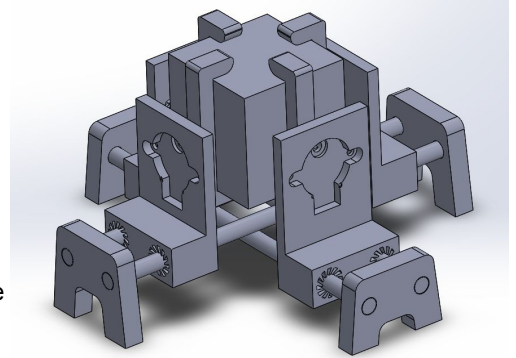


# Project Proposal - Rubik's Cube Solver

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Abstract: (What is it and what will it do)

Our project is going to be a Rubik's Cube solving robot. The final project should be able to:

- Take in a standard Rubik's Cube, and capture the state using a camera
- Use a computer algorithm to compute the solution from that position
- Use stepper motors to perform the series of moves required to solve the cube
- Additionally, we may choose to implement some other features if we have time:
  - Display the current state and remaining moves on a small LCD screen
  - Be able to perform set algorithms to the cube to put it into various fun patterns

Major software components:

- Rubik's Cube Solver
  - Must be able to represent the unique state of a Rubik's cube in memory
  - Use that state to generate a sequence of moves that will return the cube to solved position
  - Relay the sequence of moves to the motion systems
- Webcam Vision
  - Use a USB webcam to capture each side of the cube
  - Analyze different regions of the face to determine the colour at each cubie
  - Store the results into a cube state compatible with the solver
  - Mathematically determine whether the cube is in a solvable state
- Motion System
  - Control individual stepper motors through the GPIOs
  - Implement timing to make motors move together in unison to perform moves
  - Provide functions to make individual moves, to work with the solving component
  - Work with the webcam system to scan all sides before the cube is solved

Prototype plan: Experimental

By the prototype due date, we are hoping to have tested the following components:

- Electronics: connected the 6 steppers + drivers and BeagleBone Black on a breadboard, and turned the motors simultaneously (completed)
- Hardware: Assemble motion axes, try turning 3D printed components with motors (in progress)
- Computer vision: Be able to take a photo of a Rubik's cube, and be able to determine each of the 6 colours in each of the 9 positions on the face
- Cube solver: At least be able to represent a cube state in memory, possibly begin trying to implement phase 1 of the 2-phase algorithm for solving (documentation is available online: <http://kociemba.org/cube.htm> )

Hardware:

- BeagleBone Black(acquired): Main controller, running a lightweight distribution of linux and using C
- 6 Stepper motors + stepper motor driver chips: 4 rotate the sides of the cube, 2 are used to disengage the grippers so the cube can be rotated (acquired)
- 5V@2A power supply: maximum current draw shouldn't be above 1A (acquired)
- 3D printed mechanical components (being designed)
- USB webcam (acquired)

Challenges: Software & Hardware

We feel that this is a very ambitious project, so it is very likely we'll run into many challenges

Hardware	Software
<ul style="list-style-type: none"><li>- Fabricating components to proper specification</li><li>- Timing hardware actions to software commands</li></ul>	<ul style="list-style-type: none"><li>- Developing an optimal solving algorithm</li><li>- Determining cube state accurately and quickly via webcam input</li></ul>