Department of Computer Science

University of Hong Kong

Final Year Project

Project Plan

Author: Shen Si Yuan
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1. BACKGROUND

Robotic arms play an important role in factory automation. Currently, EU is one of the global frontrunners in the race of automation manufacturing. However, the strongest growth drivers for the robotics industry are found in China. It is predicted that by 2019, some 40 percent of the worldwide market volume of industrial robots will be sold there alone[1]. “Automation is a central competitive factor for traditional manufacturing groups, but is also becoming increasingly important for small and medium-sized enterprises around the world”, says Joe Gemma, President of the International Federation.

![Worldwide annual supply of industrial robots](image)

Figure 1, worldwide annual supply of industrial robots

In the past, robotic arms were typically programmed to complete a specific task by performing a sequence of predefined motion (e.g., picking up and installing components in specific locations in an assembly line). With the advance in computer vision, robotic arms are now commonly equipped with cameras that enable them to “see” their workplace. This allows more flexibility as the robotic arms can now complete their tasks by planning their motion based on what they see.

2. OBJECTIVE

In this project, I am going to build a small prototype of a computer vision assisted pick and place robotic arm. To make the project more attracting, one or two robotic arms will play chess against either with each other or with a human rival.

To perform this task, the robotic arms need to:
1. Recognize the environment, which includes arm itself, chessboard, chess pieces.
2. Recognize the shape (category), color (i.e. which side) and the position of the chess pieces.
3. Recognize the changes of the pieces on the board.
4. Pick and place a chess piece correctly under an acceptable speed and without interfering the arrangement of other pieces.

The software delivered should have the following functions:
1. Provide visual interface for both developer and player
2. Camera calibration
3. Being able to control the move of the robotic arm
4. A GUI which player can play chess on. * (May change in the future)

3. METHODOLOGY

To build such a robotic arm successfully, there are a few required steps:
First, 3D printing is needed to build the frame of the robot.
Secondly, implemented the servo control through I/O programming in Raspberry Pi or Arduino.
Up to this point, a controllable robotic arm is delivered with some basic motions, for example, moving to an assigned position, picking and placing.
Now comes to the crucial step: adding computer vision.
Before it can play the chess, the first thing is to introduce the eye of the robot. Object recognition based on machine learning will be developed.
Then, hand-eye coordination should be built to ensure that the arm perform precisely as the program required.
With all these lower level APIs, we can now combine it to a high-level user interface (software) which user will monitor the chess game. But all the physical moves (at least one side) are done by the robotic arm (or together with a human player).

Software and programming languages (some are to be determined):
1. Cura 3D printing software
2. FreeCAD
3. SketchUp
4. OpenCV
5. C++
### 4. SCHEDULE AND MILESTONES

<table>
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<th>Time</th>
<th>Progress</th>
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| By Oct 31st 2017          | 1. Hardware assembling complete  
                           | 2. Basic control implemented  |
| Nov 1st 2017 to Jan 1st 2018 | 1. Object recognition of chess & chessboard  
                           | 2. Basic hand-eye coordination (moving chess) |
| Jan 11th to 15th          | First presentation                                                       |
| By March 1st              | 1. Game software implemented  
                           | 2. Improve hand-eye coordination  |
| By April 1st              | All the combination of robotic arm and software, adjustment, test, debugging, should be complete, robotic arm with user interface are ready to be delivered |
| Apr 18th to 22th          | Final presentation                                                       |

References: