"Automatic Rubik's Cube Detection and Recognition"

Project Proposal

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1 INTRODUCTION

The Rubik's Cube is a well-known puzzle that has been invented in 1974 and is considered to be the world's best-selling toy. For this project a system will be developed for this cube based on computer vision methods. The main focus will be on the visual detection and recognition of the cube, and not on the computation of the actual solution since there are already several algorithms available on the Internet for this problem. This proposal should give a short overview of the topic that has been chosen for the project and how it will be implemented.

1.1 Objective

There is a large community of people in the world that is trying to find faster and better ways to solve the puzzle. The common need that arises is that people want to enter their particular configuration into the computer to get hints on the fastest way to complete the puzzle. However, the only way to do that is to manually enter the configuration into the computer, which is a time consuming task [1]. The motivation of this project is to design an algorithm to detect and recognize the each face of the Rubik's cube without manually entering the configuration into the computer.

1.2 Problem Analysis

In previous sections the objective of this project has been discussed briefly. To address the problem the following three components will be needed:

- Edge Detection – an initial detection of the cube object.
- Orientation information – It is mandatory to locate the orientation of each face of the three visible faces.
- Color Detection – recognizing the color cells for the three sides.
- Feature Extraction – Detect all small squares and cube features (3-D localization and orientation).

2 Assumptions

There are some variables to take into account, which will have a impact on the results of this project. Based on the goal of the project a few assumptions have been taken about the setup as possible. The background where the cube will be placed for detection will be black. The camera to be used in this project is a

normal webcam. Webcam will be placed in a way that it will have a good view of the 3 sides of the cube. The lighting condition will be in a way that it will not make cube surface to reflect. The Rubik's cube going to be used in this project will be the same as the samples stored for the testing phase.

3 Approach

Main focus of this project is to detect and recognize the cube. To implement this project OpenCV Library and C++ programming language will be used. The task is decomposed in the following way:

- Edge Detection – will do this part for initial detection of the cube object.
- Orientation information – to detect the orientation of each face visible.
- Color Detection – will do this part for recognizing the color cells for each visible side.
- Feature Extraction – This part will be done by the both members of this group to detect all small squares and cube features.

4 Anticipated Results

The final outcome of this project will be, the system should able to detect and recognize the cube. It should be able to recognize the cube from 3 side of the cube and generate a matrix that will be used to create a virtual model.

5 Challenges

The challenges of this project is:

- Illumination. ----> no use of this when the background of the scene is black <---
- Tracking entire three-dimensional cube in a 2-D image.
- Varying color schemes of the cube.

References:

1 Andrej Karpathy, "Extracting sticker colors on Rubik's cube", Semester project,https://github.com/kopernicky/rubik/blob/master/materials/Extracting%20sticker%20colors%20on%20Rubik%27s%20Cube.pdf

2 Kasprzak, W, lodzimierz and Szynkiewicz, Wojciech and Czajka, Lukasz, "Rubik's Cube Reconstruction from Single View for Service Robots", Machine Graphics & Vision International Journal Feb 2006.

3 O Faugeraus, "Three dimensional computer vision, a geometric viewpoint", The MIT press, Cambridge mass, 1993 http://dl.acm.org/citation.cfm?id=171658.