

# ALGORITHM ASPECTS OF RUBIK'S CUBE 3D GAME

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## INTRODUCTION

The Rubik's Cube is a really captivating and fascinating puzzle and it is a 3D game. There are several applications available on Rubik's cube. Some of them are games with solutions. But there is no user friendly tool which guides how to solve the Rubik's cube. To overcome this problem this paper presents a different user friendly method to solve the problem. In this application if the user is not familiar with solving cube, they can get the automatic solution which will give the steps to solve the cube. The main objective of this project is to create an algorithm which helps users to solve the cube game quickly.

In a classic Rubik's cube, each of the six faces is covered by 9 stickers, among six solid colors. A pivot mechanism enables each face to turn independently, thus mixing up the colors. The main target of the puzzle is to show that each face of the cube is in a solid color. There are 6 center color pieces of different colors. Their relative positions cannot be changed. They can only rotate around their own spindles. The color of a cube face is therefore decided by its center piece. There are 12 edge pieces, each with two colors and 8 corner pieces each with three colors in different combinations.

Learning to solve the Rubik's Cube helps to teach many life lessons such as following directions, perseverance, memorization and focus. It helps the users to imagine 3 dimensions.

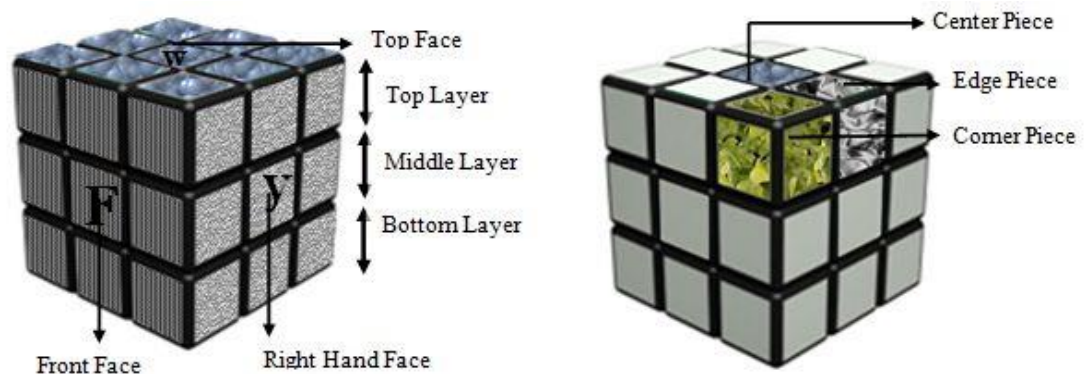


Figure 1: Rubik's Cube Structure

## METHODOLOGY

The proposed tool is developed using Visual Studio 2010 and .NET, C# and WPF (Windows Presentation Foundation) where WPF is selected to create 3D graphics easily.

## Create 3D cube

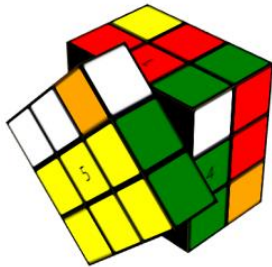
The basic idea of creating 3D graphics is to have a three dimensional model of an object. Because our screen is only two dimensional, a camera, as defined below, takes a picture of the object. The picture is a projection of the object to a planar surface. This projection is rendered into a bitmap by the 3D rendering engine. The engine determines the color for every pixel by calculating the amount of light that is reflected by any light sources to the projection surface by the objects in the 3D space.

## Elements of 3D scene

- Camera - Every 3D scene has exactly one camera. The camera defines the position and the Look Direction and the Up Direction of the viewer.
- 3D Models - A 3D model defines an object in the scene. It has a geometry that is the mesh and a material that can be a diffuse. The material itself has a brush.
- Lights - Without any lights there is nothing to see. So at least one light source is needed to be placed in the scene to illuminate our models.

To form the 3D cube first one piece of 3D cube as in Figure 2 is created. In the similar way, separate 27 cubes are created and moved to different positions using transformation.

## Rotation of Rubik's Cube sides



To rotate one side, 9 small cubes out of 27 will be moved 90 degrees. Animation was added to transform 9 cubes by 90 degree to visualize a rotation. There are twelve turns possible in the Rubik's Cube. Each page will have to turn in clockwise and anticlockwise directions. There are twelve buttons added to rotate the cube.

Figure 2: Rubik's Cube Turn

## Algorithm to solve Rubik's Cube

The following numbering system shown in figure 3 is considered to develop the algorithm.

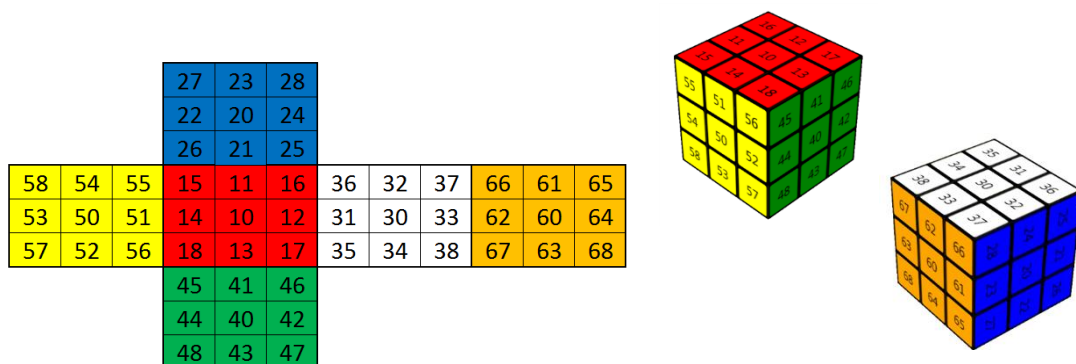


Figure 3: Number System

When the cube is in the shuffle position, a dictionary of current position and its original position are kept.

The main 5 steps of the algorithm to solve the Rubik's cube are given below.

Step 1: Solve the top layer edge piece:

In the numbering system original positions are 11, 12, 13 and 14. There are two Algorithms to identify the turns to get 11, 12, 13, and 14 to original position. In the first step (means all 4 pieces are not in the correct position) first Algorithm is used where there is no need to shuffle already taken pieces. But after making one piece to the correct position the normal Algorithm is used.

Step2: Solve the top layer corner piece:

Second step is to solve the Top Layer corner Pieces. The original positions 15, 16, 17 and 18 of the numbering system are kept.

Step3: Solve the middle layer edge piece:

Third step is to solve the Center Layer edge Pieces. The original positions 22, 32, 42, 52, 24, 34, 44 and 54 of the number systems are kept. The center corner pieces have pair of numbers. These are (22, 54), (32, 24), (42, 34) and (52, 44).

Step4: Solve the bottom layer corner piece

In this step, the numbers 65,66,67,68 are to taken to the correct Position. To do that, first check the bottom side and its pattern. If 65, 66,67 and 68 are on the bottom of the cube then check the 27,28,37,38,47,48,57,58 if that is on place now the step 4 is solved. If the third layer corner pieces are not in place, re-do the pattern for that and repeat the step 4.

Step5: Solve the bottom layer edge piece

First take the numbers 61, 62, 63 and 64 to the correct Position. To do that, first check the bottom side and check for the pattern. According to the pattern match, the step 5 is solved. If 61, 62, 63, and 64 are on the bottom of the cube then check the 23,33,43, and 53 is correct place, if so the step 5 is solved else check for pattern and repeat the step.

## **RESULTS AND DISCUSSION**

The Rubik's cube is created in 3dimension. It can rotate whole cube using mouse and rotate the layers using 12 turn buttons. The user can shuffle the cube then click the start button and they can play the game using 12 turn buttons. During the playing time it counts the number of turns and time. If the user finishes the solving process successfully it gives the success message with the total time and number of turns taken. The user can show the animation guide of how to solve Rubik's cube through clicking the shuffle button then clicking the get solution button. Then if the user click next and previous button, it gives the solution step by step and details of turn in each step. This application is very useful to studying about solving the Rubik's cube. If the user clicks automate solution, the cube is solved automatically by using the algorithm.

Some important features of this Application

- 3D Cube with the mouse rotation.
- Turn each side of Rubik's cube with animation.
- Play the Rubik's cube by counting no of turns and time.
- Get step by step solution using Rubik's cube algorithm.
- Get the solution guides in help document.

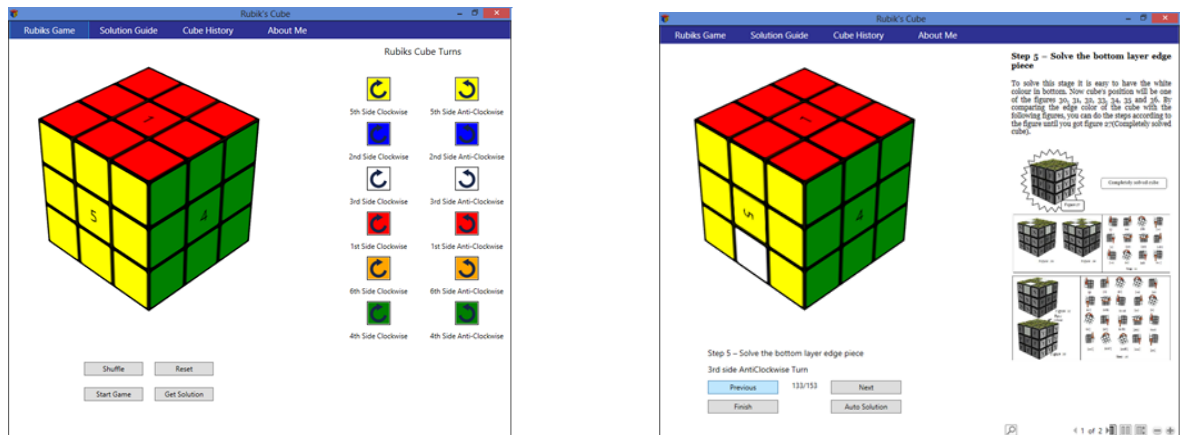


Figure 4: Application User Interface

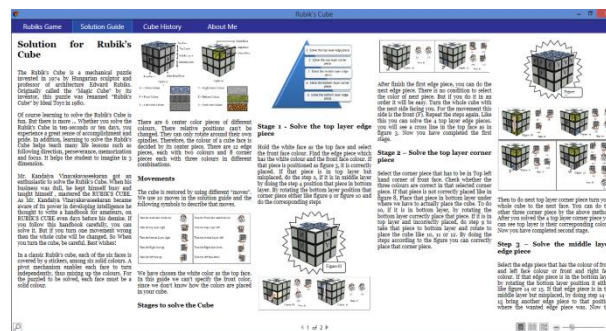


Figure 5: Solution Guide for Rubik's Cube

## CONCLUSIONS

Rubik's Cube Algorithm is successfully developed to solve the Rubik's Cube and play the game. Learning Rubik's Cube is a good exercise which will teach many life lessons such as following direction, perseverance, memorization and focus. This application is developed in a more user friendly manner and it helps users to learn Rubik's cube as it gives the solution step by step. Using this tool, any user who has no knowledge on Rubik's can understand a complete picture of it. If users get trained in using this application, they can finish the game with minimum number of turns. And also they can become either an expert in playing the game or can easily win in Rubik's competition.

## REFERENCES

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