



# Magic Glove

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MAGIC



## &lt;Info&gt;

<Keywords> experiment, environment, temperature, humidity, luminosity, magnetic field

<Disciplines> physics, chemistry, biology, ecology, computer science

<Age level of the students> 10–18

<Level 1> for primary school (age: 10–11) and secondary school (middle school, age: 12–15)

<Level 2> for secondary school (high school, age: 15–18)

<Hardware> Arduino UNO<sup>[1]</sup>, sensors compatible with Arduino (e.g. light sensor, temperature sensor, magnetic field sensor, humidity sensor, gas sensor), LCD button shield, jumper wires, external battery

<Language> C<sup>[2]</sup>, Arduino 1.8.5<sup>[3]</sup>, Snap!<sup>[4]</sup>

<Programming level> medium

## &lt;Summary&gt;

Young people are passionate about technology, so a lesson that combines science with computer science will be a successful one. The students will build and use a glove with a different sensor on each finger. This will allow them to carry out different experiments by connecting only the necessary sensor.

## &lt;Conceptual introduction&gt;

The advantage of using a device (a glove) equipped with several sensors for different measurements is twofold. Primary and secondary school students can use the 'magic' glove to measure temperature, brightness, humidity, the presence of a magnetic field, sound intensity, etc. All they have to do is select the desired sensor and they are ready to start finding various uses for the glove in different fields of study and school subjects. The glove can be taken out in the field as it is powered by a battery; this offers a possibility for the students to investigate outside of the laboratory. On the other hand, high school students can build a glove themselves to make certain determinations. The students know the theoretical notions of the various sciences (physics, chemistry, biology, ecology), and they truly enjoy the opportunity to investigate them in practical experiments.

Teachers will need to present the basic concepts for coding a program in C<sup>[2]</sup> or any other programming language supported by Arduino, including Snap!<sup>[4]</sup>, for the students to code for Arduino<sup>[1]</sup>. To acquire a basic knowledge of C, if they choose it as programming language for Arduino, the students can watch tutorials on the Internet. This will help them to better understand how the code should be written and also boost their confidence since most of them will be surprised by just how simple the code is.

## &lt;What the students/teachers do&gt;

## &lt;Level 1&gt;

The glove has an LCD display with buttons. The students put on the glove and select the desired sensor with the UP/DOWN buttons; then they press the SEL button and the measurement starts. The screen displays the value. The students can repeat the measurements whenever they want. To return to the home screen, they press the BACK button. For example, you can see the determination of the poles on a magnet in @1a–1c.



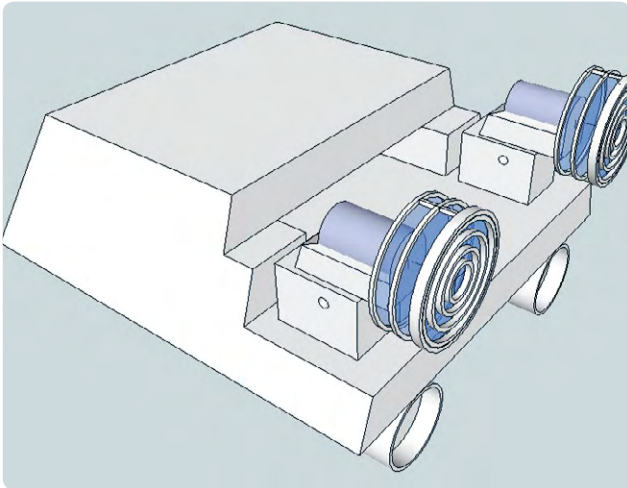
@ 1a-c: Determining the poles of a magnet

## &lt;Level 2&gt;

Students in a class can be divided into four groups. One group cuts and sews the glove, the second group makes the circuit, the third group does the coding and the last group calibrates the sensors.

## &lt;Making the glove&gt;

The students made a template (@2) after consulting documentation on several websites<sup>[5]</sup>. They folded the material (leather in our case, but other materials can be used) in three and cut it using the template. To get the proper glove, the students sewed two of the faces together. They stitched on the last piece of material after they had mounted the Arduino with LCD and sensors on the back of the palm. The students cut out the opening for the LCD display and buttons from this third piece.



© 2: Templates for the glove

### <Building the circuit>

The students made the circuit, starting from a schematic diagram that they have discussed and analysed with the teacher beforehand. The circuit can be fixed (tinned), or not. It must take into account the correct connection of the sensors to the Arduino board, namely the **GND** from the sensor to the **GND** on the Arduino board, the **VCC** from the sensor to **5V** on the Arduino, and the **OUT** on the sensor to one of the **ANALOG IN** (A0, A1, A2, A3, A4 or A5) on the board. If a sensor has to be connected to the **DIGITAL IN**, care must be taken not to use one of the inputs used for the LCD because operating errors will occur. In our example, we connected the following sensors: temperature (A1), light (A2), humidity (A3), magnetism (A4) and proximity (A5) (see © 3a–3e).<sup>[6]</sup>

### <Writing the code for the circuit>

High school students who are studying the C programming language<sup>[2]</sup> can easily program Arduino<sup>[1]</sup>. There are many tutorials available online in a multitude of languages. For example, our students used a website in Romanian<sup>[7]</sup>. Tutorials in English are among others offered on the Arduino website or on the distributors' websites.<sup>[8]</sup> There are also many other sites where the students can find tutorials.

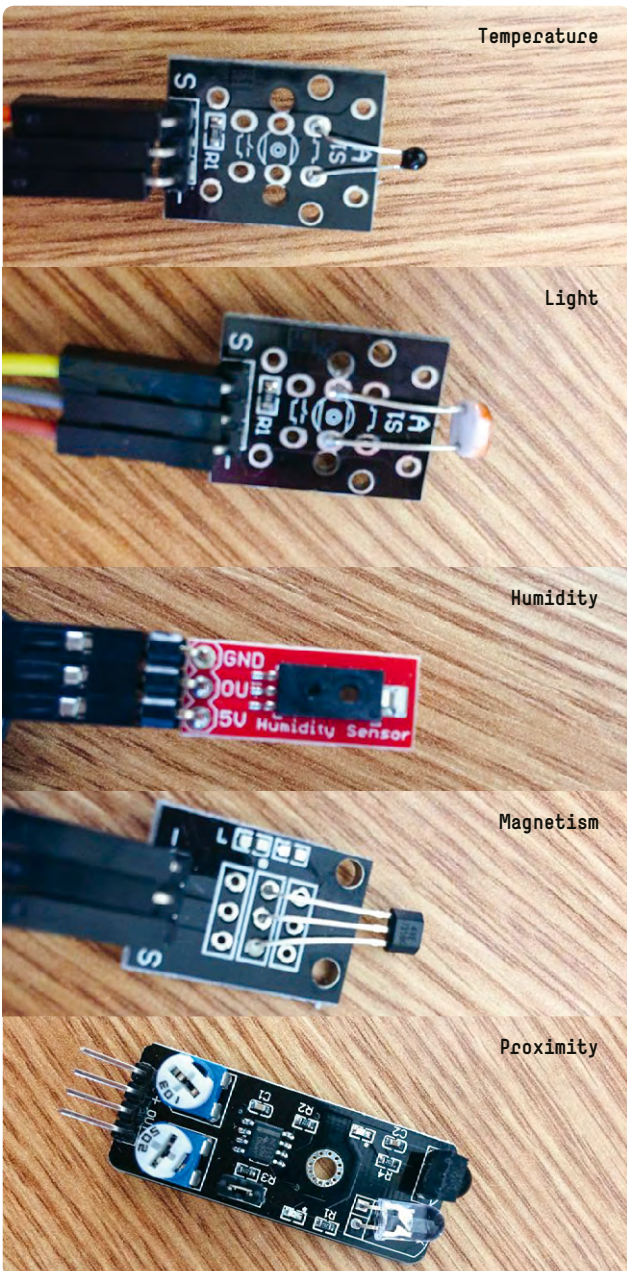
The teacher can guide them through how to write the program for Arduino, and you can find the complete code that we used online.<sup>[9]</sup>

### <Calibrating sensors>

There are calibrated sensors available, but there are also uncalibrated ones; it is sometimes more enjoyable for the students to find a way to calibrate them. They found calibration formulas for some of the sensors on the Internet. For example, there is a formula for the humidity sensor brick<sup>[6]</sup>, because the function by which the displayed values vary is not linear.

With regard to the calibration of the temperature sensor, the students tracked the values displayed by the sensor. They used a calibrated thermometer in the lab and associated the displayed value with the thermometer value. They discovered that this sensor varies linearly and found the calibration formula. There are examples with the calibration formulas for the humidity and temperature sensors in the additional material provided.<sup>[9]</sup>

Once the students have calibrated the sensors, completed the program and checked the display to ensure that the fingers of the glove are properly correlated with the data appearing on the screen, the glove is then mounted. The last step is to stitch/sew the outer layer of the material. The students used



© 3a-e: Sensors

some fastening rings for each sensor on each finger (📷4) to better fix the sensors.



📷 4: Fixing the sensors

### <Algorithm to use in other languages>

If you would like to use another programming environment, a diagram with all the necessary elements for the main program is available online.<sup>[9]</sup>

### <Conclusion>

Students enjoy discovering new things and are very inventive. They like to make experimental determinations, and the glove looks as though it came from a science fiction movie. High school students will enjoy the coding elements of the unit and see the results immediately in something practical that actually works.

This experience was an unprecedented one, and the teachers and students learnt many things together.

They did encounter one difficulty: it is not easy to find the right sensors<sup>[6]</sup> and calibrate them, but there are solutions. If a calibration formula cannot be found, a solution lies in purchasing calibrated sensors even though they are more expensive.

This glove could also be constructed using a Calliope mini, which would make it lighter and smaller. Our students are interested in trying to make such a glove even if the programming language is different.

### <Cooperation activity>

Students from different schools and countries could make such gloves using various microcontrollers and suitable sensors, and then discuss and compare the results. An art teacher could be asked to contribute to the design of the glove. Additionally, a contest between schools could be organised, in which the students propose different designs themselves.

The glove is easy to send by mail, so students in different schools could experiment with the gloves made by their peers in other schools and other countries.

### <References>

- [1] [www.arduino.cc](http://www.arduino.cc)
- [2] [https://en.wikipedia.org/wiki/C\\_\(programming\\_language\)](https://en.wikipedia.org/wiki/C_(programming_language))
- [3] [www.arduino.cc/en/Main/Software](http://www.arduino.cc/en/Main/Software)
- [4] <https://snap.berkeley.edu/>
- [5] Several websites with documentation and tutorials on how to sew gloves:  
<http://ofdreamsandseams.blogspot.ro/2012/04/1950s-hand-sewn-leather-gloves.html>,  
<https://so-sew-easy.com/easy-gloves-pattern-winter-comfort/>,  
<http://sew-ing.com/make/gloves.html>,  
[www.glove.org/Modern/myfirstgloves.php](http://www.glove.org/Modern/myfirstgloves.php),  
[www.instructables.com/id/How-to-Make-Gloves/](http://www.instructables.com/id/How-to-Make-Gloves/)  
 [all December 2018]
- [6] We used the sensors in 'sensor kit 37 in 1' for Arduino. The humidity sensor is Humidity Sensor HIH-4030, brand: Sparkfun, code: SEN-VRM-09.
- [7] [www.robofun.ro](http://www.robofun.ro) [Tutorials in Romanian. Every product has instructions on how to connect it to the circuit and what programming language to use. The website contains diagrams and drawings, sensors or other components that can be recognised from the photos, and the program is very easy to follow. This means that the students do not need to have any knowledge of the Romanian language.]  
<http://mthackathon.info/resources/37-SENSOR-KIT-TUTORIAL-FOR-UNO-AND-MEGA.pdf> [tutorials are in English; they contain instructions on how to connect the sensors of the kit to Arduino] [December 2018]
- [8] All additional materials are available at [www.science-on-stage.de/coding-materials](http://www.science-on-stage.de/coding-materials).

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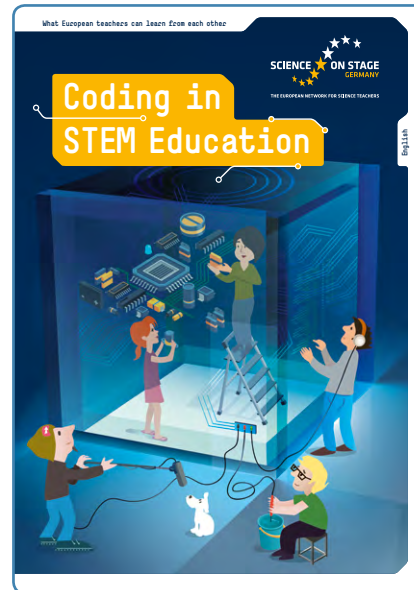
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