# Cubr: Cube Solving Robot


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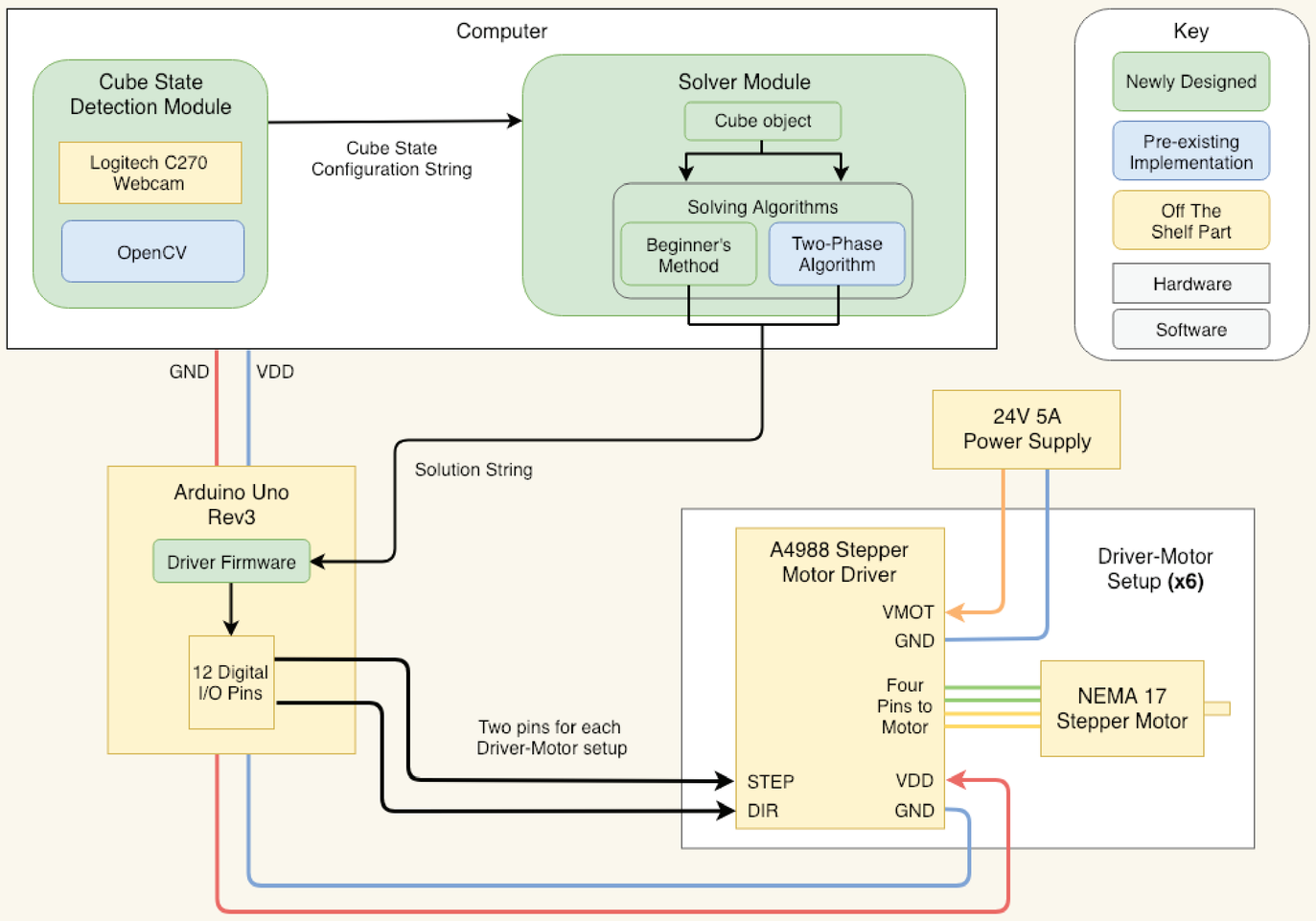
## Overview

- Cubr is a mechanical system capable of solving a 3x3x3 puzzle cube with the intention of speed.
- The solver uses computer vision to detect and map a given cube state into 2D space, creating a cube string, which is passed into our own implementation of the Beginner's Method solving algorithms to find a solution string.
- Our hardware module interfaces the solution string through an Arduino to execute the specified moves to physically solve the puzzle using six bipolar stepper motors.

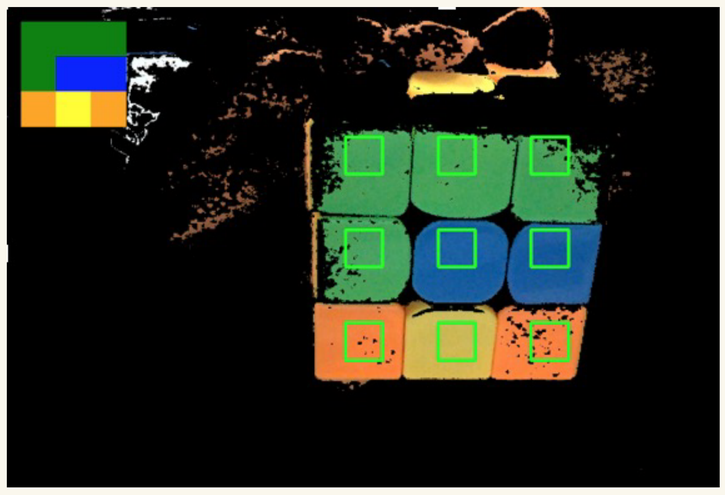
## Motivation

- Apply creative and innovative technologies to ordinary things
- Show that something that can take days for a human to learn can merely be solved by our robot in seconds.
- Utilize an algorithmic way of thinking, which is pervasive in automation
- Express the power and ability in the decomposition of a complex problem into smaller and simpler subproblems.

## System Architecture & Approach




## Cube State Detection



1. Change color space to HSV
2. Averaging of HSV values in defined region
3. Classification of color with distance function
4. Create 2D mapping of the cube state

## Evaluation & Metrics

| | Color Classification & Thresholding | Naive Beginner's Method | CFOP Method | Our Beginner's Method | Two-Phase Algorithm | Turn Speed (90 degrees) | Turn Delay |
|---|---|---|---|---|---|---|---|
| Expected Performance | 100% success | 150 moves | 57 moves | 100-200 moves | ≤ 20 moves | 1 sec | 2 sec |
| Actual (Average) Performance | 95% success | 120 moves | 87 moves | 84.4 moves | ≤ 20 moves | 0.065 sec | 0.5 sec |

Color detection accuracy: 95%

Average moves (Our Implementation): 84.4 moves

Average time to physically solve (Two-Phase): 10.8 seconds

## Solving Algorithm

Our implementation solves each layer of the cube by applying a given algorithm to each sublayer and maintaining the previously placed pieces. Solution: 60-100 moves

Steps:

1. White Cross, White Corners
2. Second Layer
3. OLL & PLL (Orient & Permutate Last Layer)