



Alternative Tactile Display Using Granular Jamming

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Goal: Produce an affordable, scalable, and DIY-able tactile display leveraging concepts of granular jamming

Introduction

Refreshable braille displays currently on market are unaffordable for most braille readers, due to the intricate technology used. In fact, typical 40-cell displays cost above \$2,000 per unit. However, granular jamming provides a technique for creating a more affordable and scalable refreshable tactile display, which can be used to convey graphic information in a visual-less manner. Granular jamming refers to the phenomenon where granular material such as coffee or sand grains become rigid but malleable in a vacuum. This phenomenon has been used in robotics to create universal gripper arms that can grab objects of varying shapes. However, little research has been done on exploiting this phenomenon to create a braille display or to convey graphic information. Some research has focused on using granular jamming as a way to provide haptic feedback, but otherwise few applications for a tactile display actuated via granular jamming have been explored.

We plan to explore the many potential applications of a granular-jamming-based tactile display, specifically in the realm of refreshable braille displays and image imprinting. Compared to commercially available braille displays, granular-jamming-based tactile displays are very simplistic and inexpensive to manufacture. Additionally, they can create low-resolution tactile images, which can be used in schools or storybooks to help visually-impaired children experience illustrations and graphic descriptions they otherwise cannot see. We hope that our project will pave the way to several different real-life applications that this technology will be able to provide in the future.

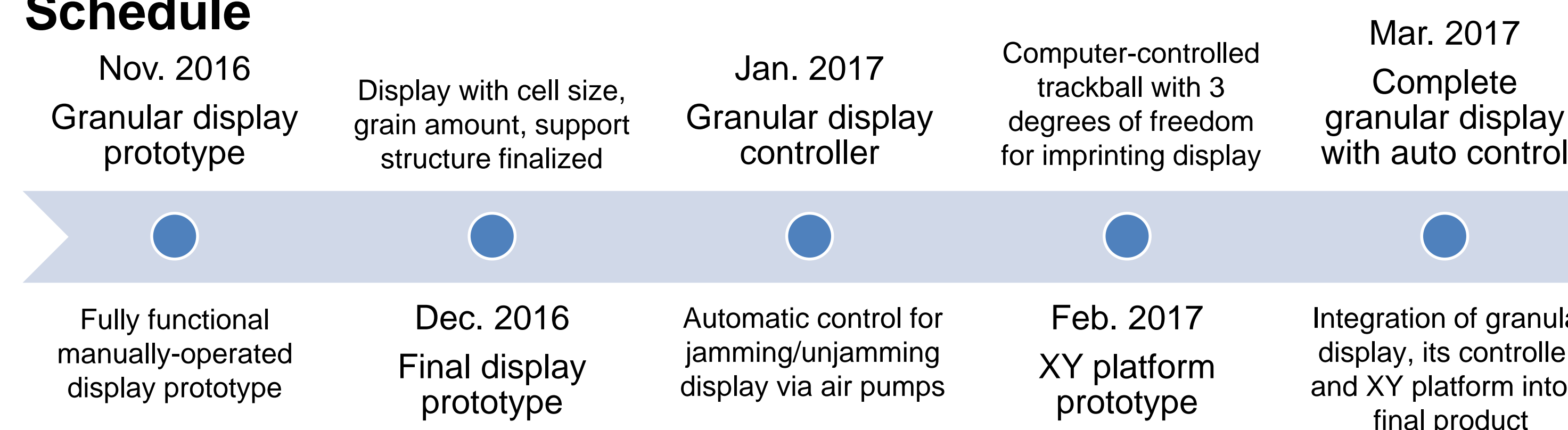
Team 33: General Tactile

| Member | Major | Responsibilities |
|------------------------|-------------|--|
| Mark Baldwin (Advisor) | Informatics | Inspiration for original project idea. Provide materials and lab space to build prototypes. |
| Leon Trinh Cao | CSE | Research and develop mechanical structure. Design and program control systems for display and XY platform. |
| Paul Vinh Dao | CSE | Work on embedded programming to control XY platform. Work on image processing software. |
| Niraj Patel | CSE | Work on software for XY platform and air flow control system. Work on image processing software. |
| Kevin Truong | Engr. EE | Assist in implementation of XY platform. Work on control system's circuitry. |

Find us on <http://srproj.eecs.uci.edu/projects/alternative-tactile-display-using-granular-jamming>

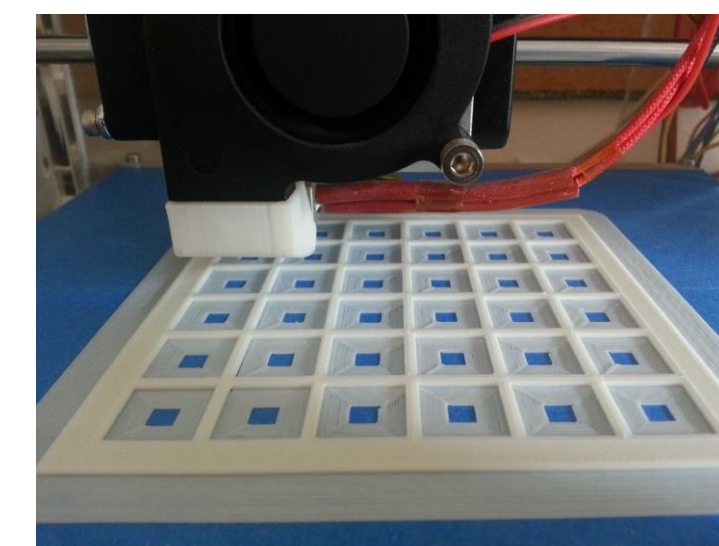
Contact us at msbaldwin@gmail.com or gcao@uci.edu

Schedule



Implementation

Affordability, scalability, and DIY-ability are the primary goals of this project, so all required components are easily acquired or assembled via 3D printing and off-the-shelf parts from makerspaces or hardware stores. As such, the tactile display only consists of a simple 3D-printed frame as well as spent coffee grains, sealed airtight between sheets of silicone caulk.



3D-printed support structure

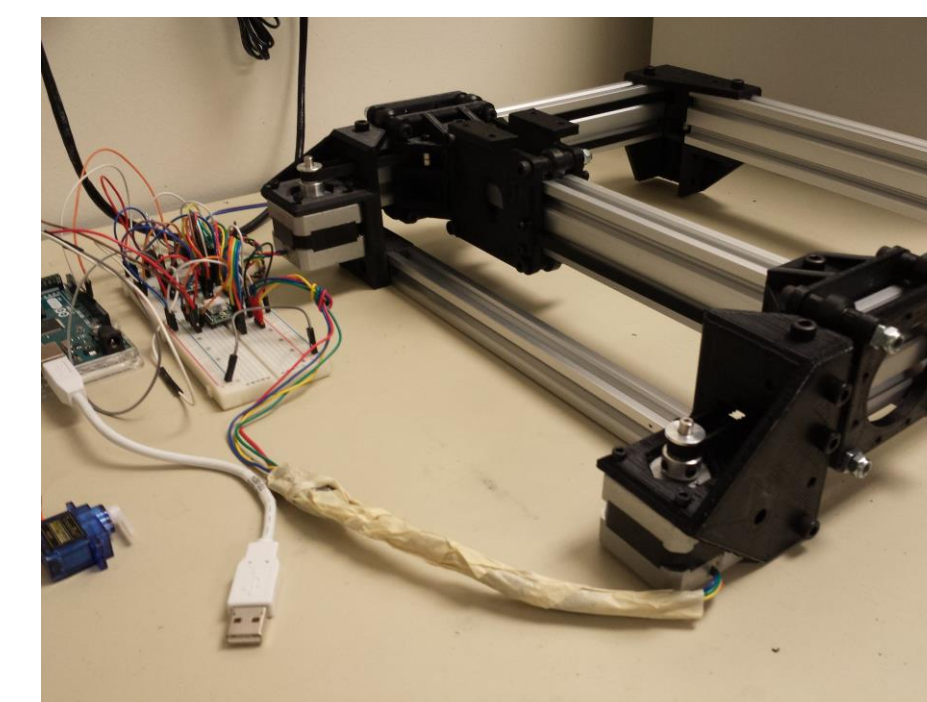


Unjammed display prototype

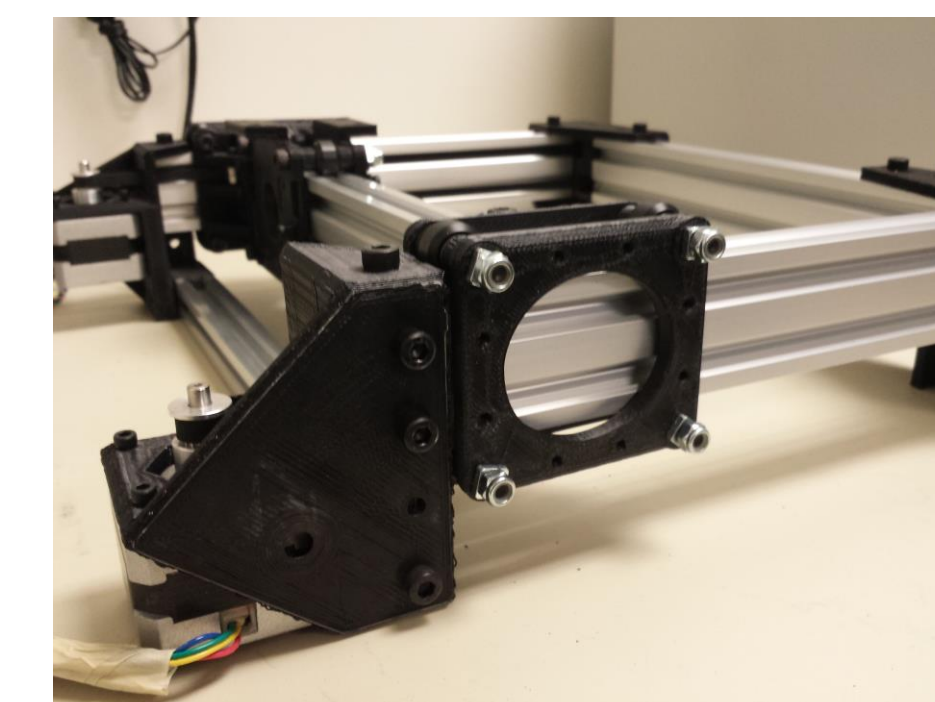


Jammed and imprinted display prototype

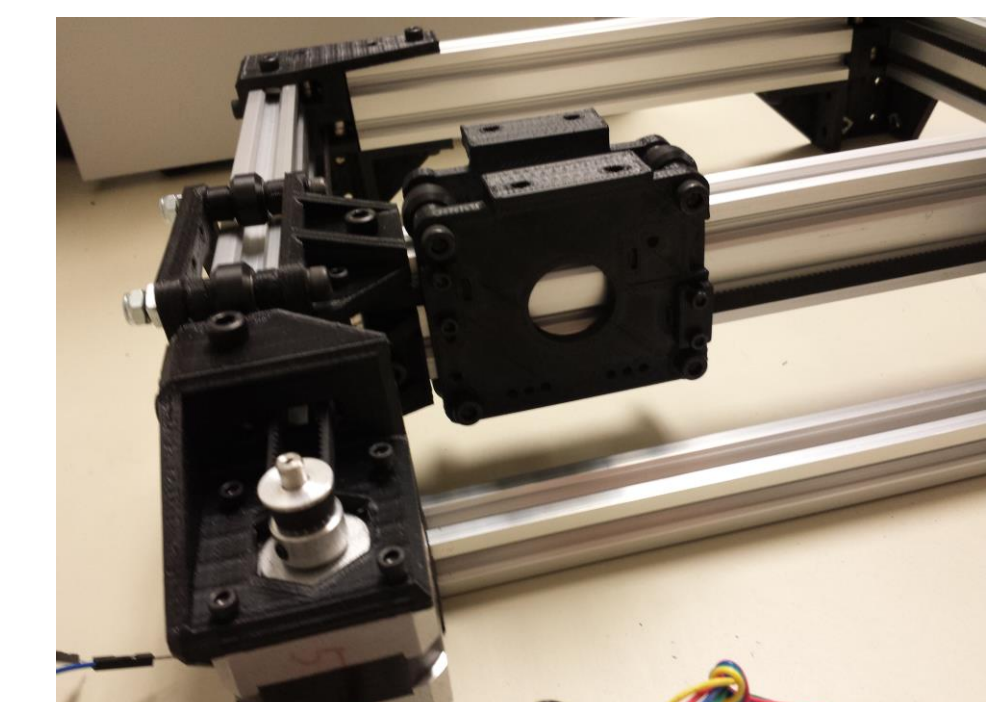
After every cell in the frame is filled with coffee grains, raised surfaces are created by evacuating air from the display and simply pressing against the grains. When jammed against each other due to the lack of air, the grains provide sufficient friction to overcome gravity. The durable and flexible silicone provides moving room for the grains in the jammed state, making it possible to create raised surfaces on the display. Additionally, any shape created in the jammed state stays until air is reintroduced. Furthermore, by its elasticity, the silicone restores the original display shape when air is reintroduced, un-jamming the grains and clearing any imprinted pattern.



Overview of XY platform prototype



Side view of XY platform prototype



Closer look at XY carriage prototype

A computer-controlled XY platform is used to automate the process of imprinting display cells. Before a tactile image is created, an air pump activates to evacuate air out of the display and jam the grains. To imprint a pattern, a ball caster is rolled against a layer of pinheads stationed directly below the silicone display, providing a contour of raised surfaces. To clear a tactile pattern, another air pump activates to reintroduce air into the display, unjamming the grains and restoring the original flat display shape.