Blind Arduino

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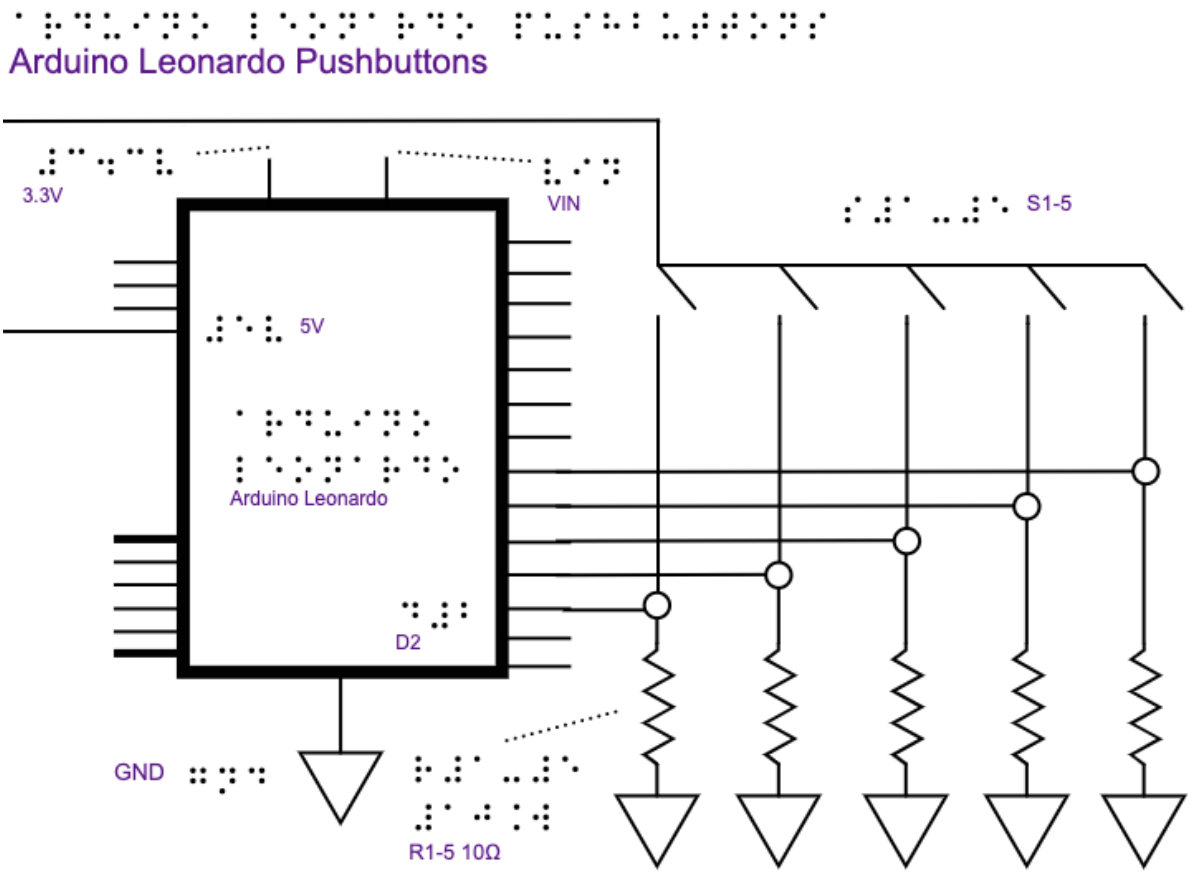

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What is Arduino and how accessible is it for blind people?

Arduino is a popular, small computer that is meant to make it easy for people to make electronic things. Since Arduino is a circuit board, many people refer to the Arduino computer as a “board.” The Arduino board is open source, which means anyone can make their own Arduino. Arduino also includes a software program. People can use the software to write code that runs on the board.

Many Arduino tutorials use schematic diagrams. Schematics are symbols that represent how a circuit works. Some tutorials use pictures or diagrams of the circuit to help people see how to connect the parts of the circuit. Unfortunately, schematics and pictures in tutorials aren’t usually shown in a way that blind people can understand.

The Arduino board has pins arranged in rows called headers. Pins are small pieces of metal on the board that attach to wires so you can create a circuit.

Each pin has a number. Some pins also have a name, such as “ground.” Pin numbers and names are usually printed on the top of the board next to each pin. It can be hard for blind people to know the pin numbers on an Arduino because they can’t see the names and numbers printed on the board.

How to design Arduino learning materials for blind people

The paper Designing Educational Materials for a Blind Arduino Workshop[1] gives an example of an Arduino workshop designed for blind people.

The workshop instructors planned to make a circuit that makes noise using a part called a piezo buzzer. This way, blind people could hear if they made the circuit successfully. For the workshop materials, they wrote circuit descriptions, created component diagrams, and printed a tactile schematic.

Eight blind people took the workshop. The authors asked the people who took the workshop how they liked each part of the workshop. Below, I’ve outlined the workshop materials and participants’ responses.

1. Circuit descriptions

Circuit descriptions are written explanations of what the circuit does and what parts, or components, it uses. Most participants read the circuit description using their phone’s screenreader. Participants said it would have been easier if the description was written as a list of things to do instead of as a block of text. However, they said that having a circuit description helped them to understand the diagrams.

2. Component diagrams

Component diagrams are pictures of the component and the component’s schematic symbol. They are printed with special puffy ink that can be touched, and the descriptions are written in braille. Showing information in a way that can

[1] (Race et al. 2020)

be felt is called a tactile graphic. Tactile graphics are most helpful when used with a text description, like the circuit description. This is because most blind people don't read tactile graphics very often so they can be hard to understand at first.

The component diagrams in the workshop also had the actual component, the piezo buzzer, glued to the paper. Participants liked that the piezo buzzer was glued to the paper with the component diagram since it helped them to find it when putting together the circuit. They also liked the size of the printed graphics.

3. Tactile schematics

Tactile schematics are pictures showing the circuit as a raised image with braille descriptions. Five of the eight participants were new to electronics and didn't know how to understand the symbols in the schematic.

A breadboard is a plastic board with holes that you can plug wires into to connect a circuit. The schematics don't show the breadboards. Instead, they show lines where the electricity flows from the Arduino to the piezo buzzer. This made it confusing for some participants because they didn't understand where to plug the wires in on the breadboard. One participant said having a raised image of the breadboard would have made it easier to understand.

Chancey Fleet's tips for designing workshop materials

I also watched the talk The need for accessible technology[2]. This talk is by one of the previous paper's authors, Chancey Fleet. She is the Assistive Technology Coordinator at The New York Public Library. She continues to design Arduino workshops for blind people.

In her workshops at the New York Public Library, Chancey Fleet now includes an electronic reference guide in a text that is arranged in the shape of a circuit. Participants can use this reference diagram to find the pins, headers, and components on Arduino.

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[2] (Fleet et al. 2020)

A good example of a schematics workshop for the blind that Chancey Fleet helped to design is at https://abilityproject.github.io/schematicsworkshop[3]. It is written in a list of steps. It describes the Arduino and its pins using just text.

Chancey Fleet also gives tips for how blind Arduino users can wire their circuits. Wires in a circuit are usually color coded: red for positive, black for negative. Blind users can tie a knot in the wire for their positive connection to stay organized.

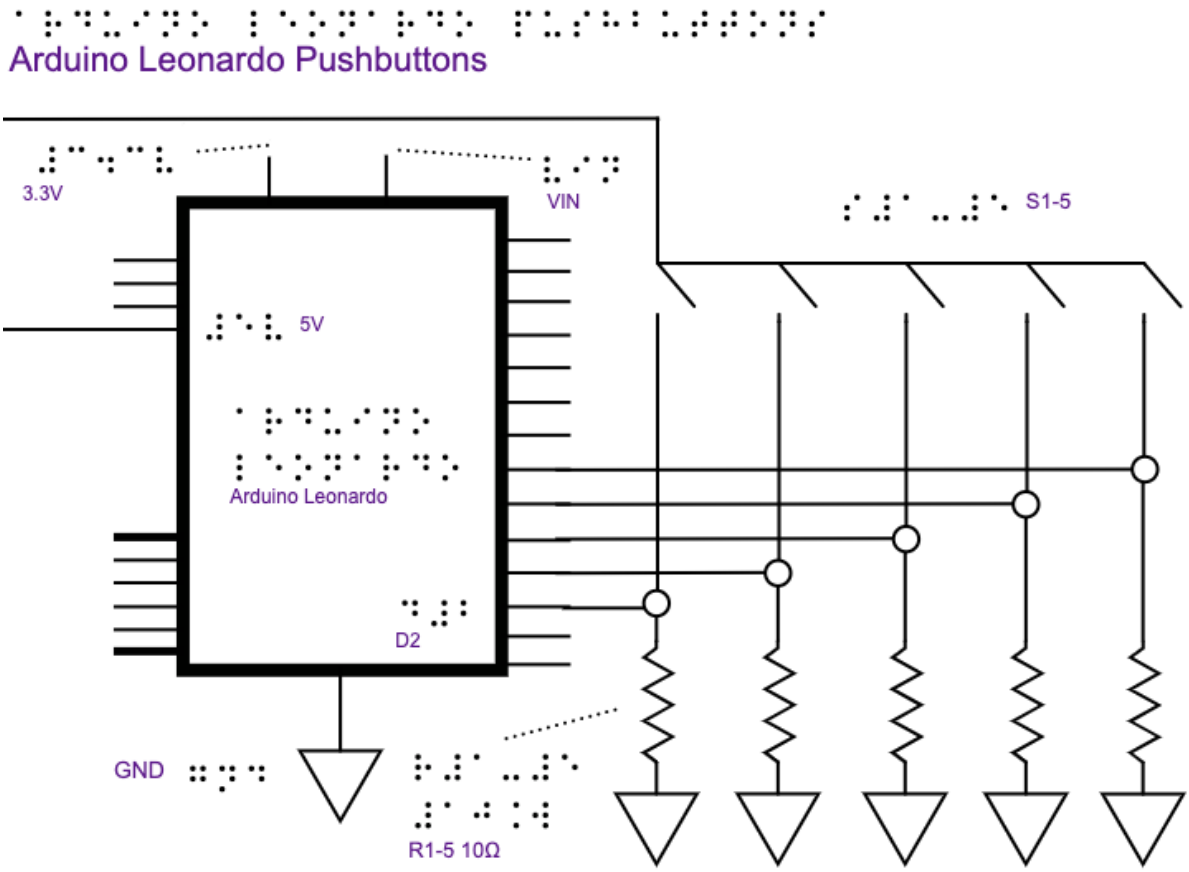
Tips and tricks for blind people using Arduino

Besides the paper and talk outlined above there are many other resources for blind Arduino users. Blind makers share their knowledge on sites like the Blind Arduino Blog and The Blind Arduino Project. There are also tutorials on sites like Adafruit.com that can be read with a screenreader[4].

Blind Arduino users also share tips and tricks at events like the Bay Area Blind Arduino Monthly Meetup, maker spaces, and similar venues. I've listed some tips below.

[3] (Fleet et al., n.d.)
[4] (Website Accessibility Statement, n.d.)

Designing tactile schematics



Lauren Race created a [set of best practices][5] for designing tactile schematics. People designing Arduino tutorials can create their own tactile schematics to make their tutorials friendlier for blind people.

Using Arduino with a screenreader

The Arduino software is able to be read by screenreaders since [version 1.8.10] came out in 2019. If you need to use an older version of the software, blind Arduino users have found workarounds, like using Visual Studio or Notepad++ to write code for Arduino.[6]

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[5] (Race et al., 2020)
[6] (Miele, 2016a)

Using servo motors as gauges

Joshua Miele, a famous blind Arduino user, wrote an article on how to blind people can use servos as displays to show measurements[7]. Servo motors are little motors that spin. Some are able to spin all the way around, and others are only able to spin in a half circle.

Servos often come with a small piece of plastic called a servo arm that shows how far the servo has spun. Servo motors can be wired to an Arduino to show measurements from sensors. The servo might show measurements like how humid it is or how much power part of the circuit is getting. Blind people can feel the measurement by touching the servo arm to see how far the motor has spun.

[7] (Miele, 2018)

Talking multimeters

A multimeter is a tool that measures how much electricity is in a circuit. Most multimeters show the measurements on a screen that blind people can't see. There are talking multimeters for sale but they can be expensive. There are instructions to build at talking multimeter yourself[8].

Continuity testers

Most multimeters include a continuity tester. Continuity testers make a sound that lets you know if current is flowing through a circuit. Some even change the pitch of the sound depending on the resistance in the circuit. This is a useful tool to make sure a circuit is set up in the way you want. Joshua Miele has instructions for how to make your own continuity tester using an Arduino[9] at the Blind Arduino Blog.

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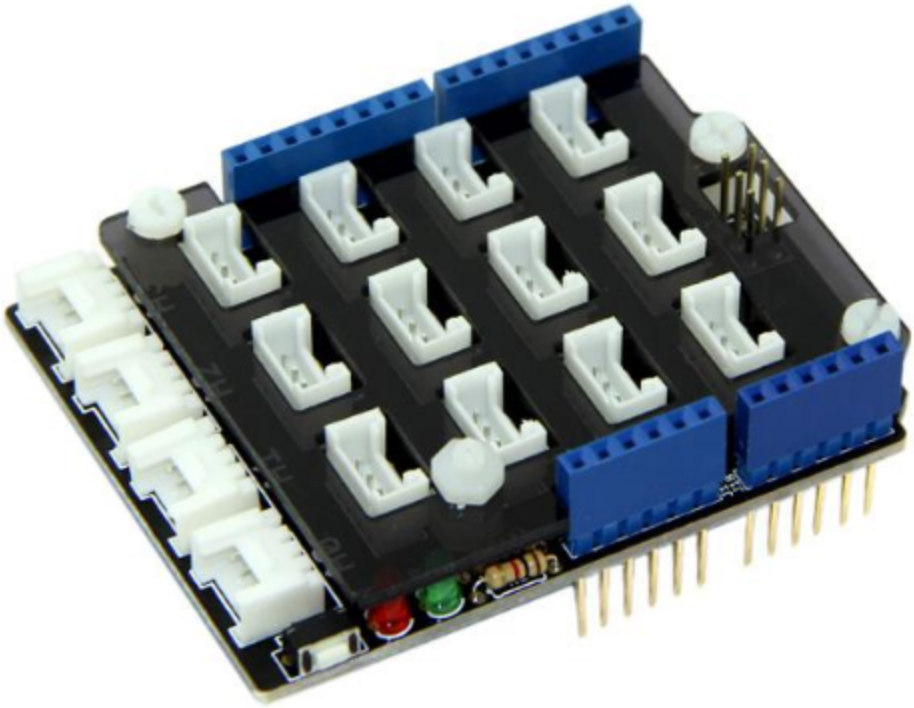
[8] (Pankhurst, 2015)

[9] (Miele, 2016b)

The Grove Base Shield



The Grove base shield is a circuit board that sits on top of the Arduino and plugs into the Arduino's pins. It has connectors on top that use special wires to make it easy to plug things into the Arduino without needing a breadboard or soldering. This lets students focus on coding concepts and not wiring.

Conclusion

When designing workshop materials and tutorials, it's important to include both tactile schematics and text instructions in workshop materials. Blind and sighted instructors should work together when designing materials. If they work together, sighted people can learn from blind people how to create better tutorials for the blind.

Blind makers have made accessible tutorials on sites like the Blind Arduino Blog with tips and tricks for blind makers. Tutorials on sites like Adafruit are written to work well with screenreaders. However, there are thousands more Arduino tutorials that use visual graphics that could be translated into better formats for blind people.

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