Solving Rubik's Cube with Lego Mindstorms

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Abstract

This should be two or three short paragraphs (100-150 words total), summarising the report. A suggested flow is background, project aims, and achievements to date. It should not simply be a restatement of the original project outline

Acknowledgements

Thanks to my parents, who raised me since I was a boy. And Rik van Grol, who raised me afterwards.

Abbreviations, Definitions and Notations

Basic Definitions

Abbreviation/Word	Definition
Rubik's Cube Cube	A standard 3x3x3 Rubik's Cube[1].
Slice	A central layer between two faces. Usually referenced by the faces it spans.
Quarter Turn	A clockwise rotation of a face or slice by 90°
Half Turn	A clockwise rotation of a face or slice by 180°
Quarter Turn Metric	When counting moves, a Quarter Turn is counted as a single move and a half is two moves.
Half Turn Metric[2]	Quarter turns and half turns are both counted as single moves.
Cubie	One of the twenty-six smaller cubes that make up a Cube.
Goal State	All the cubies on a given face match the colour of the centre cubie. i.e. a solved Cube.
Position	A Cube's state (mixed or solved).
Valid Position	A position that can be achieved with a real-world Cube without dismantling it.
Move Sequence	A series of moves performed consecutively. e.g. $F\ D\ F'\ D2\ L'\ B'\ U\ L\ D\ R\ U\ L'\ F'\ U\ L\ U2$
Solve (Sequence)	A move sequence which leads to the goal state.
Depth n	A Cube which has been moved n times away from the goal state.

Notation

Symbol Notation	Meaning	
L	Left	This notation is used to show a quarter turn of a face. It can have a single quote or a '2' appended to show a counter-clockwise quarter turn or a half turn respectively.
R	Right	
F	Front	
B	Back	
U	Up (Top)	
D	Down (Bottom)	
X	Clockwise 90° rotation of a Cube about the relevant axis.	
Y		
Z		

[1] This Dissertation is only dealing with 3x3x3 Rubiks Cubes, and any discussion of alternative dimensions will be explicitly stated.

[2] For this Dissertation the Half Turn Metric is used unless explicitly stated.

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1 Introduction

1.1 Background

In 1974, Ernö Rubik was struggling to create a cube with independently moving parts which remain together, regardless of how much they moved. His first attempts made use of elastic, which broke and rendered the cube unusable. Rubik persevered in his attempts to hold the blocks (now called "cubies") together - eventually concluding that the best way was to have the cubes hold themselves together. He called this design "The Magic Cube", and it would go on to be one of the world's best-selling puzzles [1]. It was later re-branded to "*Rubik's Cube*" to overcome an oversight involving patenting and copyrighting the design.

In an unpublished manuscript [2], Rubik described first randomising his new cube,

> It was wonderful to see how, after only a few turns, the colors became mixed, apparently in random fashion. Like after a nice walk when you have seen many lovely sights you decide to go home, after a while I decided it was time to go home, let us put the cubes back in order. And it was at that moment that I came face to face with the Big Challenge: What is the way home?

It took Rubik over a month to solve this first cube - he knew intuitively that there must be a method to solving the cube, but lacked the finer methodology [3]. Since Rubik devised the first method, hobbyists and mathematicians alike have been immersed in solving the Cube as quickly and efficiently as possible. Whilst many solutions are markedly successful when it comes to optimisation, others only better them in quirkiness or internet fame [4].

There is one method which is mere speculation, despite having been proved mathematically: God's Algorithm. God's Algorithm states that an omniscient being would always make the most efficient moves and that they would be able to solve a Cube from any given position in a certain number of moves or less. This is referred to as God's Number, and was finally proved to be twenty in 2010 by a group of 4 researchers [5].

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References

[1] O. Waxman, "The 13 Most Influential Toys of All Time," 2014.

[2] E. Rubik, "The Perplexing Life of Erno Rubik," *Discover Magazine*, p. 81, mar 1986.

[3] Rubik's Cube, "Rubik's UK Website," 2017.

[4] C. Chan, "This Guy Can Solve 3 Different Rubik's Cube While Juggling Them at the Same Time," 2016.

[5] T. Rokicki, H. Kociemba, M. Davidson, and J. Dethridge, "cube20," 2010.