Cubr: Cube Puzzle Solver

18500 S19 Team D6
Project Proposal
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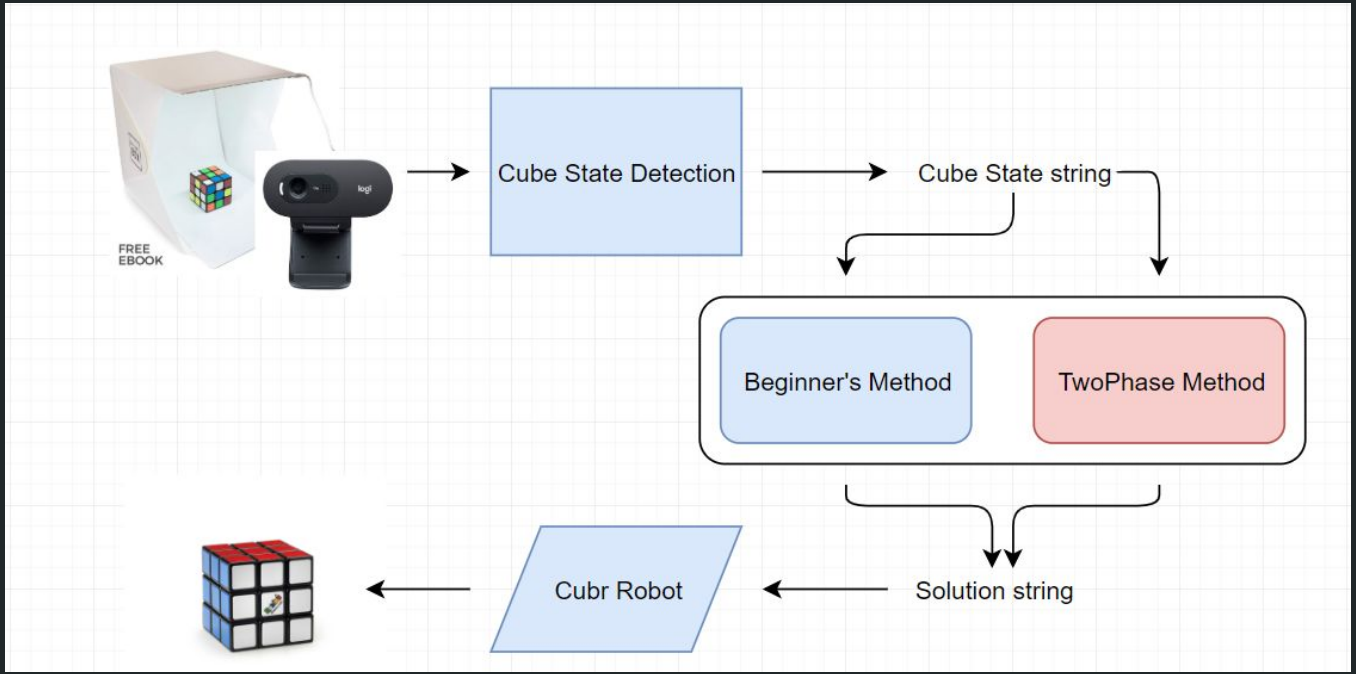
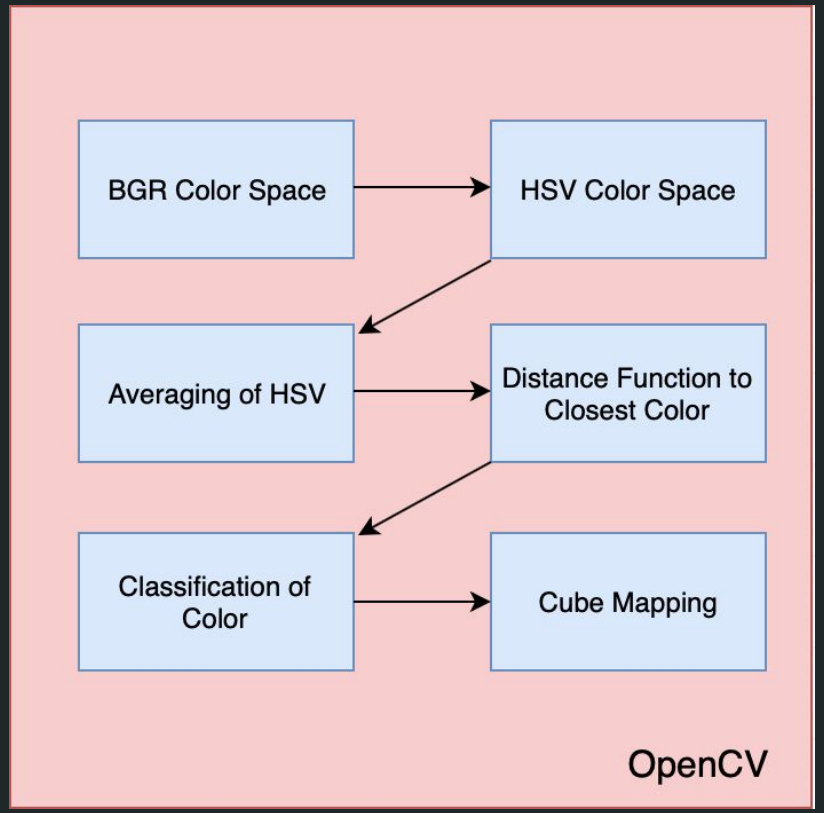
Solution and System Specification



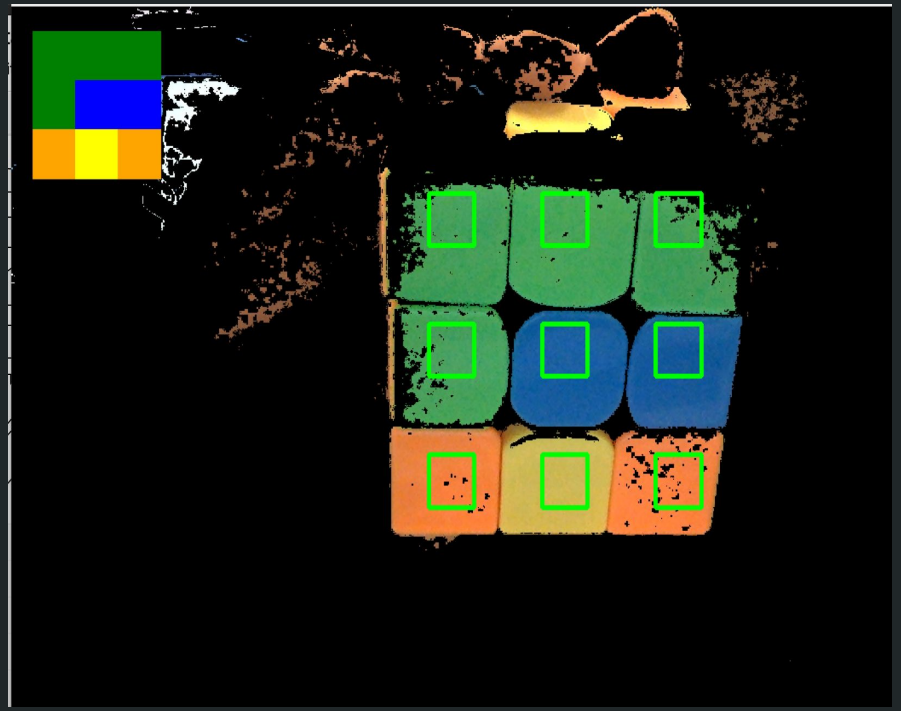
Cube State Detection

- Change color space to HSV
  - Color detection with different lighting
- Averaging of HSV in defined region
  - Hue, Saturation, & Value
- Classification of Color
  - Distance function
    - Lower & Upper bound of color
    - HSV values read from stream
- Map colors detected on cube side
  - Based on center piece color



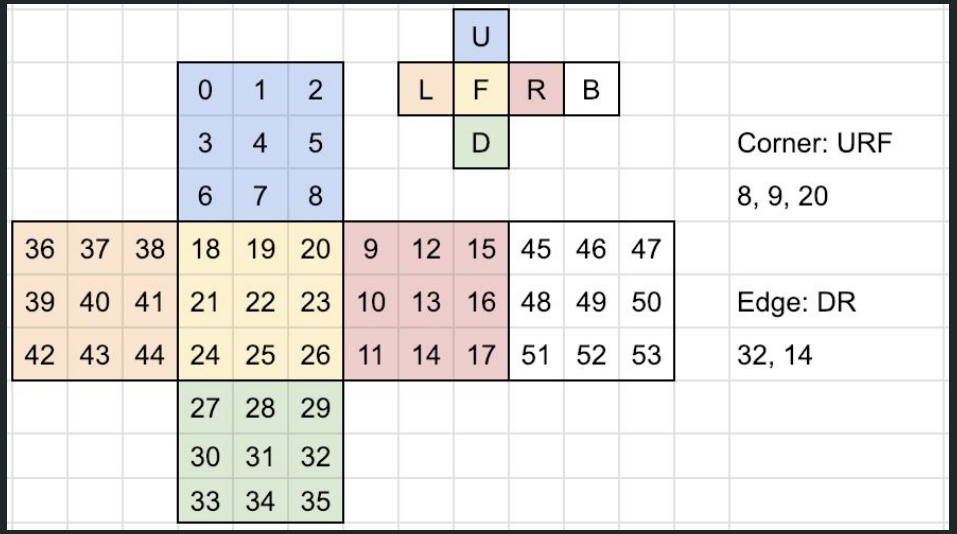
Cube State Detection Interface

- User places face of cube in region
  - Live color tracker for validation
- User presses spacebar to capture
  - Capture based on center piece
- Outputs cube string
  - User presses enter after all sides scanned
  - String in correct notation
  - Interfaces with both solvers



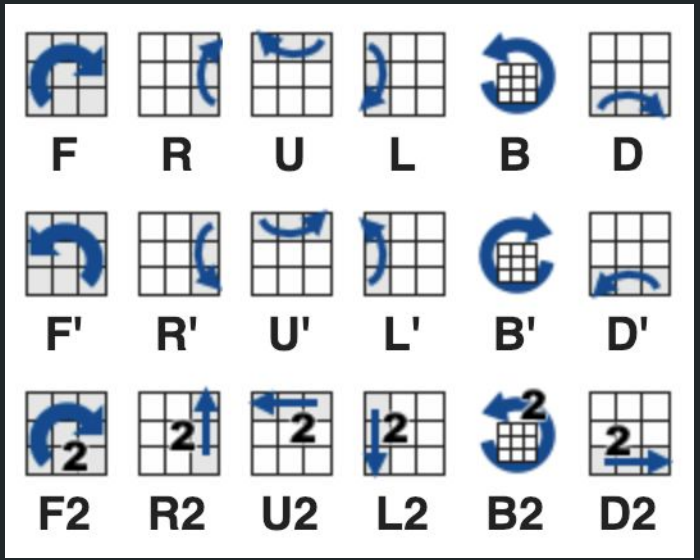
Software Design

- Written in Python
- Cube
  - String representation → object
  - OOP implementation
    - Cube
    - Color
    - Cubie pieces
    - Move (types of rotations)
- Cubie piece linkages + identification
  - Corners
  - Edges



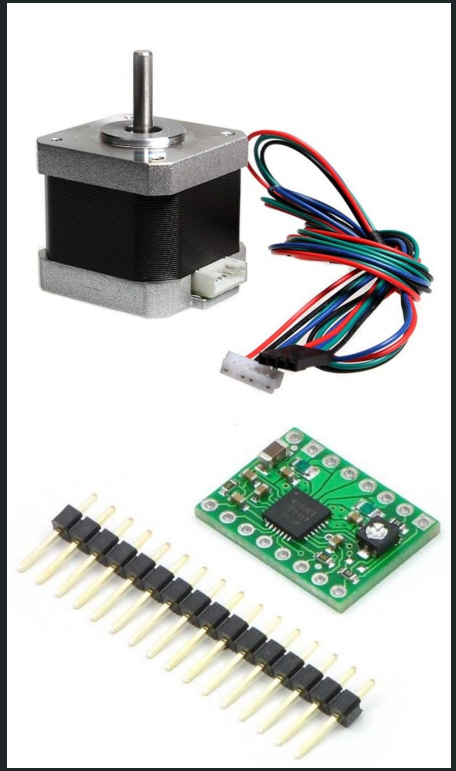
Solving Algorithm

- Cube object
  - String config input
  - Instantiate object
  - Identify cubie pieces and location
- Beginner's Method
  - Solve by layer
  - Pre-existing algorithms for each layer
- Output: solution string of moves to achieve fully solved state

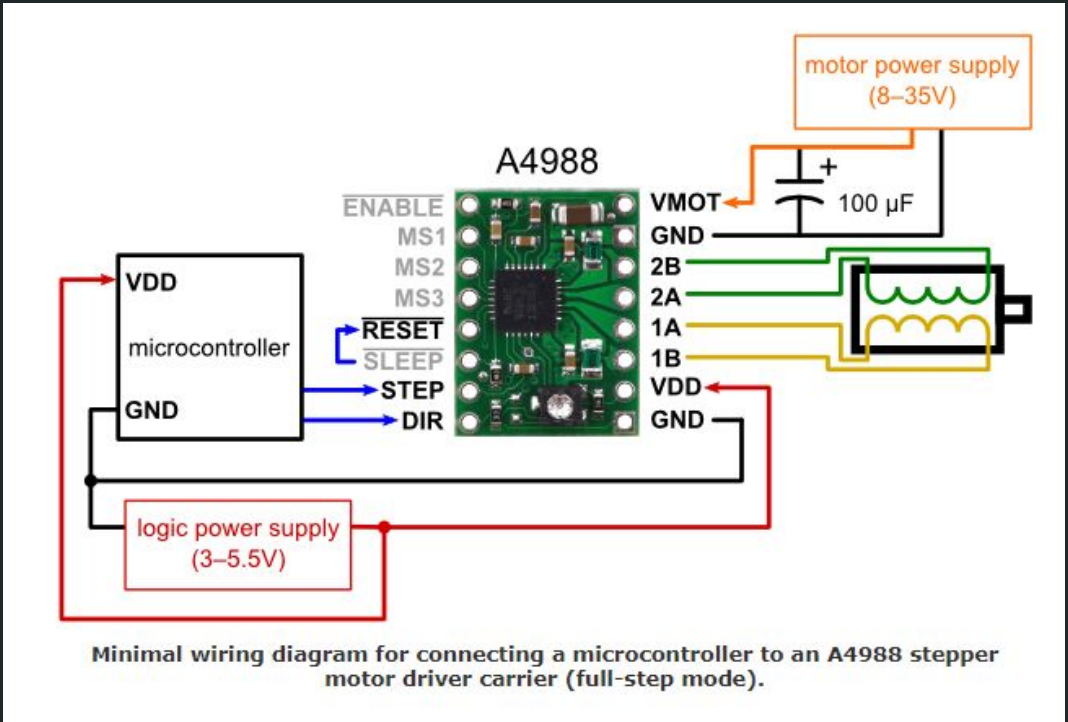


Executing Solution: Core Hardware

- NEMA-17 Stepper motor
  - 200 steps/rev
  - 1 step = 1.8 degrees
- A4988 Stepper Driver
  - Operates from 8V-35V
- 24 Volt 5 Amp DC wall adapter
  - 6 motors at .35A = 2.1A
  - Upper limit of drivers
- Arduino Uno Rev3
  - 14 Digital I/O pins



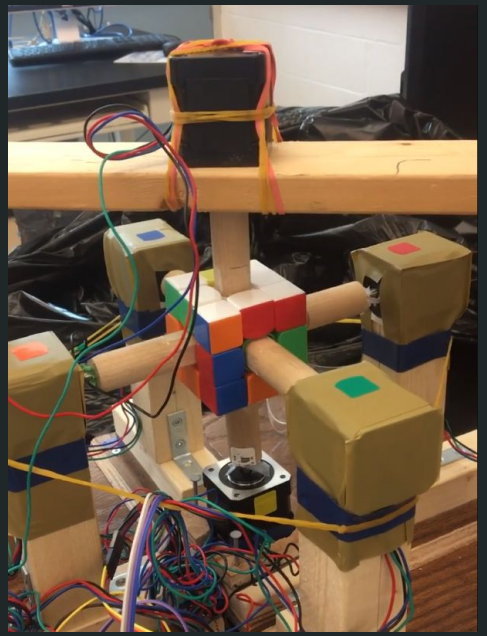
Executing Solution: Setup



Minimal wiring diagram for connecting a microcontroller to an A4988 stepper motor driver carrier (full-step mode).

Executing Solution: Setup

- Robot housing
- Coupling arms
- 24 Volt 5 Amp Power Supply
- Breadboard
- Wires



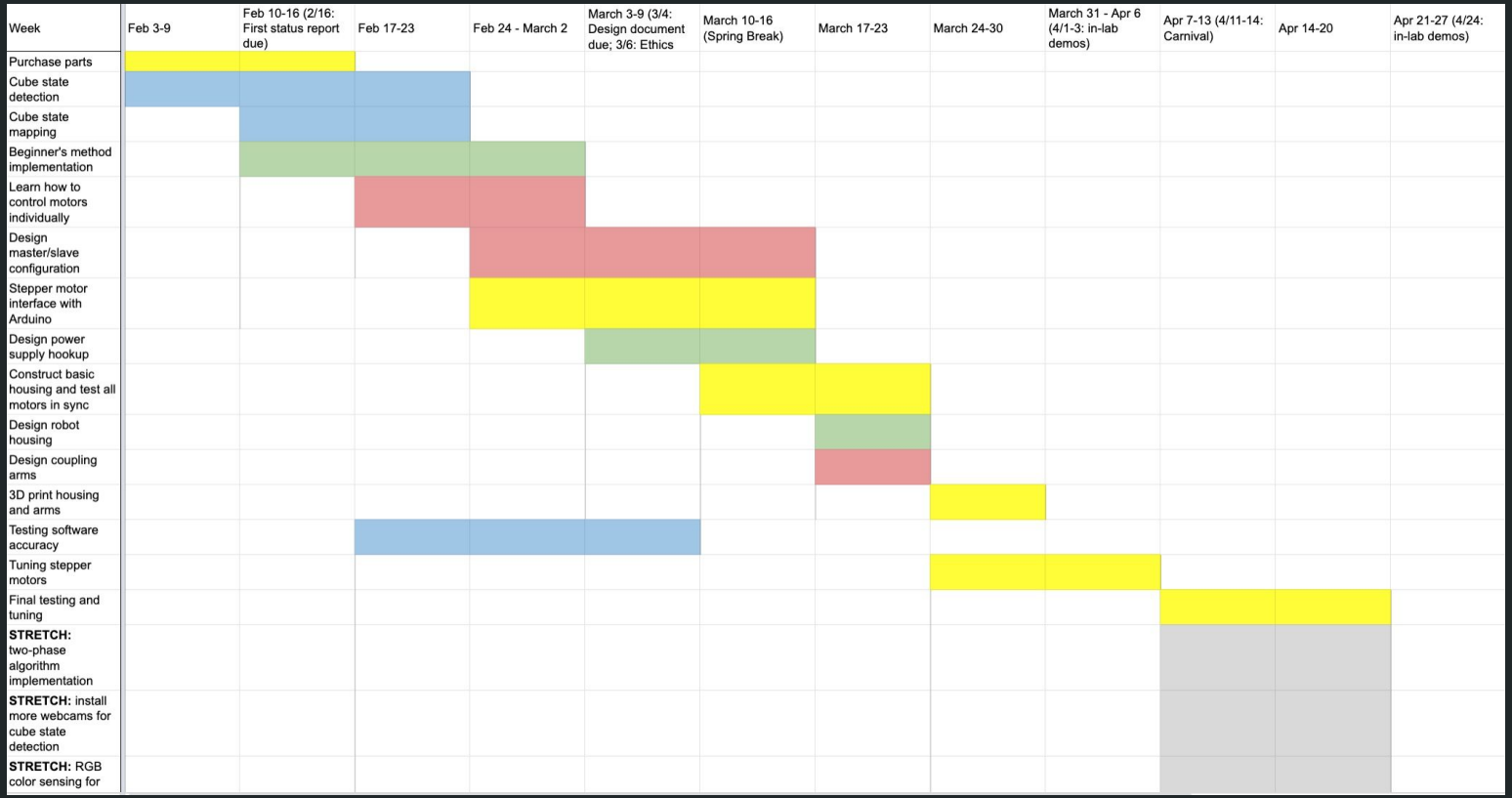
Metrics and Validation

- Cube state detection
  - Live color tracking accuracy
- Algorithm efficiency
  - Number of cube movements to solve the cube
  - Was a solution found?
- Stepper motor precision & timing
  - Verify correct movements are made for any given input
  - How fast to execute a solution string (Baseline 20 moves)
- Is the cube physically solved?

Total Purchases

Note: These estimates exclude tax and shipping costs				Running Total:	$ 414.97			
Product	Where to buy	Quantity	Price per unit	Shipping fee	Total Price	Purchase Date	Arrival Date	
Nema 17 Stepper Motors	https://www.adafruit.com/product/324	12	$ 12.60	$ 7.81	$ 159.01	Feb, 11		Priority
A4988 Stepper Motor Driver	https://solarbotics.com/product/51090/	12	$ 6.49	$ 19.14	$ 97.02	Feb, 11		Secondary
DRV8825 Stepper Motor Driver	https://www.pololu.com/product/2133	~~12~~	~~$ 7.49~~	~~$ 8.37~~	~~$ 98.25~~	~~Feb, 11~~		Alternative
12V 2A Power Supply Adaptor	https://www.amazon.com/TMEZON-Power-Adapter-Supply-2-1mm/dp/B00Q2E5IXW	1	$ 7.99	$ -	$ 7.99	Feb 11		Stretch
24V 5A Power Supply Adaptor (alternative)	https://www.amazon.com/ALITOVE-100-240V-Adapter-Converter-5-5x2-1mm/dp/B01GC6VS8I/ref=sr_1_17?keyword	1	$ 19.99		$ 19.99	Feb 20		
Arduino Uno Rev3	https://store.arduino.cc/usa/arduino-uno-rev3	1	$ 22.00	$ 4.37	$ 26.37	Feb 11		
Logitech - C270 (Cheap webcam alternative)	https://www.amazon.com/Logitech-Widescreen-designed-Calling-Recording/dp/B004FHO5Y6/ref=pd_lpo_vtph_147_b	0	$ 19.86		$ -	Feb 19		
Lighting Box Tent Kit	https://www.amazon.com/BrightBox-Portable-Photo-Studio-Light/dp/B01N75CIVP	0	$ 21.99	$ -	$ -	Feb 19		
Valk 3	https://www.thecubicle.com/collections/3x3/products/valk-3	2	$ 19.99	$ 3.22	$ 43.20	Feb 11		
Mofang JiaoShi MF3RS2	https://www.thecubicle.com/collections/3x3/products/mofang-jiaoshi-mf3rs2	2	$ 7.99	$ 3.22	$ 19.20	Feb 11		
MoYu WeiLong GTS2 M	https://www.thecubicle.com/collections/3x3/products/moyu-weilong-gts2-m	1	$ 25.99	$ 3.22	$ 29.21	Feb 11		
Breadboard-friendly 2.1mm DC barrel j	https://www.adafruit.com/product/373	3	$ 0.95	$ 10.13	$ 12.98	Feb 11		

Updated Timeline



Week	Feb 3-9	Feb 10-16 (2/16: First status report due)	Feb 17-23	Feb 24 - March 2	March 3-9 (3/4: Design document due; 3/6: Ethics	March 10-16 (Spring Break)	March 17-23	March 24-30	March 31 - Apr 6 (4/1-3: in-lab demos)	Apr 7-13 (4/11-14: Carnival)	Apr 14-20	Apr 21-27 (4/24: in-lab demos)
Purchase parts												
Cube state detection												
Cube state mapping												
Beginner's method implementation												
Learn how to control motors individually												
Design master/slave configuration												
Stepper motor interface with Arduino												
Design power supply hookup												
Construct basic housing and test all motors in sync												
Design robot housing												
Design coupling arms												
3D print housing and arms												
Testing software accuracy												
Tuning stepper motors												
Final testing and tuning												
STRETCH: two-phase algorithm implementation												
STRETCH: install more webcams for cube state detection												
STRETCH: RGB color sensing for												