Sketching with Hardware - Documentation

Team 2

WS16

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Our idea

In the Sketching with Hardware course in 2016 we, team 2, made an electronic Twister. Twister is a game for children of all ages, where the players have to put their hands and feet on a play mat with colored circles. The movements of the players limbs are assigned randomly by a turntable. Another person, not playing, turns the pointer on the turntable. The game is played on the floor as the playing field is very spacious.

In our Twister we wanted to eliminate the need of a third party and wanted to make the game ‚intelligent'. So now our game knows which player put each body part on which circle on the game field. Also, the person turning the turntable is exchanged by an Arduino.
Our plans worked out really well, at least the hardware components all do their jobs as expected! And of course the fun is enhanced! So how does all of this work?

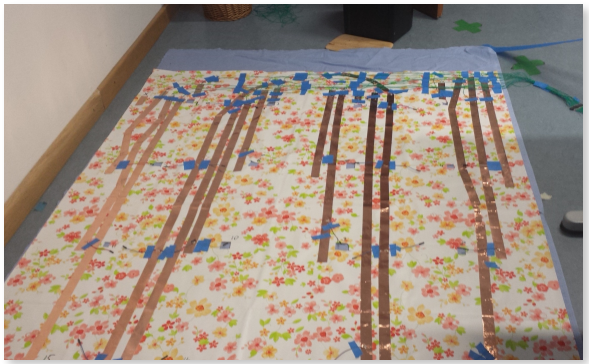
Our hardware

We have two core electronic components in our Twister with Hardware:

- A wired mat with the contact points for the body part recognition
- A turntable gamebox with a random round generator

The game field

The game field consists of an upside down tablecloth and 16 colored paper circles with copper tape - these are the contact points (Pic. 1). Through the contact points the Arduino knows which player is on the field. The players hold the counterpart. The original Twister has a 4x6 circle matrix, but since the Arduino Mega only has 16 analog pins and we used these, this was our limit. We slightly enlarged the field though, through putting the circles apart a little bit (130x160cm). The circles can be removed individually and then again reconnected to the cables that lead to the Arduino. This has the advantage that if a circle breaks there is no need to replace the entire mat. The circles



Pic. 1. The game field with copper tape cables, the color circles and upside-down (the circles are usually not on the bottom side).

are fixed to the mat with Velcro tape. The mat has a hole underneath each circle, through which the cables are wired - this way nothing can be seen from above.

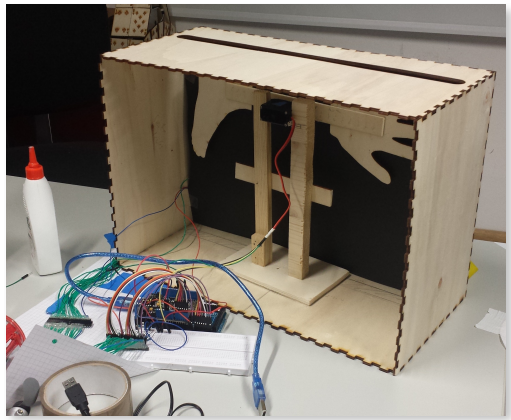
The players have contact pads on their hands and feet. These pads hold resistors and then different resistor values in each pad make it possible to determine which body part is at which position. Copper tape and kitchen sponges (Vileda Glitzi Power) transfers the signal of

Pic. 2. One pad with kitchen sponges and holding a resistor.

the resistor. The pads themselves are made from wood and formed ergonomically to fit to the body parts. They are adjustable in size.
The pads on the hands and feet of the players then close voltage circuits at the circles they touched. The two contacts then have to be put one on the middle circle and one on the outer circle. These inner circles are made from copper tape and are connected to the Arduino. This way the resistance of the pads can be measured and the Arduino knows, which body part is on which circle. The Arduino beforehand calculated where the players body parts had to be at which time of the game and then compares the differences.

Pic. 3. One paper circle with an example pad.

The gamebox



Pic. 4. The open game box showing the motor construction.

The second important electronic gadget of our game is the gamebox. The gamebox replaced the turntable of the usual Twister, which normally has to be operated by an outside referee. The box itself is made from wood, that we glued together in the end. The gamebox also has two electronic components, one is the hand/foot display and the other one is the LED color display.
The hand/foot display indicates whether a hand or foot should be moved by the players, this is then shown by a sign that is displays outside the box. The sign is steered by a small servomotor and consists of a rod which at one end has a foot and on the other end a hand. In the middle there is the motor which then rotates by either 90 ° or 180 °. At the beginning of the game, the rod is horizontal and it is not seen (Pic. 4).

Pic. 5. The finished gamebox.

The LED display was simply some holes in the front shield of the box, filled out with Plexiglas. To enlighten the letters, we used Neopixel LED Strips, two for each letter (so L, O and R). They were placed above and below the letters and glued on a cardboard construction. We covered the LEDs with reflective foil and cardboard between the letters, so the light wouldn't shine onto the other letters.

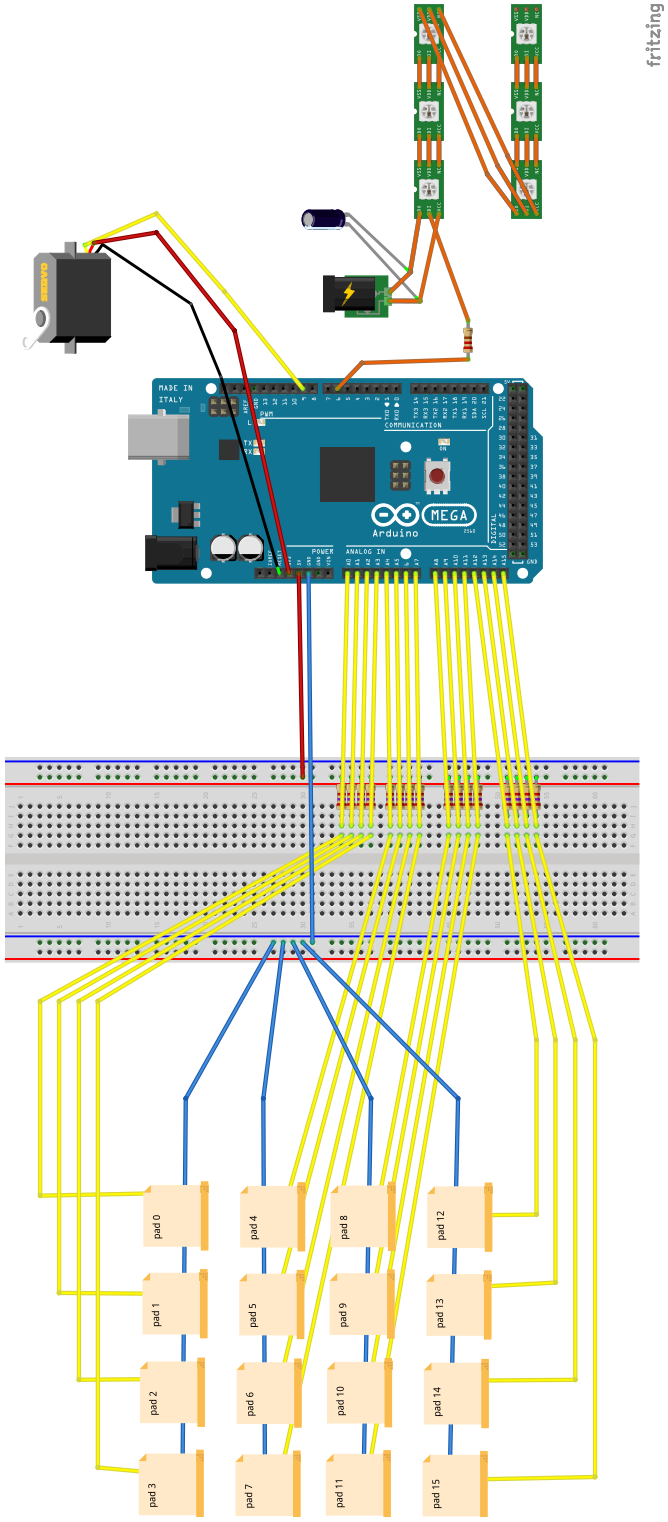
So, what do we have connected to the Arduino so far?

Everything that we need is now explained: The field with the matrix circuit, the LED display and the servo motor. An audio output was planned at first, but after having a lot of difficulties with that we decided against loudspeakers. The Arduino referee now shows which player won or lost via the LED display.

In this circuit diagram constructed with Fritzing software you can see all of the components (Pic. 6). The circles of the play field are connected to all analog pins that the Arduino Mega holds (0-15) and a ground pin, respectively. The LED display - six RGB LEDs on a strip, is connected to digital pin 6, an external voltage source and the servo motor to digital pin 9 - and ground. In the picture the play field is displayed as beige pads, since the Fritzing software does not hold a Twister field picture.

Our Arduino software

As already mentioned an Arduino Mega controls all parts of our game. We have small parts in our program code, that take on tasks like controlling the servo motor and the LED display. Also the Arduino generates the random foot/hand assignment for the players. This is done via a random generator, which simply calculates



Pic. 6. The circuit diagram.

numbers. Every body part has an integer value, so for example the right foot is the 0 and the right hand is the 1. This is then send to the hardware components like the LED display.

The Arduino also calculates the resistance. This is to know where each pad is connected to. Since the Arduino knows which pad is on which limb, it can calculate if everything is at the right place. The Arduino uses this resistance formula (Ohm's Law) to measure the resistance:

$$\text{voltageR2} = \frac{\text{sourceVoltage}}{1023.0} \cdot \text{measurement};$$

$$\text{resistance} = \text{rs1} \cdot \frac{\text{voltageR2}}{(\text{sourceVoltage} - \text{voltageR2})};$$

The game logic is a little more complicated. The Arduino has to first run the random generator, then display the movements and check whether the players are on the correct circles. So the program should do exactly that. The game begins with a prefixed phase to show the players that it now starts (the box blinks and shows hand and foot). To properly work, the Arduino has to have the first positions of the players, so they are assigned. But this is the same in the real Twister - at least with the foot positions. After this the random generator starts and displays the next moves. The Arduino has to save this move to then check if all limbs are in the right place. So if a player doesn't have the correct limbs on the correct circle, the Arduino recognizes that. A player usually doesn't lose right away and can have up to 2-53missed contacts. Of course the Arduino knows when the player have to lift up limbs and doesn't count that as an error. So if one of the players falls down and loses all contacts he is out! The other player wins and the game is over!

Pic. 7. Our workplace.

Since we started without any knowledge concerning electronics and the Arduino, this project worked out very well in the end. Not everything worked perfectly, but we were very happy that the most uncertain factor of the game, the body limb recognition does its job! You can see the diversity of our tries in picture 7 - a photo of our workplace at the end of the project.