

D.I.Y Smartcube:

A Sound of New Life for the Rubik's Cube as a Pedagogical Tool

Solving a Rubik's Cube teaches problem solving skills. Digitizing the cube can improve learning.



Invented to teach spatial reasoning to architecture students, the cube has sold over 450,000,000 units, reaching 1/7 of the world's population.

Now "smartcubes", which track every face rotation, promise real-time feedback for beginners and advanced solvers alike.

Existing smartcubes require Bluetooth circuits too large for use in normal Rubik's Cubes.



Commerical smartcubes use rotation sensors to detect movements, then broadcast them to a smartphone via Bluetooth.

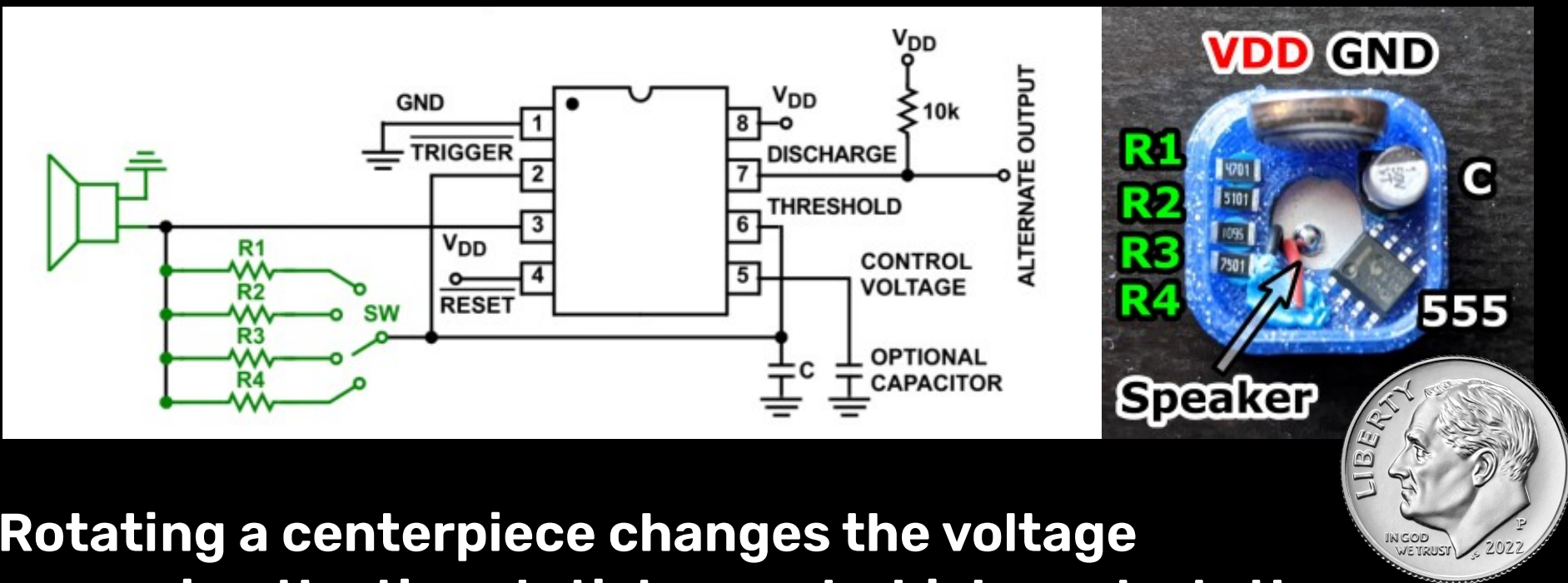
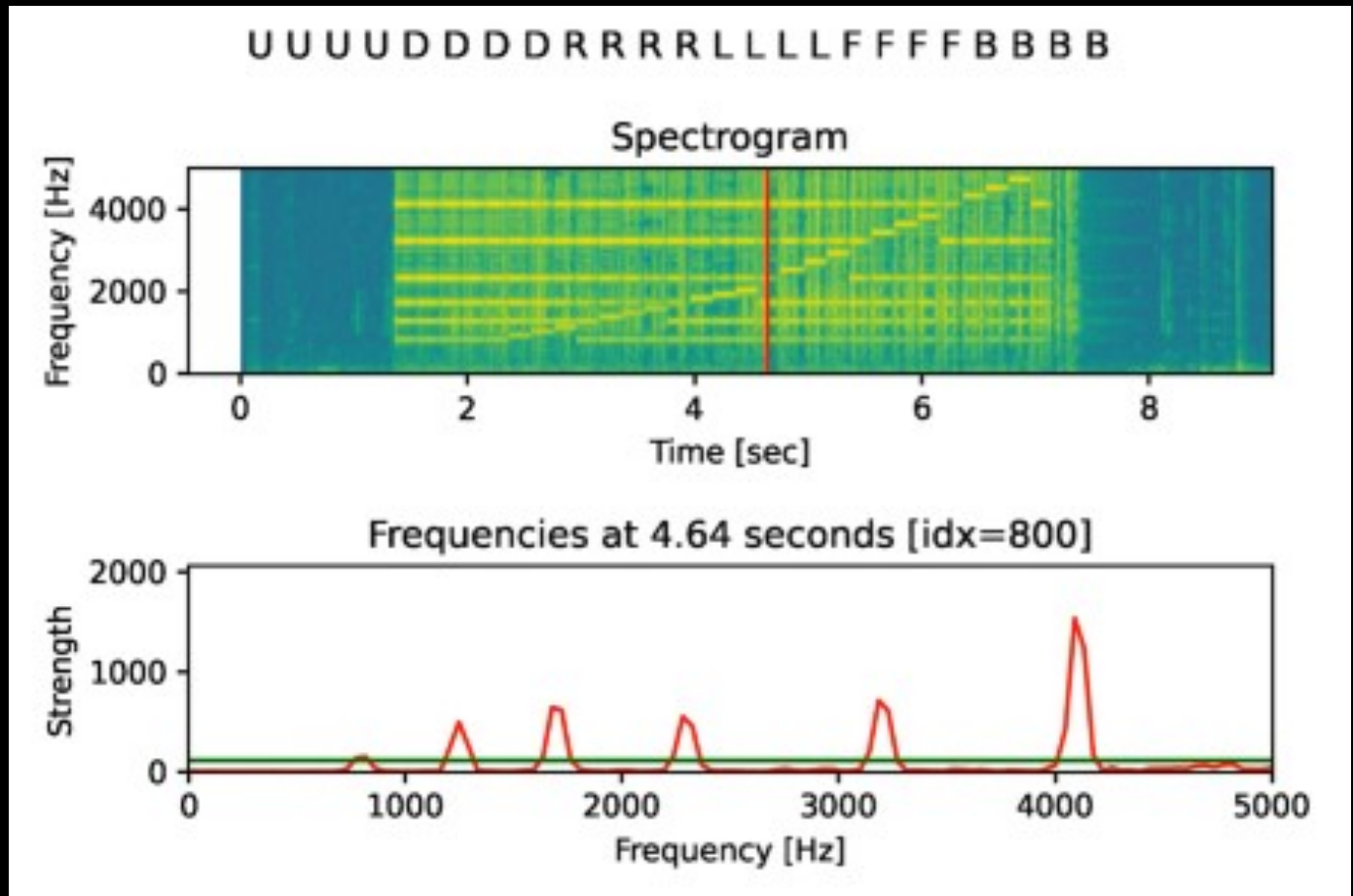
All those electronics require a large battery and housing for a circuit board slightly bigger than a quarter.

A normal Rubik's Cube has much less space. Typically the 20 moveable pieces rotate tightly around a small, solid core about the size of a dime.

Small speakers can transform a normal Rubik's Cube into a digital teaching tool.

A sound-based smartcube design fits inside the dime-sized centercaps of a Rubik's Cube.

Each centerpiece plays unique tones for each angle of rotation. Analyzing a recording of the tone changes detects the rotations.



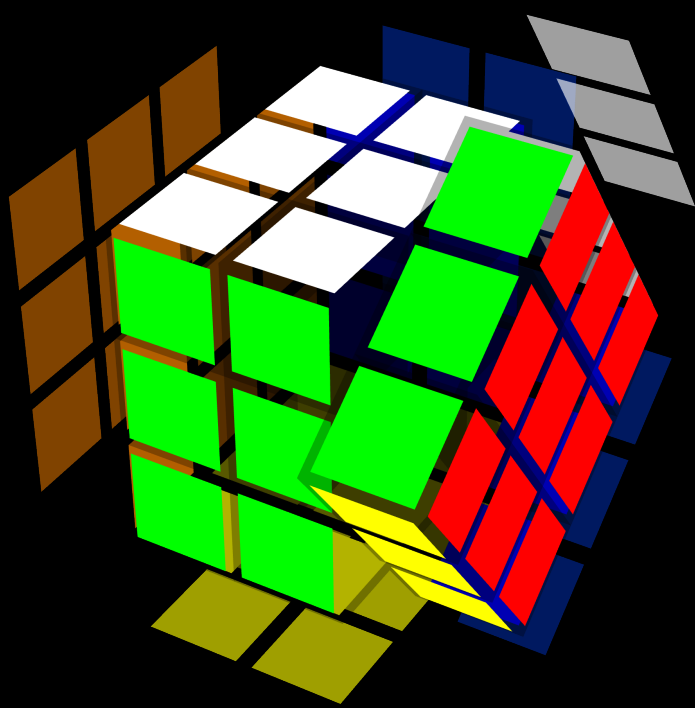
Rotating a centerpiece changes the voltage governing the timer's tick speed which controls the vibration frequency of the speaker generating the tone.

The complete circuit has less than 10 components, which all fit in the dime-sized space within a centercap.

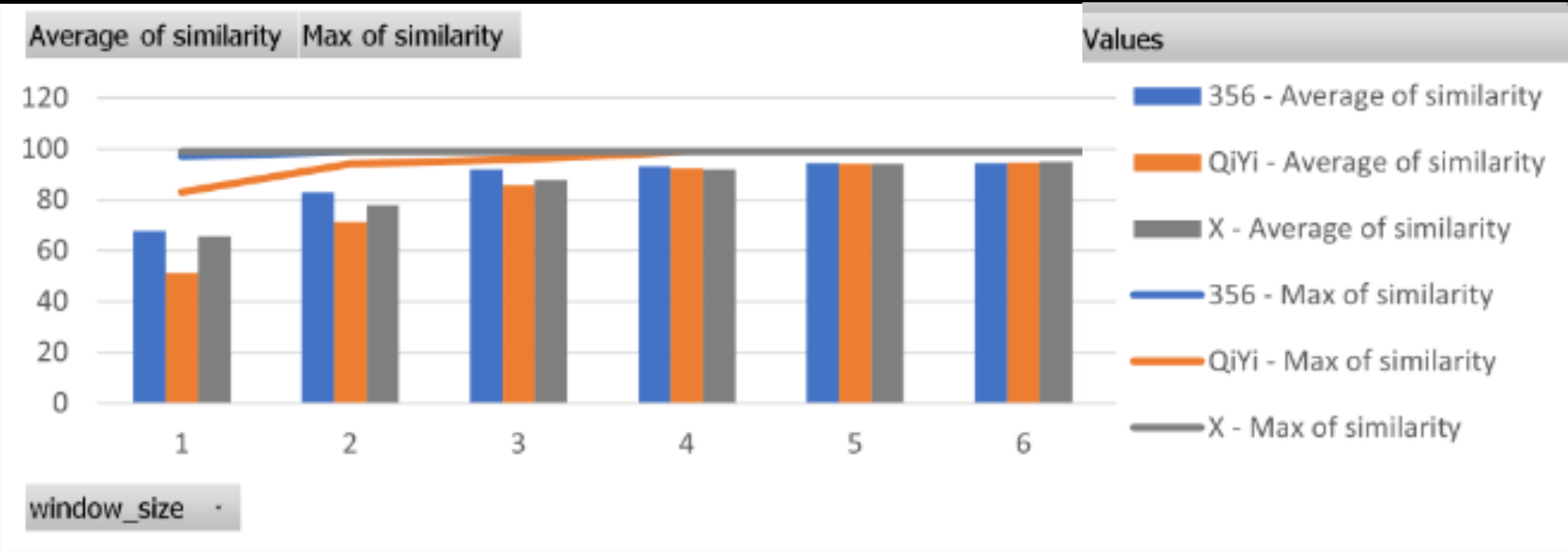
Future improvements to smartcube software will unlock new learning opportunities.

Recorded face rotations can be analyzed to find solving patterns and recommend improvements.

- Creation of step-by-step, guided tutorials.
- Identify common mistakes then provide personalized training.
- Share rich statistics about every aspect of a solve for enhanced personal reflection.



Face rotations transmitted via sound can be detected with up to 100% accuracy.



The rotation detection algorithm decoded several tone sequences overlaid with noise from solving various Rubik's Cube models.

When running with high levels of error checking, the algorithm decodes tone sequences with 2 turns/second with 100% accuracy, and 5 turns/second with 95% accuracy across all cube models.