EE106B Project Propasal

Catching a ball by Baxter

Spring 2018

1 Contact Information

Name	SID	Email
Yichi Zhang	27005775	784777187@qq.com
Jingjun Liu	3033483513	liujingjun@berkeley.edu
Jiarong Li	3033483511	jiarongli@berkeley.edu

2 Problem Statement

1. **Problem Description**
   We try to let Baxter catch a ball thrown by us. Firstly, we should recognize the moving object and predict the trajectory of the fast-moving ball. We used a series of cameras positioned around it to measure the trajectory, velocity of the ball to model its movement. Then, we predict the feasible catching configuration to catch the object. At last, we should plan the BaxterâĂŹs arm fast.

2. **Application**
   It is interesting to let Baxter catch a ball and there will be lots of application in it. To catch flying objects, a robot must react to unpredictable events and integrate several pieces of information in very little time. It demands for a tight interplay of skills in mechanics, control, planning and visual sensing to reach the necessary precision in space and time.
   For this fast-reacting robotics limbs, if we succeed in catching a moving object with random trajectory, we can use it in marine exploration, such as, catching delicate moving marine creatures in water currents with slippery biofilms. We can also use it in satellites to clean up some of the moving space junk in orbits.

3 Related Work

The first paper develop a distributed system to visual ball tracking trajectory by using online kinematically realtime optimization [1]. The second paper presents a realtime perception system for catching ïňĆying balls [2]. The third paper describe the result of catching flying balls [3].

References

[1] Berthold Bauml, Thomas Wimbock and Gerd Hirzinger, "Kinematically Optimal Catching a Flying Ball with a Hand-Arm-System," in *The 2010 IEEE/RSJ International Conference on Intelligent Robots and Systems*. October 18-22, 2010, Taipei, Taiwan.

[2] Oliver Birbach, Udo Frese and Berthold BÂÍauml, "Realtime Perception for Catching a Flying Ball with a Mobile Humanoid," in *2011 IEEE International Conference on Robotics and Automation*. May 9-13, 2011, Shanghai, China.

[3] Berthold BÂÍauml, Florian Schmidt, Thomas WimbÂÍock, "Catching Flying Balls and Preparing Coffee: Humanoid RollinâĂŹJustin Performs Dynamic and Sensitive Tasks," in *2011 IEEE International Conference on Robotics and Automation*. May 9-13, 2011, Shanghai, China.

4 Proposed Methodology (Project Description)

In this project, we are planning to grasp a moving object, hope that at the end of the story we are able to grasp a flying object that we throw to the baxter. Here are the steps and assumptions under each scenario.

4.1 Steps

1. In 2D case, we assume that we know the trajectory of a moving object parameterized by time, and try to grasp it. This is quite similar to the trajectory following task. We can apply the velocity controller and plan the motion for the baxter to make it follow the path and finish grasping.

2. Again in 2D case, we assume that we don't know the exact trajectory of the moving object, but we know that it is a ordinary geometric path, for example, an ellipse. In this case, we plan to use the camera to sample some positions of the object, and do polinomial regression to extract its trajectory. The following thing will be the same as what we plan to do in senaro 1.

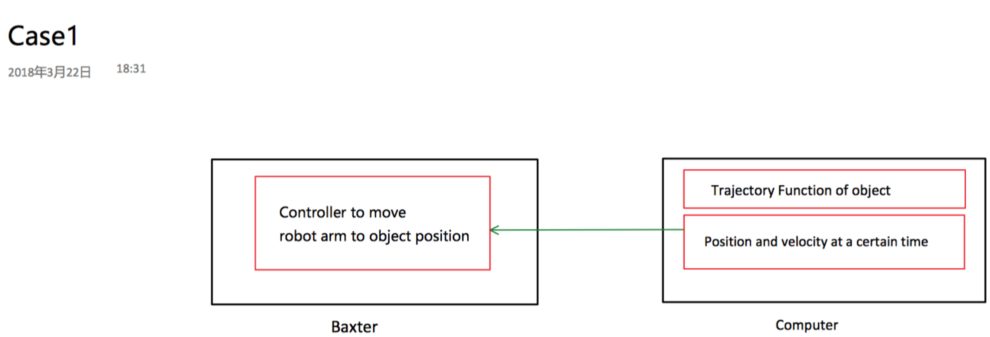
3. After we make everything work in 2D case, we plan to explore how things work in 3D case. We'll assume that we know the trajectory of an object moving in the 3D space, for example, a flying ball, whose trajectory is a parabola. We plan to use the camera to sample some positions again and then do PCA to reduce the dimensionality to a 2D case. Then we predict the position of the object and transform it back to the 3D space. After that, we'll try to grasp it.

4. To make things even more complicated, this time we shall assume that we do not know anything about the trajectory of a moving object in the 3D space, and we'll try to grasp it. The current idea is that we can use the camera to sample the object twice at each time and get the velocity of the moving object. Then we predict its next position and move our end effector towards that predicted position. The total goal will be minimize the distance between the gripper and the predicted position, so it'll be an optimization problem.

4.2 Novelty

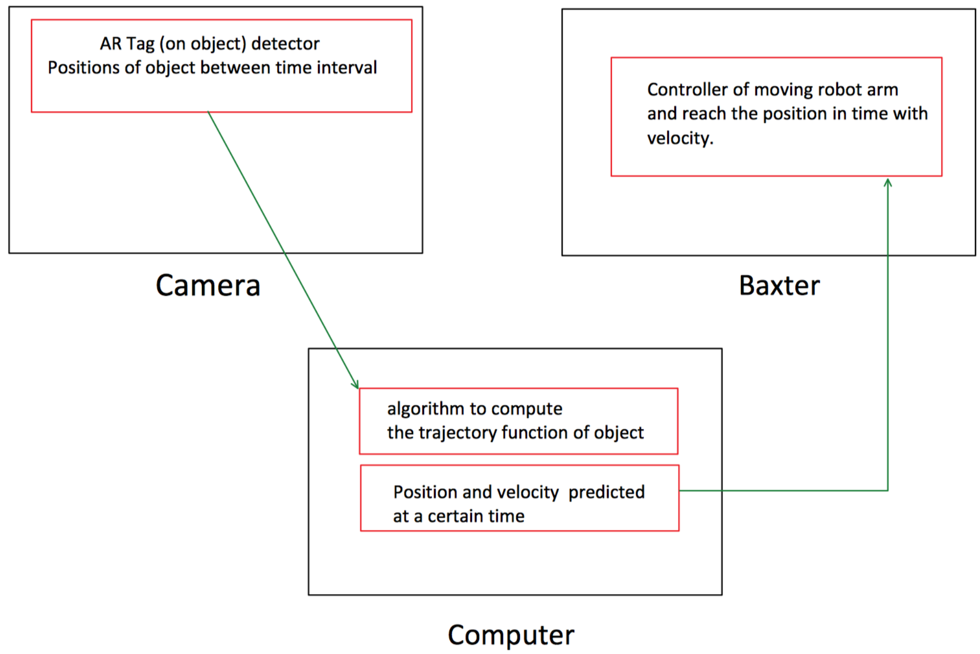
The novelty in our method is that we use regression to predict the trajectory, thus making the algorithm faster. What's more, we use the optimization problem and the prediction to grasp an object with random trajectory in the space.

5 Experimental Plan (Tasks)



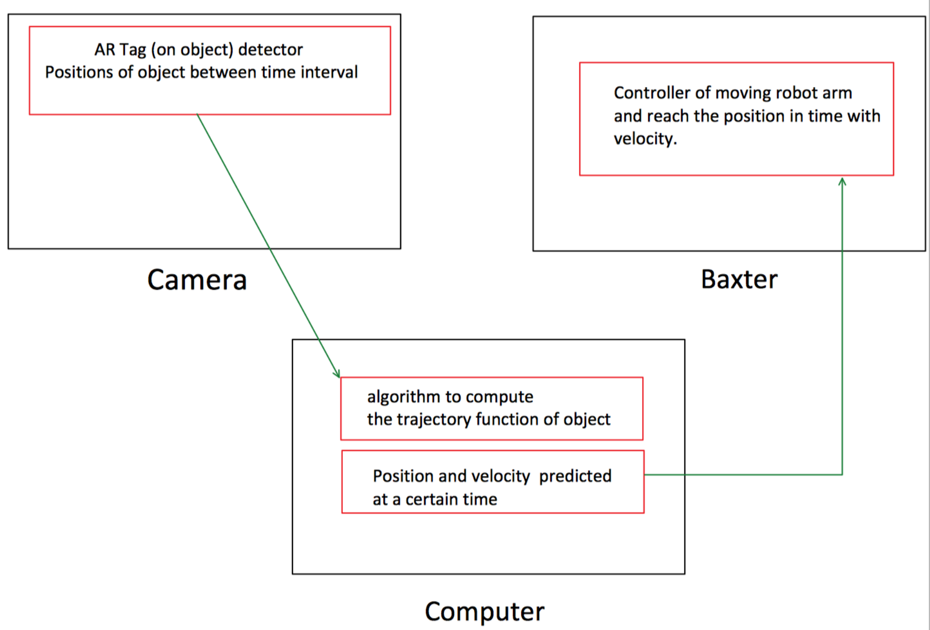
Case2

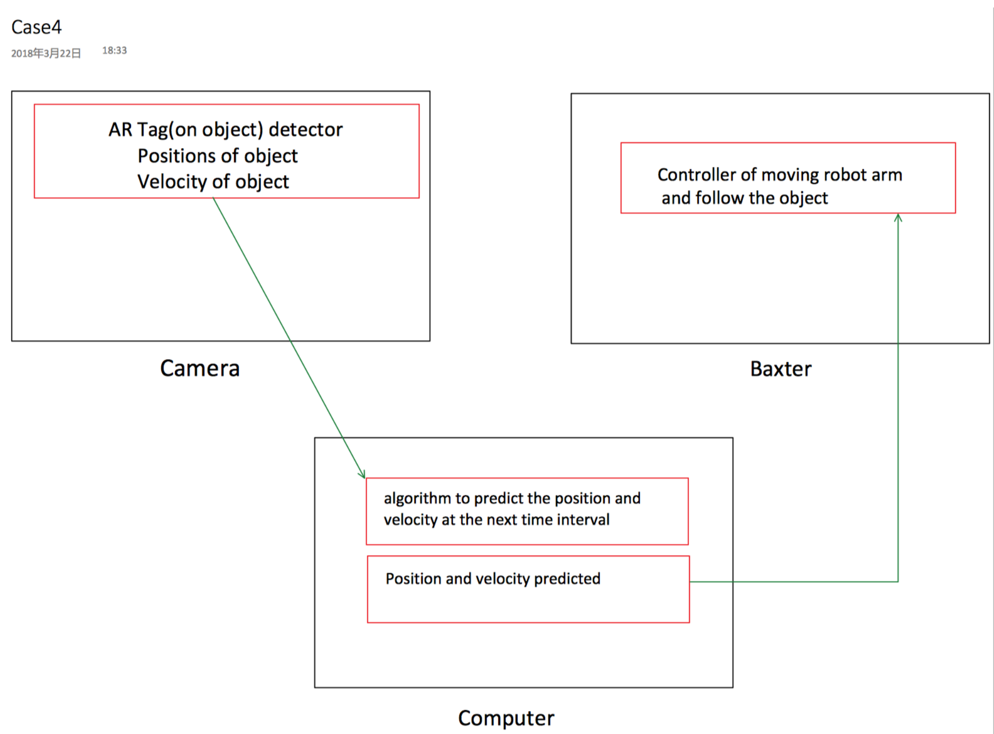
2018年3月22日 18:33



Case3

2018年3月22日 18:33




Case4
2018年3月22日 18:33
AR Tag(on object) detector
Positions of object
Velocity of object
Camera
Controller of moving robot arm
and follow the object
Baxter
algorithm to predict the position and
velocity at the next time interval
Position and velocity predicted
Computer