ARTIFICIAL INTELLIGENCE ROBOT FOR BUILDING A TOWER BY ITSELF

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Introduction

The goal of this project is to design an artificial intelligence robot, which can build a tower with blocks by itself. Based on this project, more complex robot arm models can be made, what we need are only some adjustment and extra training time, so it can be easily spread and applied.

Application

Recently, small amount but manifold flexible manufacturing systems are increasing. Many of the tasks in small amount but manifold systems rely heavily on workers, but now artificial intelligence robotics are build to deal with differentiation of products and to meet diversified needs automatically.

Examples:

- Bin picking
- Foundry industry
- Medical instrument production .

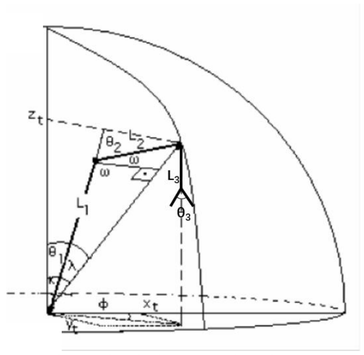
ABB and others have introduced robots designed to assemble small parts and detect whether products are being put together properly. PHOTO: ABB ROBOTICS

Methods

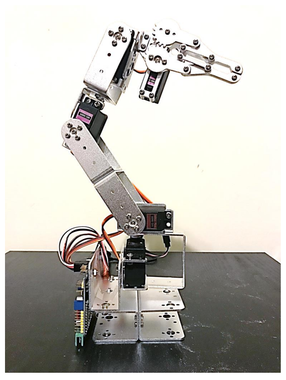
The project consists of three parts, firstly, build a robot arm, secondly, recognize blocks in different shapes and then develop policy networks which controls how the robot behaves.

A. Robot Arm Controlling

The first step is to build a robotic clamp claw, so I built a 5 degree of freedom model, with 3 arms and 5 joints, 5 servos are used to control the movement and the behaviors.

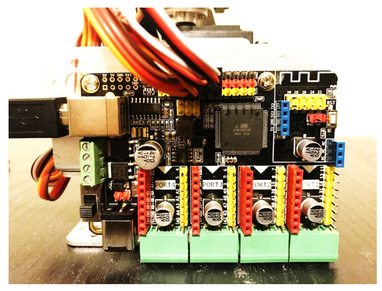


The simulated robot arm and arm kinematics.



5 DOF Mechanical Robotic Clamp Claw for Arduino. PHOTO: Aideepen

Servos used to control the joints.(MG996R)



Arm controller: Makeblock MegaPi Board

Based on graph of the arm kinematics, when a point (x, y, z) in a 3D space is given, 4 degrees can be calculated, so the claw can move to the right position according to the degrees, then the claw can pick up or put down the blocks.

B. Image Recognition

A camera is fixed and it can send the image to the computer, then different shape of blocks are identified and the claw can pick them and move them to the right position.

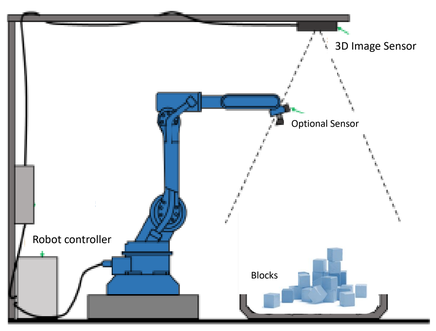


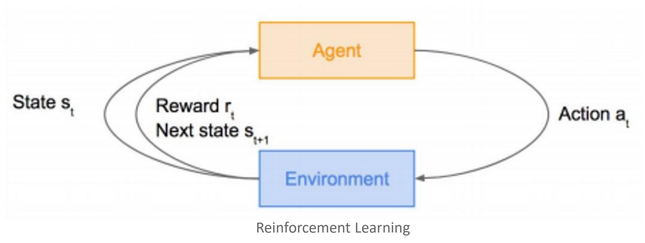
Image recognition framework

Blocks, Photo: www.shutterstocks.com

C. Policy Network

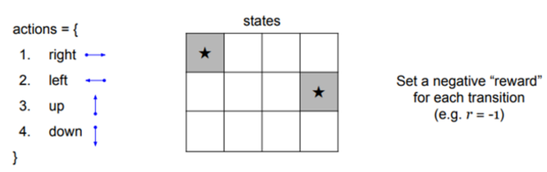
Policy network is the algorithm that can control the robot behaviors. In this part I'll use deep learning skills like Reinforcement Learning, Markov Decision Process, Q-deep Learning, maybe something more.

- Reinforcement Learning



Reinforcement Learning

- Markov Decision Process(an example)



Objective: reach one of terminal states (greyed out) in least number of actions

A simple MDP: Grid World

- Q-network Architecture

Initialize $Q(s,a)$ and $Model(s,a)$ for all $s \in \mathcal{S}$ and $a \in \mathcal{A}(s)$
Do forever:
(a) $s \leftarrow$ current (nonterminal) state
(b) $a \leftarrow \varepsilon$-greedy(s,Q)
(c) Execute action a; observe resultant state, s', and reward, r
(d) $Q(s,a) \leftarrow Q(s,a) + \alpha\left[r + \gamma \max_{a'} Q(s',a') - Q(s,a)\right]$
(e) $Model(s,a) \leftarrow s', r$ (assuming deterministic environment)
(f) Repeat N times:
$s \leftarrow$ random previously observed state
$a \leftarrow$ random action previously taken in s
$s', r \leftarrow Model(s,a)$
$Q(s,a) \leftarrow Q(s,a) + \alpha\left[r + \gamma \max_{a'} Q(s',a') - Q(s,a)\right]$

Achievements

I have finished the robot arm control part, and the image recognition is in process, for the third part, learning should be step by step, so I started with several similar but simpler examples.

1. Robot arm control
2. Image Recognition
3. Deep learning example and algorithm

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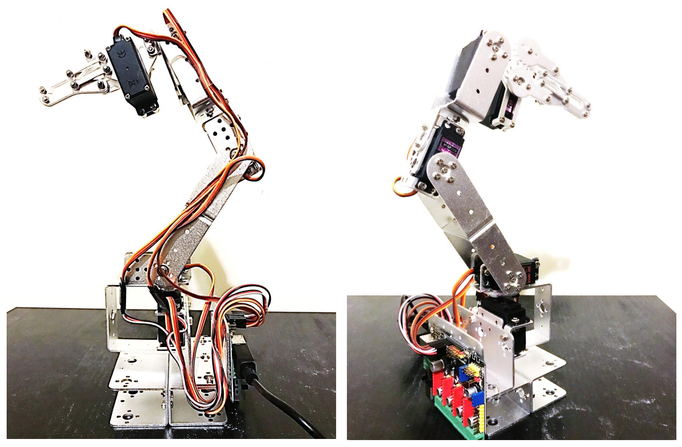

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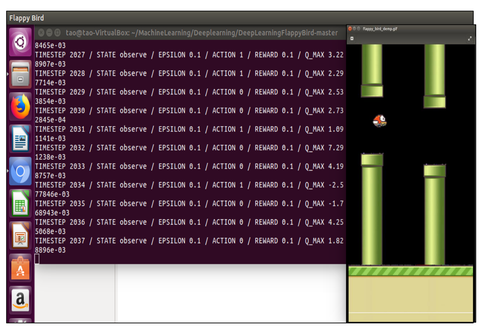
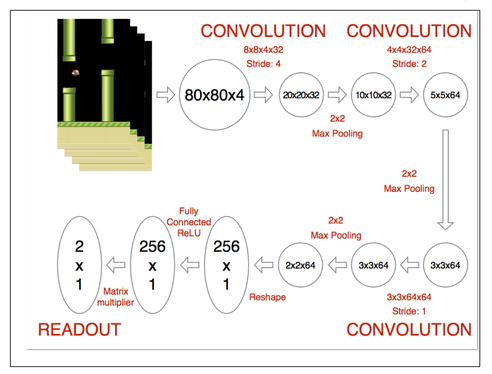
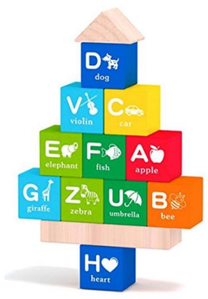




Future Work

a. Image Recognition, build the equipment, get the training data set and train the model.
b. Policy Network algorithms.
c. Training and testing.



References

1. Stanford Online Course CS231 and materials.
2. Arm Kinematics in Matlab, 3rd edition.
3. Flappybird, https://github.com/fullstackio/FlappySwift
4. Programming in Arduino.

Acknowledgements

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