are frequently overpowering. [3] The paper intends to line up with those of the authority RoboCup Federation, a global association, enrolled in Switzerland, to arrange worldwide exertion to advance science and innovation utilizing soccer matches by robots and programming specialists. [4]

Autonomous navigation and tracking require appropriate modelling of the environment [1]. Astounding advancements have been done throughout the years and there is continuous research each year. For this task, we use NAO, a total humanoid robot made by Aldebaran Robotics. NAO has 2 cameras mounted on his head which give an augmented field of vision, making it ready to find before him or at his feet. The broad capacities because of the assortment of sensors that he has in addition to its simple to-utilize SDK settles on him an amazing decision to intertwine computer vision and movement dynamics into one single task. Right now, will enable NAO to play out a low-level control of movement as well as utilizing his cameras for streaming pictures and do further handling the video for tracking an item. This idea has been generally utilized in a well-known competition called RoboCup that happens each year, where robots play soccer among themselves. [1]

We used a polymer sheet for NAO to walk for the secure movement of NAO for testing purpose. NAO will find the ball, move to the ball, change walking speed as moving towards the object, adjust and focus on the kick, and kick the ball to the goal line. We are using a Red Ball, of 20 cm diameter and using a rectangular black box (50 cm X 40 cm) as a goal post.

The details of the NAO used in the project is as shown in the fig. 1. In NAO each joint has 25 degrees of freedom which enable him move and adapt to its environment. There are total of 7 touch sensors located on the head, hands and feet, sonars and an inertial unit to perceive his environment and locate himself in space. There's also 2 cameras and 2 speakers which enables him to interact with humans. NAO have a speech recognition of 20 different languages. It is also open and fully programmable.

Figure 1: NAO Robot Details

Since 1998 (With NAO from 2008) the RoboCup is held every year. The process of development towards positive punishment is going on since beginning. In [1] creators have utilized Reinforcement Learning to expand this to 85%.

Healthcare professionals are using humanoid robots in assisting medical procedures, sterilizing rooms, dispensing medicines and significant other activities.

Aside from its stability turns into a significant part when adjusting on one leg. The stability is grouped into two sorts:

A) Static Kicking

The continual feedback input from camera to body is not required for static kicking. It doesn't reconsider once the choice is taken. [1] and [2] examine keyframe based methodology utilizing Bezeir Curves which we have likewise followed.

B) Dynamic Kicking

PID (corresponding vital differential) is taken for dynamic kicking, by utilizing feedback controllers or the input from the gyroscopic sensor of NAO. NAO can opt whether the successive keyframes are steady or not. The papers depicting this are [3] and [4].

The perceptions gave by the lightweight sensors that are being normally utilized with humanoids are somewhat boisterous and untrustworthy. Accordingly, accurate navigation, which is viewed as predominantly tackled for wheeled robots, is yet a difficult issue for humanoid robots. Various papers are composed each year tending to this issue, particularly utilizing NAO [5]. In view of these publications, we devised a plan to make our own line of methodology which is clarified in the following segment

III. METHODOLOGY

For NAO to perform any task it needs to be trained using Choregraphe software having various modules for various task. We used pynaoqi, python-sdk having support for python libraries for connecting and performing certain tasks. We have provided two cases of how NAO would kick the ball which are as follows:

(1) *A Penalty kick can be broken down into the following steps (as shown in figure 2)*

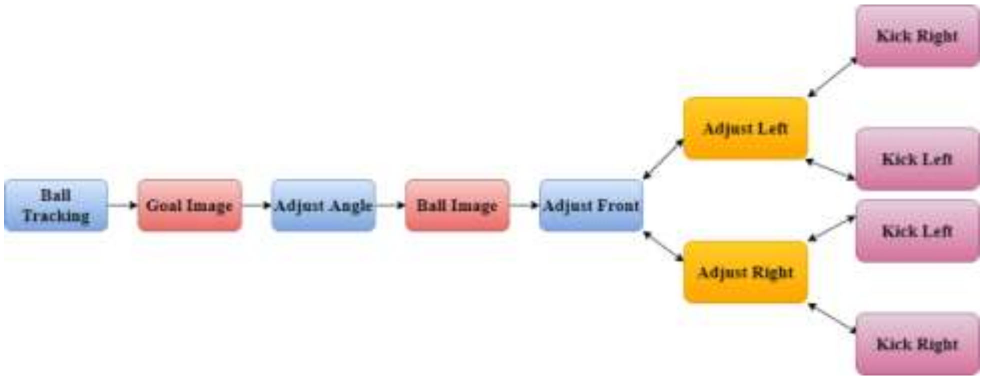

Figure 2: Penalty Kick Wireframe

Here, NAO would first look for the ball and will track it. After reaching to the ball (8 cm away), it would find the center of the black box meant as a goal post and would adjust its direction with respect to the goal. Again, it would look for the ball and adjust its position to kick with right or left leg whichever is nearer to the ball.

A) Ball Tracking

For detecting the red ball, we have used an API of PyNAOqi (ALTracker) where it is predefined. Also, we set a parameter for the ball i.e. diameter, its position with respect to NAO, and the distance from the ball where NAO will stop. In figure 3, radius of NAO’s camera is shown, if the ball is present in this radius, NAO can track the ball.

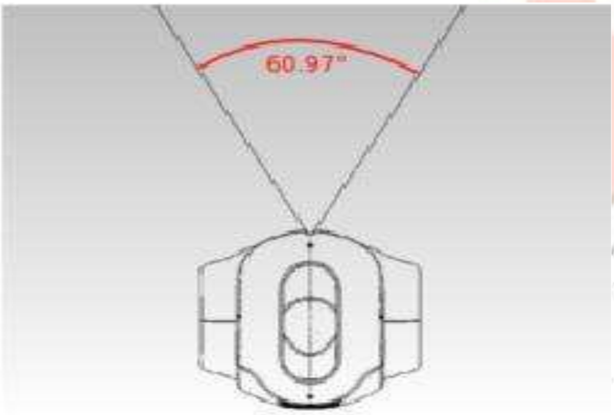

Figure 3: Top View of NAO Showing its Field of View

B) Goal Detection

NAO’s forehead camera is utilized for goal detection taking an RGB picture. It is converted first into an HSV (Hue Saturation Value) space and thereafter, adding a filter for Erosion and Dilution. Lastly, as shown in figure 4, the center of the goal is detected.

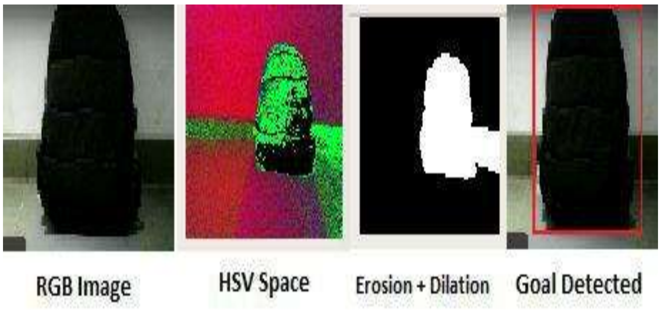

Figure 4: Goal Detection Images

C) Adjusting Angle

Figure 5, as shown below, depicts the change in body direction of NAO towards the goal. The KISS (Keep it Simple Stupid) model is used [6]. The ratio of pixels between two distinct point in a picture is equal to the ratio of their separation i.e. $P_{AB}/P_{AC}=D_{AB}/D_{AC}$

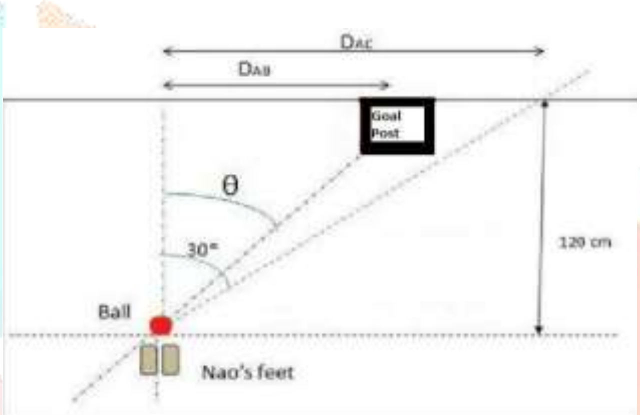

Figure 5: Calculation of angle to be adjusted

The area of vision covered by the upper camera is utilized to calculate D_{AC}. The perpendicular distance D is fixed at 120cm which is taken as limiting value.

To find θ¸ which is the angle between NAO and the goal post.

$\tan\theta = D_{AB}/120$

D) Ball Detection

The primary criteria for ball detection after NAO being stabled is the use of its lower camera. The value of HeadPitch[7] is changed from 0 to 29.5 degrees, so that it can look down fully. The identification of ball is done similar to goal detection, as shown below in fig 6.

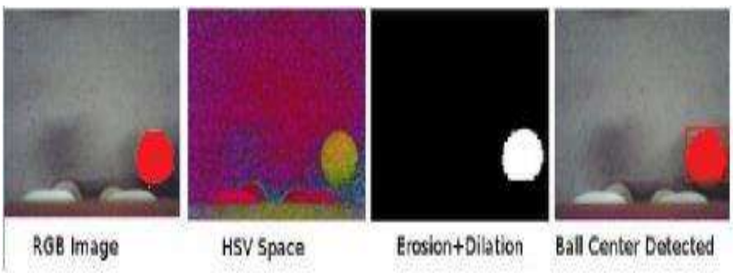

Figure 6: Ball Detection Images

E) Adjust Position

After the ball is located, NAO adjusts itself by moving left or right. As shown in figure 6, NAO moves ahead and then to the right to be in proper position. The number of steps taken is a component of the abscissa and facilitate to the ball in the picture.

F) Kick

Underneath in figure 7 you can see the 3 keyframes (can be seen conversationally as "screen captures"). Each keyframe showing HipPitch[7], KneePitch[7] and AnklePitch[7] points. Here, as opposed to utilize a movement motor [1] we have physically tested the aforesaid edges by checking the soundness of NAO in these positions.

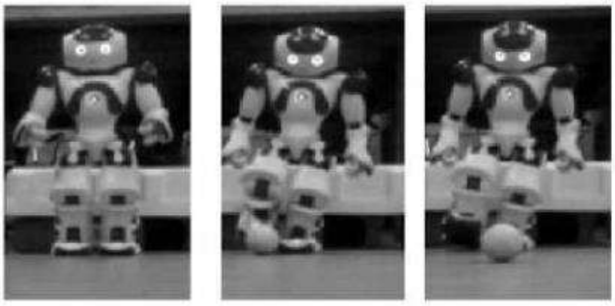

Figure 7: Keyframes for Kicking the ball

(2) *Kicking from anywhere in the frontal hemispherical plane can be broken down into the following steps (as in figure 8)*

Figure 8: Kicking from Anywhere Wireframe

Here, NAO would first look for the ball by turning its head in a semi-circle until it finds the ball and as soon as it will find the ball it will start tracking it. After reaching to the ball (8 cm away), it would again turn its head in a semi-circle and find landmark image as in figure 8 which is a predefined symbol for NAO to recognise as the landmark. Thereafter, it would find the center of the black region on the landmark image and it would adjust its direction with respect to the symbol (as explained above). Again, it would look for the ball and adjust its position to kick to the landmark symbol.

Figure 9: Landmark Symbol as Goal Post

Thus, the methodology is similar to as in penalty kick except for the head rotation which is as follows:

A) Head Rotation to locating for the ball

NAO will rotate its head 180 degrees sideways, until it sees the ball. In this process as soon as it locates the ball it starts tracking and moving towards it.

B) Head Rotation to locating for the landmark symbol

Here also, NAO will rotate its heads 180 degrees sideways to locate the landmark. As soon as it sees the symbol it will adjust itself towards it.

IV. RESULTS AND DISCUSSIONS

The percentage conversion of the penalty kick through our implementation is coming out to be 60 % in each test, where we run the simulation 10 times. And in case of kicking from anywhere in frontal hemispherical plane percentage success to kick the ball into the goal post comes around 30 %.

Thus, the failure rate to kick the ball, comes to 40% and the reason behind it depends on the characteristic of the floor, such as existence of small groves and slopes.

The limitation in kicking process is the vulnerability of NAO's joints which gets heated up after every 10 kicks. So, NAO needs an hour of inactivity before it can be used again.

It is very difficult to develop this project in the Choregraphe software, we had to use the pynaoqi, python-sdk for connecting and performing various tasks with NAO. And we wrote codes[i] using Eclipse IDE for designing our navigation system and for kicking the red ball.

V. CONCLUSION

Starting as of now we have executed just static kicking. For example, once the choice to kick the ball is taken, NAO will invariably kick, regardless the location of the ball. Dynamic kicking apart from above also include reception of feedback from gyroscope by which NAO will adjust itself. There is a lot of room for further development in future.

Likewise, at the present time, we just have a single type of kick for example no sidekick and so on. We can discover keyframes for perhaps, a couple of more kick types and apply reinforcement learning [1] which will settle on the choice procedure sound and improve the outcomes from 60% hit rate to 85% as expressed in [1].

VI. ACKNOWLEDGMENT

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VII. REFERENCES

[1] T. Hester, M. Quinlan and P. Stone, "Generalized model learning for Reinforcement Learning on a humanoid robot," 2010 IEEE International Conference on Robotics and Automation, Anchorage, AK, 2010, pp. 2369-2374, doi: 10.1109/ROBOT.2010.5509181.

[2] S. Czarnetzki, S. Kerner, and D. Klagges, "Combining Key Frame Based Motion Design with Controlled Movement Execution," in RoboCup 2009: Robot Soccer World Cup XIII, Springer Berlin Heidelberg, 2010, pp. 58–68.

[3] Y. Xu and H. Mellmann, "Adaptive Motion Control: Dynamic Kick for a Humanoid Robot," in KI 2010: Advances in Artificial Intelligence, Springer Berlin Heidelberg, 2010, pp. 392–399.

[4] J. Müller, T. Laue, and T. Röfer, "Kicking a Ball – Modeling Complex Dynamic Motions for Humanoid Robots," in RoboCup 2010: Robot Soccer World Cup XIV, Springer Berlin Heidelberg, 2011, pp. 109–120.

[5]Master's Thesis of Tomas Gonzalez Sanchez, Department of Computer Science and Mathematics, Universitat Rovira I Virgili, September 2009, 64-82

[6]Documentation of NAO by Aldebran Robotics http://doc.aldebaran.com/2-4/family/nao_dcm/actuator_sensor_names.html