Humanoid Robot: Throw Ball At A Target

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ABSTRACT

Our project aims to identify known target through ALDEBARAN NAO and then to throw an object towards it. In our project we first detect the known target using Image Processing techniques, then we compute the position of that object and finally we perform the throwing action.
The throwing object ability make a humanoid to manipulate the target or object outside the movable reach of the robot. In the throwing action the robot motion is quich and dynamic. There are many ways to perform this action and this makes the inverse kinematics very non-trivial. Also throwing action requires precision between the timings of different part. This project proposes the feedback learning based approach to throw objects towards target.

INTRODUCTION

- The interest in humanoid robotics has increased manifold especially in creating intelligent and autonomous bots. Humanoids are expected to perform day to day task and actions so that they become more interactive with humans.
- Performing throwing action is one such task which fulfills a whole lot of needs. It enable one to manipulate places out of ones direct reach. This procedure has many applications in army, humanoid game playing and several other fields.
- In our project, we detect the known target, estimate the depth and direction of the target using prior knowledge of the target size and specifications, perform throwing action using its right hand.
- Then we process the video and find the angle of throw and then calculate new angle of trajectory needed.

PREVIOUS WORK

- In [1] authors discuss the control for throwing manipulation by one joint robot. The present paper proposes the control strategy based on the iteration optimization learning to perform the throwing action effectively.
- In [2] authors formulises the idea of task-level learning to make a robot throw a ball at a target. Task-level learning can compensate for the structural modelling error of the robot's lower control system.
- In [3] author shows that reinforcement learning can be employed to refine the hitting skill acquired by imitation learning according to a cost function.
- Complete analysis of inverse kinematics of Aldebaran Nao has been done in "Complete Ana-lytical Forward and Inverse Kinematics for the NAO Humanoid Robot" by Konas, Nikolaos, Emmanouil Orfanoudakis, and Michail G. Lagoudakis
- Object recognition and depth estimation is proposed in [4]

METHODOLOGY

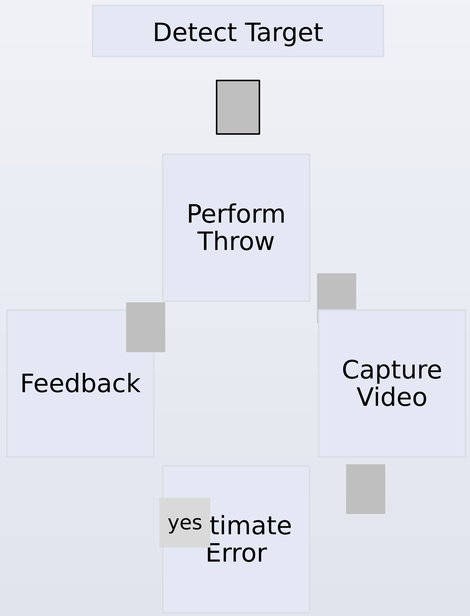
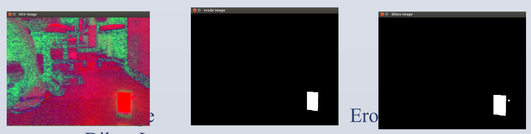


Figure 1. Flowchart depicting the approach.

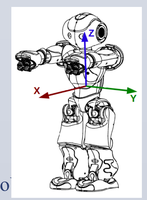
Detect Image

- NAO is fixed at a position.
- Convert RBG image to HSV as it produces better results for creating binary image and also it makes the computing faster.
- HSV to Binary Image by Erosion And Dilation.



Dilate Image

- Determining co-ordinates of the target
- Get target center and height.
- From the prior knowledge of height and width of the target, calculate x and y coordinates in nao torso frame.



- naoX = (imgX - imgWidth/2)*W_real/W
- naoY = (imgHeight - imgY)*a

Source: Nao Documentation

- Angle of throw in nao's torso: tan(θ) = naoX/nao

METHODOLOGY

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Throw Action

- Joints Used: RShoulderPitch, RShoulderRoll, RElbowYaw
- Learn parameters for throw in specific angles.
- For the given angle do the following:
  - Using binary search find the containing learned angles.
  - Assuming linear model, estimate parameters for the given theta.
  - Perform throw actions following these parameters.

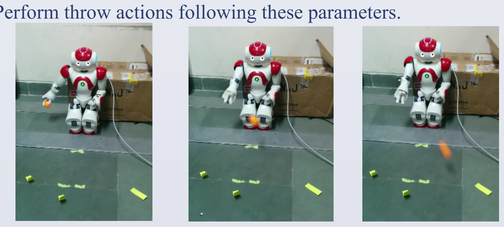


Fig: Nao throwing ball at a specified target point

Video Capture and Error Estimation

- As the nao throws the ball it simultaneously capture the video.
- From video, track the ball.
- Track the ball and note the point of contact with the ground.
- From this point, calculate the angle of throw (A)
- Compare A with θ, and error is difference of both.

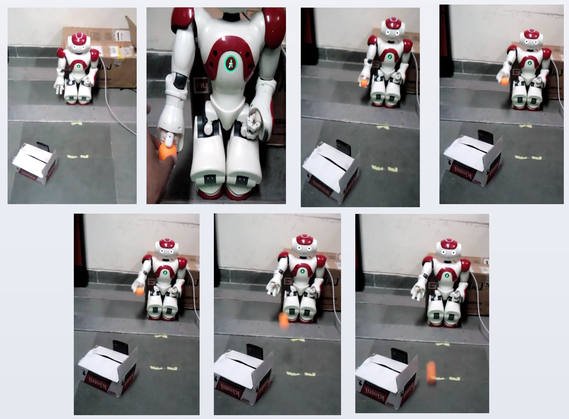
Fig: Track Ball In Video

Feedback

- B = θ-A
- θ2 = θ + B
- Perform throw action for this new θ2

RESULTS

- The method was tested with random position and average error is 5-10 degrees.



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- [3] Kober, Jens, Katharina Muelling, and Jan Peters. "Learning throwing and catching skills." Intelligent Robots and Systems (IROS), 2012 IEEE/RSJ International Conference on IEEE, 2012.
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IMPROVEMENTS AND FUTURE WORK

- If the target is not in field, nao does nothing. This can be treated by moving head to detect target and then performing throw action.
- Detecting target of different geometry and shape.
- Able to throw directly at the target.

ACKNOWLEDGEMENTS

We would like to show our sincere gratitude towards Prof. Amitabha Mukerjee, Department of Computer Science and Engineering, IIT -Kanpur for his valuable guidance throughout the project and to keep us motivated.
We would also like to thank the tutors, Mr. MS Ram and Ms. Sunakshi Gupta of the course for their support whenever we required.

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