A tutorial to Arduino LilyPad and AMICI software

revised to teachers in the framework of the TACCLE 3 coding project

IBP
Institut für Berufspädagogik
und Allgemeine Pädagogik

Karlsruher Institut für Technologie

This handout is based on the tutorial by Daniela Reimann, Simone Bekk et.al (ed., 2015), developed in the framework of the BMBF research project “MediaArt@Edu” (ACRONYM). The version was translated by the KIT translation service and revised and adapted for TACCLE3 by Daniela Reimann and Christiane Maday, KIT.

Institute of Vocational and General Education (IBP)

Prof. Dr. Martin Fischer (head of institute)
Sekretariat: 0721-608-43691
Hertzstraße 16, D-76187 Karlsruhe
Karlsruhe Institute of Technology (KIT)

Dr. Daniela Reimann (Projektleitung TACCLE3 at KIT)
phone: +49-721-608-44973
E-Mail: Daniela.Reimann@kit.edu

Christiane Maday, B.A. (research assistant)
E-Mail: Christiane.Maday@kit.edu

www.ibap.kit.edu
www.ibap.kit.edu/berufspaedagogik/

Table of contents

Arduino LilyPad and AMICI software – A Tutorial

1. Introduction

Interactive textiles, which are also referred to as smart textiles or wearables, represent a new generation of clothes and accessories with embedded microcomputers and offer various possibilities of creatively dealing with so-called intelligent media that can perceive their environment by means of sensors. Using e.g., conductive yarn (as cable), sensors, motors, LED lights, and sewable circuit boards (Arduino LilyPad), smart textiles create a link between sensual-haptic materials, precise computer control, and creative concepts. New interfaces – sewed, woven or stitched – can be experienced between body, clothing, and the environment. In conjunction with the open-source Arduino technology, they are currently tested by artists, designers, computer scientists, do-it-yourself computer tinkerers, and musicians creating, for example, story-telling wearables (Tan 2005), wearable music (Rosales 2012) or sounding artifacts (Trappe 2012).

The concepts and models developed during the project will be tested and evaluated through young people and students at KIT and at ZKM | Center for Art and Media. Application of the new options will be supported pedagogically and scientifically. During the planned workshops, artistic design processes will be given the same relevance as technical project implementation. The educational objectives consist in social and personal skills such as working in a team, developing one's own ideas, solving emerging problems or implementing the respective ideas in terms of design and technology. Besides, the combining of artistic and technical aspects is expected to trigger identification and self-reflection processes enabling the participants to be more aware of their strengths and weaknesses and, on that basis, develop a perception of their (professional) future. For the respective participants, the possibility of creating intelligent clothing according to their own ideas has a high potential of motivation to succeed in learning.

The tutorial on the "smart textiles" media module hence also represents a summary of the results and experiences gained in workshops and provides the possibility of becoming acquainted with the fundamentals of programming the applied microcontrollers. The tutorial introduces the participant both to the handling of the LilyPad Arduino hardware and to the application of the AMICI user interface and can be used as instructions for teaching processes related to interactive clothing.

Since, however, the handling of the software and hardware used in the project is documented only insufficiently in German, it was decided to write down in a structured way the experiences gained. Although the resultant tutorial does not claim to discuss all software and hardware issues, relevant problems need to be explained in detail. The tutorial was developed on the basis of the EduWear manual compiled by the "Digital media in Education (dimeb)" research group of the University of Bremen.[1]

---

[1] http://dimeb.informatik.unibremen.de/eduwear/wpcomponent/uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf [August 2015]

2. The LilyPad Arduino hardware

The core of the system consists of microcontroller LilyPad[2], which was developed on the basis of the microcontroller Arduino. Arduino exists in different versions. Whereas some of these are simple improvements of the original Arduino, others e.g., the LilyPad for textile uses, have been designed especially for particular uses. Inventor of the LilyPad Leah Buechley (software developer at MIT) had the idea to use this microcontroller in the area of textiles to create synergy effects.

Based on the above, the project EduWear[3] was launched with the objective of acquainting children with the related technology. The system has been used at Karlsruhe Institute of Technology (KIT) within the framework of the project MediaArt@Edu[4]. Within that project, the components and skills for working with the system were tested and evaluated in different institutions.

2.1 Further Reading

René Bohne: Making Things Wearable. Intelligente Kleidung selber schneidern. O'Reilly Verlag, 2012.

Manuel Odendahl, Julian Finn und Alex Wenger: Arduino. Physical Computing für Bastler, Designer & Geeks. O'Reilly Verlag, 2009.

Diana Eng: Fashion Geek. Clothing. Accessories. Tech. North Light Books, 2009.

Syuzi Pakchyan: Fashioning Technology. A DIY Intro to Smart Crafting. O`Reilly, 2008.

[2] www.arduino.cc [August 2015]
[3] http://dimeb.informatik.uni-bremen.de/eduwear/tag/amici/ [August 2015]
[4] http://www.ibp.kit.edu/berufspaedagogik/media-art-edu.php [August 2015]

2.2 Micro controller

The microcontroller can be referred to as the brain of a circuit. It is programmed in accordance with individual requirements and requests. The microcontroller records the strong or weak signals of the sensors, processes them, and, in accordance with the programmed parameters, sends the signals to the actuators, which in consequence are either activated or switched off.

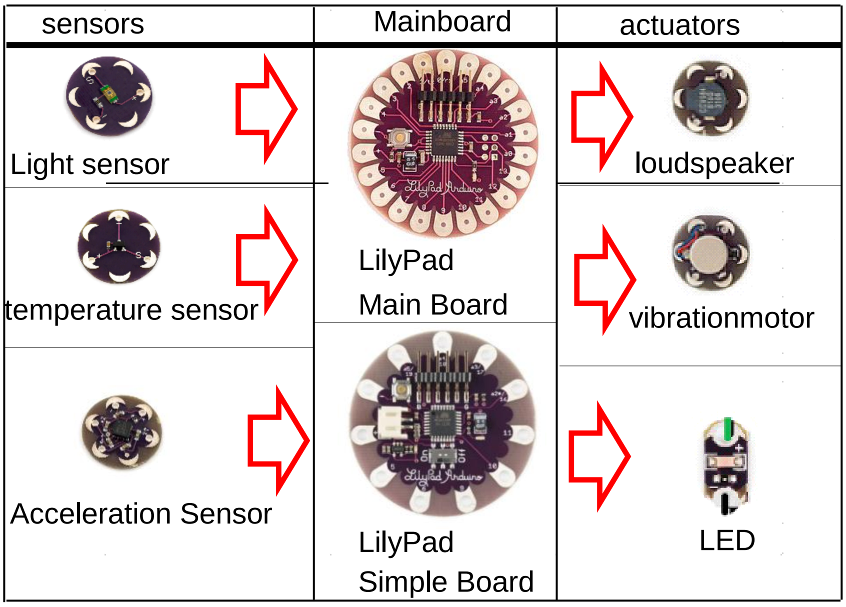


Figure 1: Interaction between sensors, LilyPad, and actuators

2.2.1 Sensors

LilyPad can perceive environmental impacts by means of sensors and can thus react, for example, to changes in the light or temperature conditions or changes in position. Conventional sensors perceive brightness, temperature, sound, and position. The strong or weak signals are recorded and then processed. See[5] for further sensors.

2.2.2 Actuators

Signals and commands (according to programming) are carried out by means of actuators and thus are the last link of smart textiles. As a rule, actuators can generate sound, vibrations, and light. These output options, however, can be extended depending on one’s creativity and technical knowledge.[6]

2.2.3 LilyPad Main Board

Ein Arduino LilyPad Main Board (siehe Abb.2) enthält die folgenden Anschlüsse („Pins“) für Sensoren/Schalter und Aktuatoren:

---

[5] http://www.watterott.com/de/Sensoren/ [August 2015]
[6] For more components, see https://www.tinkersoup.de/ [August 2015]

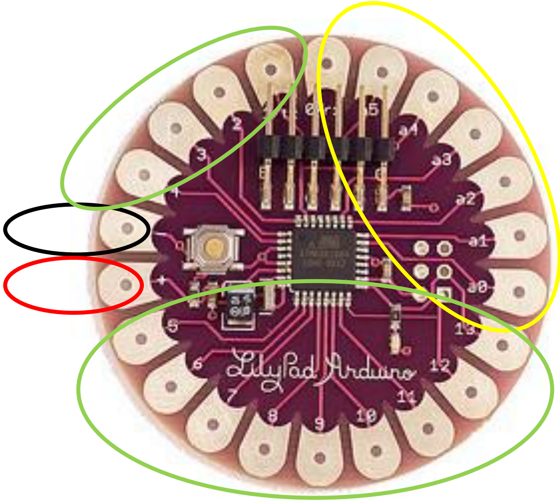


Figure 2: LilyPad Main Board

14 digital inputs and outputs:	(„Digital I/O“) for connecting switches and actuators
6 6 analog inputs:	(„Analog in“) for connecting sensors
Grounding:	(„GND”)for connecting LilyPad with the negative terminal of a voltage source
+5 volt connection:	for connecting LilyPad with the positive terminal of a voltage source.

2.2.4 Digital pins

The digital pins are the pins 0 – 13. They can be used as inputs or outputs, depending on how the software has been programmed. In simple terms, “digital” means that a pin, when serving as input, can identify two conditions only: ON and OFF. Whereas switches can be connected to digital pins as inputs, LEDs, buzzers, and small motors can be connected as outputs. If a digital pin is to serve as output, pins 9 – 13 can generate a signal by means of pulse-width modulation (PWM), which is perceived as variable voltage by the actuators. Since this, however, is not relevant to this work and is used only rarely otherwise, it is not discussed here any further. The digital pins 0 – 8 can only generate ON or OFF.

- Pin 0 (RX) and Pin 1 (TX) have an additional function for loading sketches[7] on to the LilyPad by means of special programming. However, it is recommended not to use these pins too often due to unexpected LilyPad reactions.
- Pin 2 - Pin 8 can be used as described above.
- Pin 9 – Pin 11 work like analog outputs i.e., output voltages analogous to values in the range of 0 to 255 can be generated at the digital pins via programming. Whereas 0 corresponds to 0 volt, 255 is equivalent to 5 volts. At 5 volts, LEDs, for example, are brightest or buzzers are loudest. Since at most 5 volts can be generated, there is no risk of damaging the LEDs or other devices.

[9] Programs that are generated using AMICI and are then copied on to the LilyPad are referred to as sketches.

- Since pin 13 is provided with an upstream resistor, conventional LEDs can be connected without the need for additional resistors. Apart from that, a 220-ohm resistor must be series-connected upstream of each conventional LED. Since the LilyPad LEDs on the small chips have built-in resistors, no additional resistors are needed. Any undesired behavior occurring in a circuit in individual cases may be due to inappropriate combinations of pins and may be remedied by simply trying out other constellations.

2.2.5 Analog pins

The analog pins serve to enter sensor values. They should be connected with sensors only and cannot be used as outputs. The relevant voltage division differs in relation to the digital pins. The voltage is divided into values in the range of 0 and 1023. 0 = 0 volt, 1023 = 5 volt.

2.2.6 LilyPad Simple Board

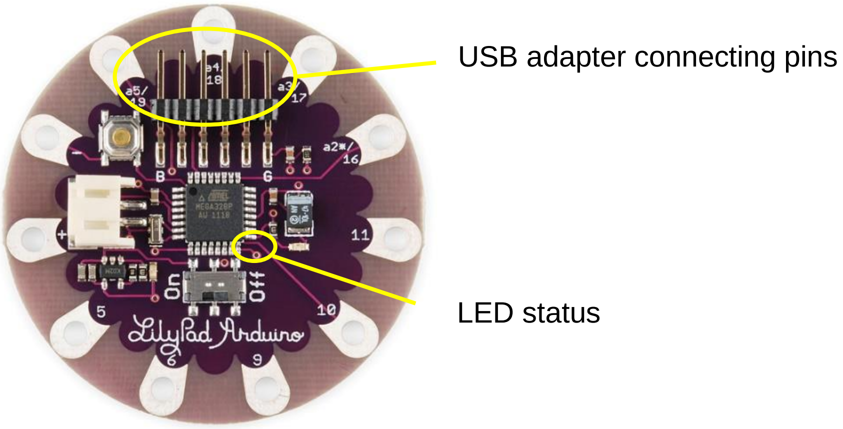


Figure 3: LilyPad Simple Board

Since only selected pins are used for most projects implemented with a LilyPad, a version having less pins than the LilyPad Main Board was developed. The LilyPad Simple Board has only 11 pins. However, the holes of these are noticeably larger and hence can be sewn more easily. The Simple Board has a plus and a minus terminal. Whereas pins 5 to 11 are digital pins (with pins 9 to 11 being suitable for PWM), pins a2 to a5 are analog inputs. These are used as explained in Sections 2.2.4 and 2.2.5.

2.3 USB-adapter

Figure 4: USB-adapter

The supplied FTDI breakout/USB adapter (see Fig. 4) is used together with a USB cable to connect the LilyPad to the PC. It serves to transfer programs and, while being connected to the PC, can be used as a voltage supply. To operate the controller without PC, a voltage supply is provided in the form of a circuit board with battery. The USB adapter is connected with the PC both via mini USB and via the six long pins of the LilyPad (see Fig. 3).

ATTENTION: In order not to damage the LilyPad and the USB port, use only an external current source or USB port to supply the LilyPad with power.

2.4 External voltage supply

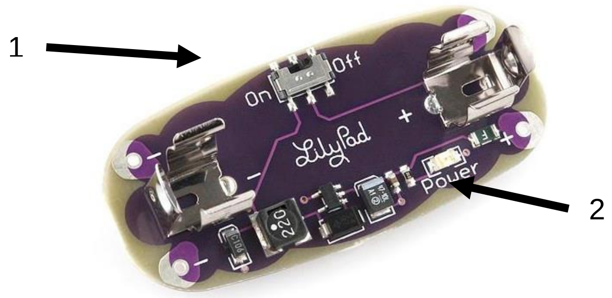


Figure 5: External Voltage Supply

The external power supply is used to operate the built-in LilyPad in clothes. A 1.5 volt (AAA) micro battery is needed to put into operation the power supply. The voltage supply has an ON/OFF switch (see Fig. 5, No. 1). When the voltage supply is ON, a red LED lights up in addition (see Fig. 5, No. 2). The voltage supply can be replaced by a conventional or home-made button cell retainer. In view of the smaller sizes, this is mainly recommendable for small projects such as bracelets or gloves.

ATTENTION: In order not to damage the LilyPad and the USB port, use only an external current source or USB port to supply the LilyPad with power.

2.5 Light sensor

Figure 6: Light Sensor

The light sensor (Fig. 6) measures the current light intensity and passes it on to the LilyPad. During programming, a specific threshold value can be adjusted for the LilyPad to carry out an action. The light sensor can be identified by the fact that the chip on the board is transparent. The sensor has three pins:

- + 5 volt (marked +)

- Grounding (marked -)
- Sensor output (marked S), which is connected with an analog input

2.6 Temperature sensor

Figure 7: Temperature Sensor

The temperature sensor (Fig. 7) measures the current ambient temperature and passes it on to the LilyPad. During programming, a specific threshold value can be adjusted for the LilyPad to carry out an action. The temperature sensor looks similar to the light sensor but the chip on the board is black. The sensor has three pins also:

- \- + 5 volts (marked +)
- Grounding (marked -)
- \- Sensor output (marked S), which is connected with an analog input.

2.7 Acceleration sensor

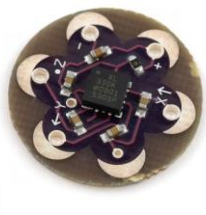


Figure 8: Acceleration Sensor

As the name suggests, the three-axis acceleration sensor (Fig. 8) serves to detect movements and vibrations. More strictly speaking, it is a position sensor measuring positions in all axis directions. During programming, a specific threshold value or interval can be adjusted for the LilyPad to carry out or not carry out an action.[8] The movement sensor has five pins. In addition to the voltage supply, three sensor outputs are provided. Since, like in a Cartesian coordinate system, these are arranged at 90 degrees to each other in the X, Y and Z directions, three different movement directions can be measured.

The movement sensor has five pins:

- \+ 5 volts (marked +)
- Grounding (marked -)
- \- Sensor outputs (marked x, y, and z), each of which is connected with an analog input

---

[8] Compare Bohne 2012, p. 76

2.8 Purchase of and information on the hardware components

The hardware components are available both as set in a case from EduWear Construction and as individual components online at http://www.watterott.com/).

More information on the LilyPad and the individual components is provided at:

- http://arduino.cc/en/Guide/LilyPadWindows[9]
- http://web.media.mit.edu/~leah/LilyPad/[10]
- http://lilypadarduino.org/ [11]

and by the EduWear manual compiled by the Dimeb research group of the University of Bremenwhich can be accessed at:

- http://dimeb.informatik.uni-bremen.de/eduwear/wp-content/uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf [12]

where the different LilyPad components (sensors, actuators, controllers) as well as the components of the AMICI software are presented.

[9] http://arduino.cc/en/Guide/LilyPadWindows [August 2015]
[10] http://web.media.mit.edu/~leah/LilyPad/ [August 2015]
[11] http://lilypadarduino.org/ [August 2015]
[12]http://dimeb.informatik.uni-bremen.de/eduwear/wp-content/uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf [August 2015]

3. Wiring and PC connection

3.1 Amici-Software

The software of the AMICI user interface is free ware and is provided as free download at http://dimeb.informatik.uni-bremen.de/eduwear/753/amici-1-0-q/.[13] The latest version of AMICI 1.0 q was published on June 5, 2012. The file must be unpacked using a specific program (e.g. 7-ZIP) and can then be used directly as Java applet from the directory. To do so, the file amici.exe must be opened.

3.2 Connecting the LilyPad with the PC

For copying the program sketch, The LilyPad must be connected with the PC. This is done by means of the FTDI/USB adapter. As soon as the USB cable is connected to the PC and connected to the LilyPad through the FTDI/USB adapter, the status LED (green) should light up on the LilyPad. The LilyPad has its own USB driver, which installs through plug and play. If problems should occur nevertheless, the latest drivers should be installed (see Section 5).

ATTENTION: In order not to damage the LilyPad and the USB port, use only an external current source or USB port to supply the LilyPad with power.

3.3 Adjusting the AMICI

To be able to copy the created program code to the LilyPad, some adjustments must be made in AMICI. For this purpose, the "serial port" must be determined in the upper bar below the "tools" tab (see Fig. 9). As a rule, the available ports are displayed automatically after the LilyPad has been connected to the USB port. In most cases, the highest available COM port needs to be selected.

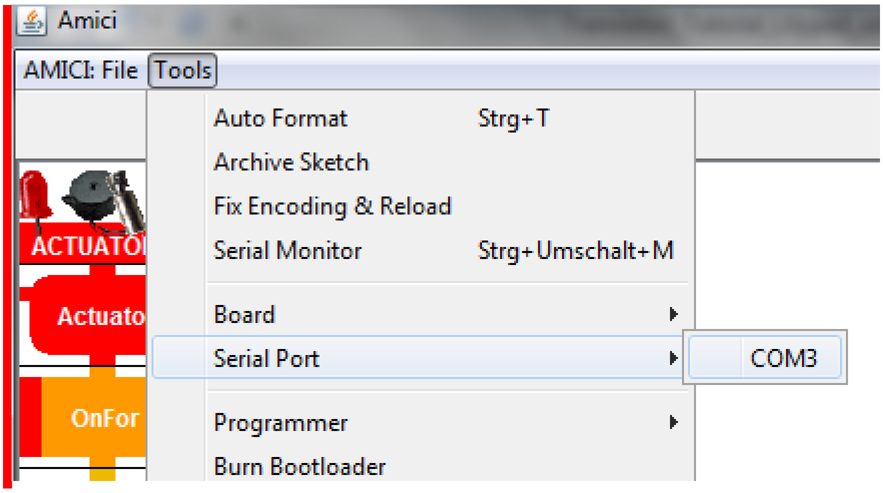


Figure 9: Select serial port (USB port)

Subsequently, the LilyPad to be used (e.g. LilyPad Arduino 2/ATmega328) must be selected under "tools" – "board" (see Fig. 10).

---

[13] http://dimeb.informatik.uni-bremen.de/eduwear/753/amici-1-0-q/[August 2015]

The exact type designation is printed on the processor (black chip in the center of the LilyPad).

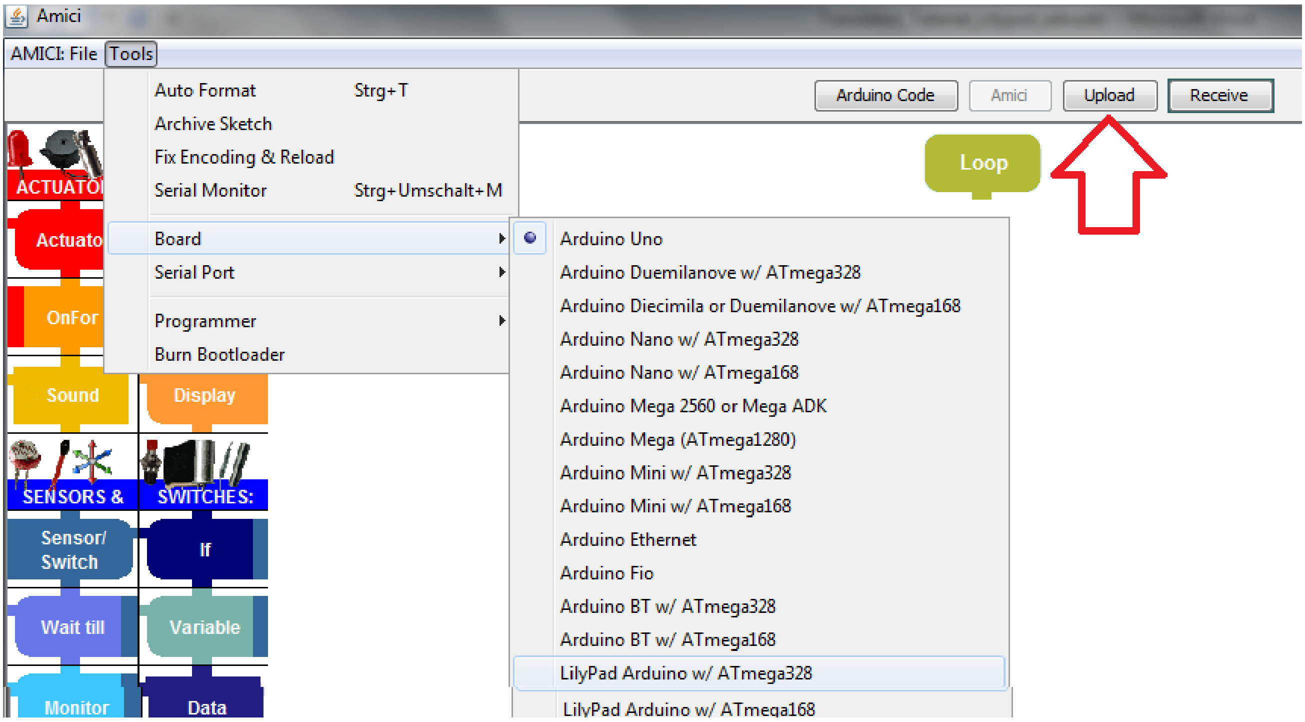


Figure 10: Select LilyPad

3.4 Connecting the sensors

Since, when connected to the digital inputs of the LilyPad, the sensors do not provide any usable values, they should only be connected to the analog ones. The analog pins measure the amount of voltage provided by the sensors between 5V (+) and grounding (-). In the trial phase, cables with crocodile clips can be used for connecting.

As shown in Fig. 11, the sensor output marked S is connected with an analog pin, whereas the outputs marked + and – are connected with the respective plus and minus terminals of the LilyPad.

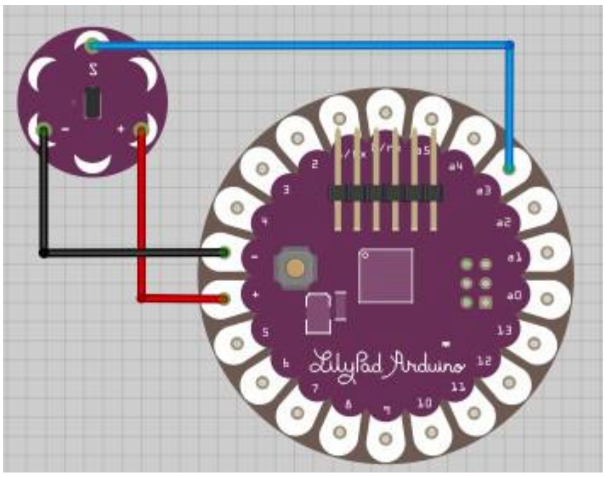


Figure 11:Connecting the Sensors

3.5 Connecting the Power Supply

A power supply (Fig. 12) is used to be able to also operate the LilyPad without PC connection at a later stage. Whereas the negative pole of the battery board is connected with a black cable to the negative pole (ground) of the LilyPad, the positive pole of the battery board is connected with a red cable to the positive pole of the LilyPad.

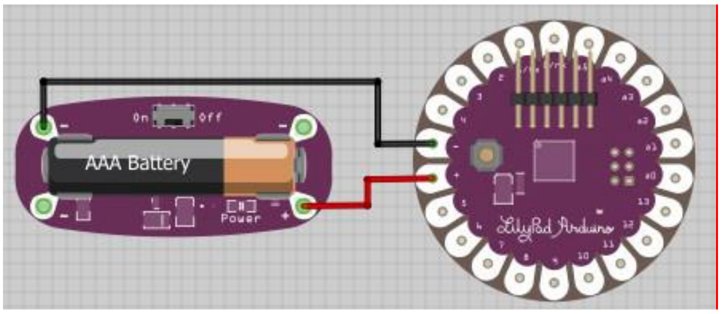


Figure 12: Connecting the Power Supply

3.6 Connecting the actuators

Figure 13: LED, vibrating motor, loudspeaker

The most frequently used actuators are LEDs, loudspeakers (buzzers), and vibrating motors (Fig. 12). Each of these actuators has two terminals i.e., one positive and one negative pole. Whereas the positive pole is connected with a digital pin, the negative pole is connected with the negative pole of the LilyPad.

<u>PLEASE NOTE:</u> This tutorial is based on the use of original LilyPad LEDs, which due to resistors integrated on the LED chips do not need an additional resistor. Special series resistors are required when using other LEDs.

Several actuators used on one pin must be connected in series (Fig. 13) by connecting the positive pole of one element with the negative pole of the next element. Such series connection is characterized by the fact that the same current flows through all elements of the series. Since, however, the overall resistance increases with each new series element, only few elements can be connected. Another disadvantage of series connection is the susceptibility to failure i.e., if one element fails, all other elements fail as well.

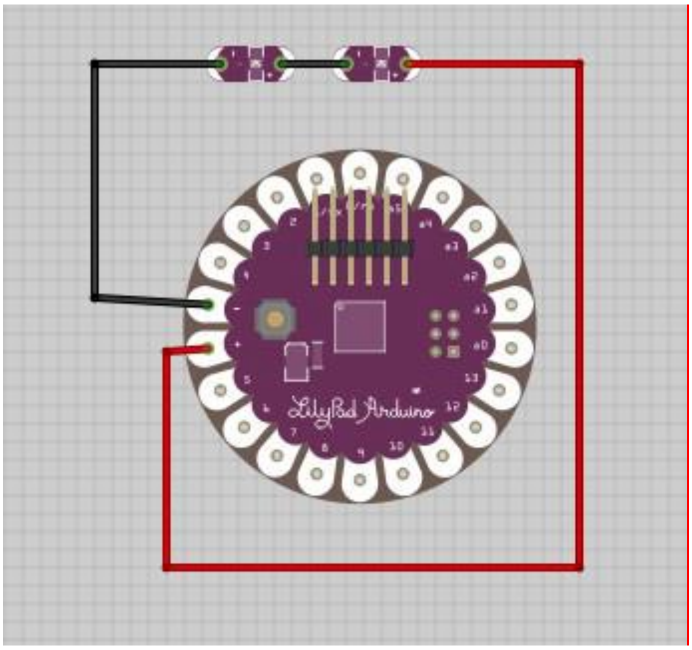


Figure 14: Series connection

Due to the above, parallel arrangements are recommendable for the case of several elements to be connected to one pin (see Fig. 14). In contrast to series connection, all identical poles are connected with each another. The total resistance of a parallel connection decreases with each further consumer load and, hence, is always smaller than the smallest individual resistor. The same voltage is applied to all elements. Besides, individual elements can fail or be removed without influencing the remaining elements.

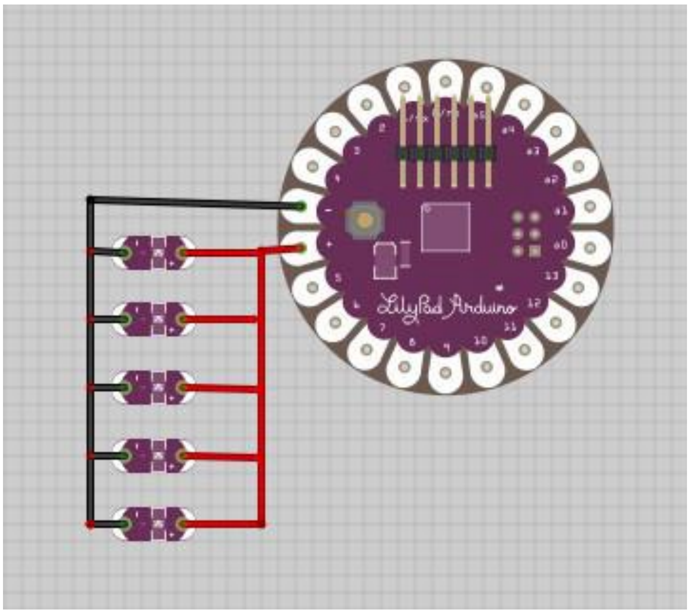


Figure 15: Parallel connection

4. Programming with AMICI

4.1 The Programming Blocks

This program always starts with the LOOP or SETUP block.

When a program is written after the SETUP block, it is carried out only once.

The program after the LOOP block runs in a loop as long as the voltage supply is switched on. For that reason, most actions are attached under the LOOP block.

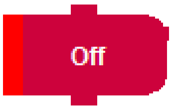
An arbitrary number of blocks can be attached to the LOOP block. The coupling points at the blocks determine how the program must be structured.

By means of the mouse, the individual program code blocks can be moved under the respective start block. The colors at the front sides of the different blocks indicate which other blocks can be docked to the latter. Only identical colors can be combined.

Programming the actuators

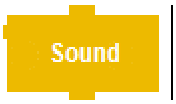
Actuator programming always starts with this block. Subsequently, the desired actuator is selected and connected to a digital pin. Pins 9 to 11 differ in that the amount of current (0 – 255) needed for the operation of the actuator must be defined (pulse width modulation - PWM, see Section 2.2.4).

The actuator is switched on.



The actuator is switched off.

The actuator is switched ON for the defined time and is then switched off again. The time can be variably adjusted (adjustment is in milliseconds → 1 s is equivalent to 1000 ms)



When a piezo buzzer is connected to pins 9 – 11, this block generates sounds and operates like an ON block. This block may be positioned under the SETUP or LOOP without needing an actuator on its side.

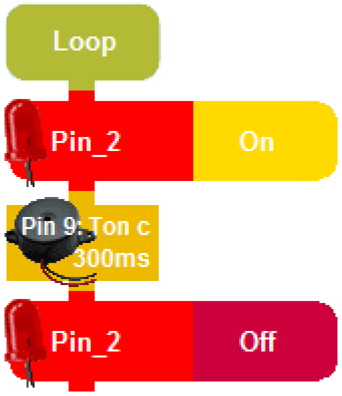


Figure 16: Example of a programming sequence

Example

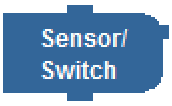
During program start-up, the program switches through the LOOP block. Here, an LED is switched on at the digital pin 2. Subsequently, the sound C is heard for three seconds from the piezo buzzer. Finally, the LED at pin 2 is switched off again.

Example with Method Blocks:

Several actions can be combined into one method. For that purpose, a rounded method block is created and is given an arbitrary name e.g., "blink". Below it, the actions to be carried out are defined. When the combined actions are activated, only the square method block must be inserted in the desired place. Care must be taken that both the square and the rounded method blocks bear the same name.

Figure 17: Use of the method block

Programming of Switches and Sensors



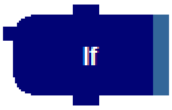
This block enables users to choose between switch and sensor.

The different available sensors and switches can be selected by means of the respective request.

The sensors then are connected to an analog pin. The limiting value below which the sensor is to fall or which it should exceed or reach precisely to perform the desired action is determined subsequently. The limiting value can be chosen to be in the range of 0 to 1023 (for details on the determination of the limiting value see Sections 4.21 and 4.2.3).

Switches are connected to a digital pin. The user can choose whether the switch carries out the function in the ON or OFF condition.

The blocks below determine how the switch and sensor values are applied. These blocks are in front of the sensor/switch block



This block controls whether the adjusted sensor/switch block value has been reached and the action is being carried out. A sensor/switch must be attached to this block to administer the limiting value and the connected pin.

This block waits until the adjusted value has been reached before switching through to the next block. As in the case of the IF block, a sensor/switch block always needs to follow.

The limiting value of the sensor or switch can be stored through a variable in the form of a name (a word). The value can be compared with a new limiting value e.g., of the IF block, at a later stage.

The SEND block shows the current value of the sensor or switch, thus enabling its adjustment to the situation or environment. This function is important to be able to determine the threshold value for a sensor (see Section 4.2.1 and 4.2.3).

To show the current value, click on “Receive” above the block program (see Fig. 18). Prior to this, the program must be loaded onto the board.

To remove the current limiting value, click on “Receive” once again.

Figure 18: Displaying the current sensor value

4.2 Programming by Example of a Temperature-dependent Circuit

By means of a temperature-dependent circuit, actuators can be controlled such that from a certain temperature, they can perform actions provided for in the program code e.g., lighting up of an LED when values fall below or exceed a specific limiting temperature.

As described above, the setup block performs the programmed actions once at the beginning of the program. In our case, the program is to be performed in the loop mode (iteratively) because instead of lighting up only once after the start, the LED is to light up each time the temperature sensor measures an increase in temperature. For almost all projects using the LilyPad software, programming under the LOOP block is the better choice because only in that way can the LilyPad react to changed environmental influences.

4.2.1 Defining the Sensor

Using the mouse, the SEND block is dragged under the LOOP block, which via the serial monitor, display the current value of a connected sensor. The sensor to be read out is defined by placing a SENSOR block beside the SEND block (see Fig. 18). In doing so, a window opens where one can choose between a sensor and a switch (see Fig. 19). We decided in favor of the sensor.

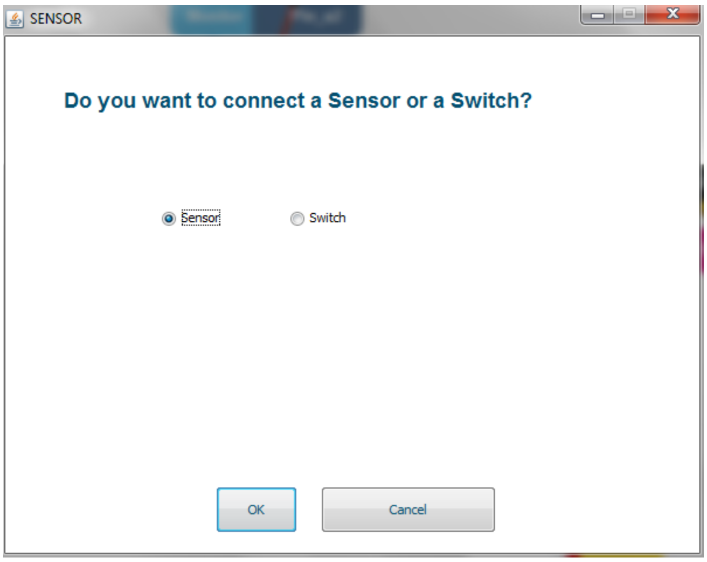


Figure 19: Selecting the sensor

Next, a new window (see Fig. 20) opens, where one can choose between a light, temperature or vibration sensor and others. We select the temperature sensor. Moreover, the analog input of the LilyPad where the sensor is connected must be selected. In our example, (see Fig. 21), the sensor connected to the analog pin 3 provides values and, thus, must be selected.

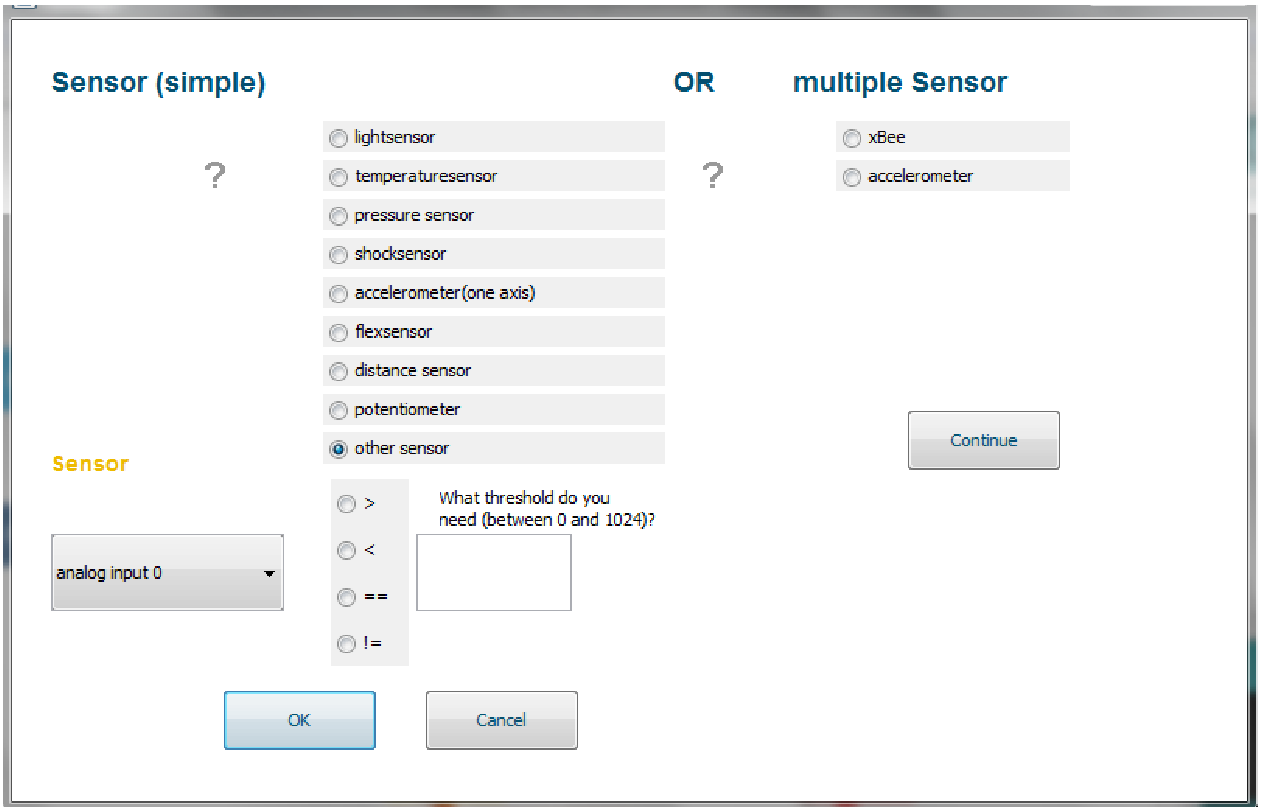


Figure 20: Sensor adjustment

4.2.2 Wiring

Prior to further programming, the circuit should be set up as shown in Fig. 21 and be connected to the PC by means of the USB adapter. Ideally, the voltage supply should not be connected before programming. The limiting values for light, movement, and temperature can be represented by means of the button “Receive” in the serial monitor and thus be defined. To obtain appropriate values and check which values are received, the sensor should be subjected to a test run in its prospective environment. By means of these data, the limiting values for the execution of the programmed code by the LilyPad can be determined (see Section 4.2.3).

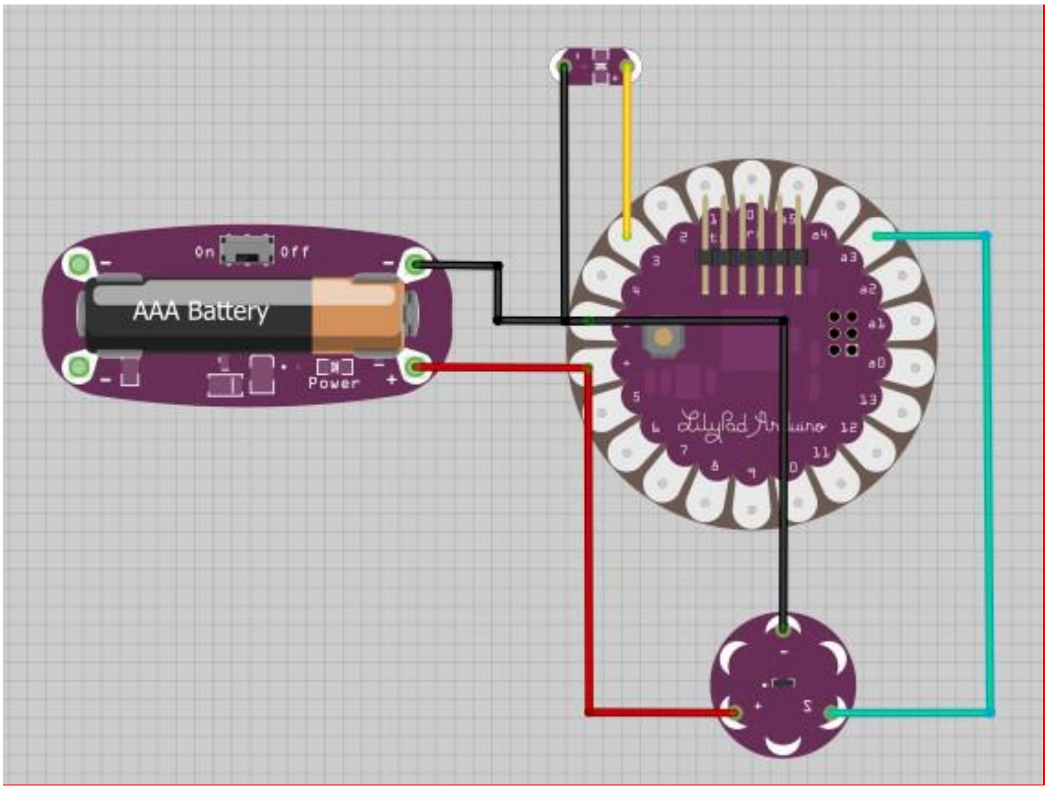


Figure 21: Circuit arrangement with temperature sensor

Provided that the sensor is selected according to its sensitivity to temperature, light or vibration, this example of the programming and arrangement of a temperature-dependent circuit can also be applied to the examples described in Sections 4.3 and 4.4.

4.2.3 Read-out of sensors by means of the serial monitor

The serial monitor (see Fig. 22) serves to represent the values sent by the sensors to the LilyPad. By means of the values displayed in the serial monitor, the limiting values for the actuators to carry out certain actions can be adjusted.

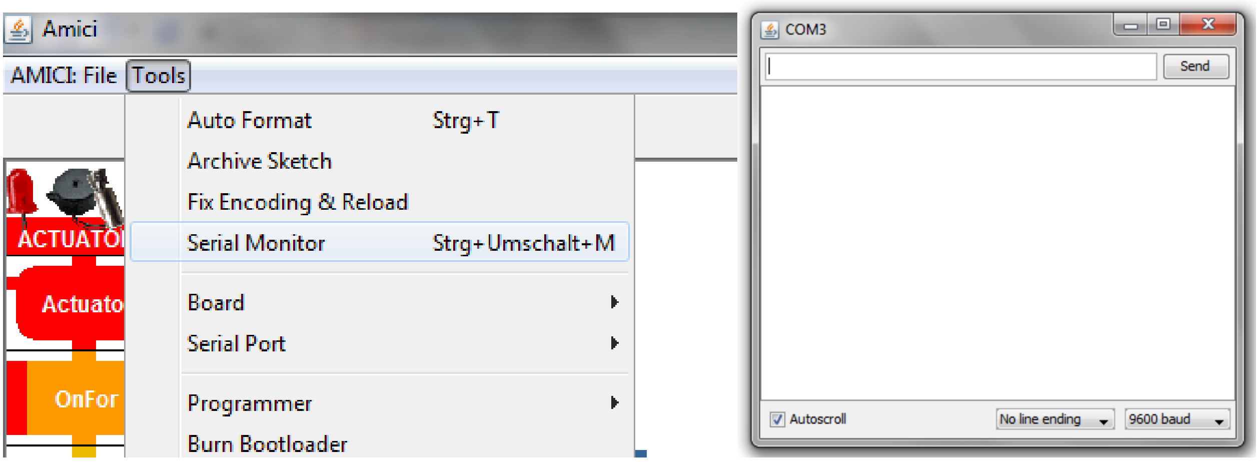


Figure 22: Call-up of serial monitor

For that purpose, the sensors are connected with the LilyPad, and the LilyPad is then connected with the PC by means of the USB adapter. As a start, a SEND block is connected with a SENSOR block and is positioned under the LOOP block (see Section 4.2.1). Subsequently, the program is loaded onto the LilyPad (see Section 4.2.5). The current value is displayed by clicking the button “Empfangen” (receive) over the block program (see Fig. 18).

The serial monitor now provides the sensor values. Values in the range of 0 to 1023 can be read in the relevant sensor situations (hot ↔ cold, bright ↔ dark, vertical ↔ horizontal). To determine the limiting value, the sensor must be brought into the situation for which the LilyPad must carry out a function. A temperature sensor to be used, for example, must be subjected to the desired temperature from which the LilyPad is to carry out its function. At the desired limiting temperature, the limiting value can be read from the serial monitor. This value must be entered in the programming menu.

To do so, the SENSOR block is used in combination with an IF block (see Fig. 23). As soon as the SENSOR block has been connected to the IF block, the windows described in Section 4.2.1 open one after the other to allow defining of mathematical operators for interpretation of the LilyPad limiting value (see Fig. 20).

“>” When the provided sensor value is greater than the adjusted limiting value, the programmed actuator is activated.

“<” The actuator is activated when the sensor value is smaller than the limiting value.

“==” The actuator is activated when the sensor value is equivalent to the limiting value.

“!=” The actuator is activated when the sensor value is not equivalent to the limiting value.

4.2.4 Programming of actions

Actions of actuators can be attached to this IF sensor block by means of the actuator or sound ON or OFF blocks. In the example, an LED is switched on at digital Pin 3 when the limiting value set at 160 is exceeded and is switched off when the value falls below the defined limit (see Fig. 23).

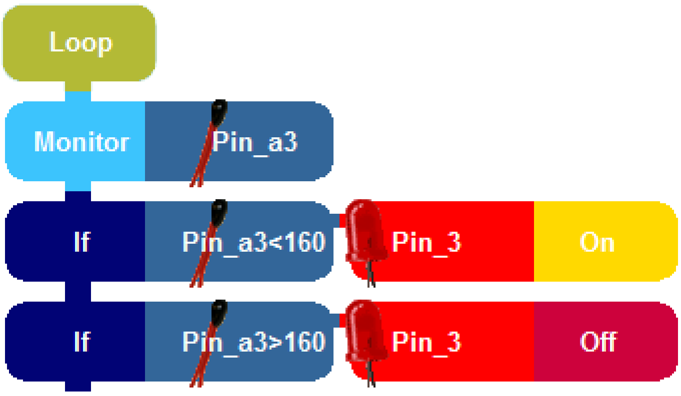


Figure 23: Programming of temperature-dependent circuit

4.2.5 Uploading the program

The completed program is installed on the LilyPad by clicking on the button “Upload”

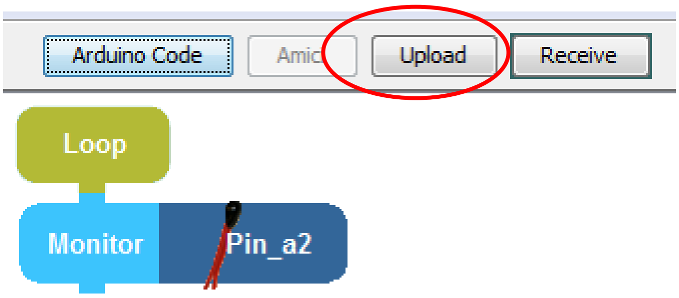


Figure 24: Button upload

4.3 Structure and programming of a light-dependent circuit

Wiring and programming of a light-dependent circuit are analogous to wiring and programming of a temperature-dependent circuit (see Section 4.2).

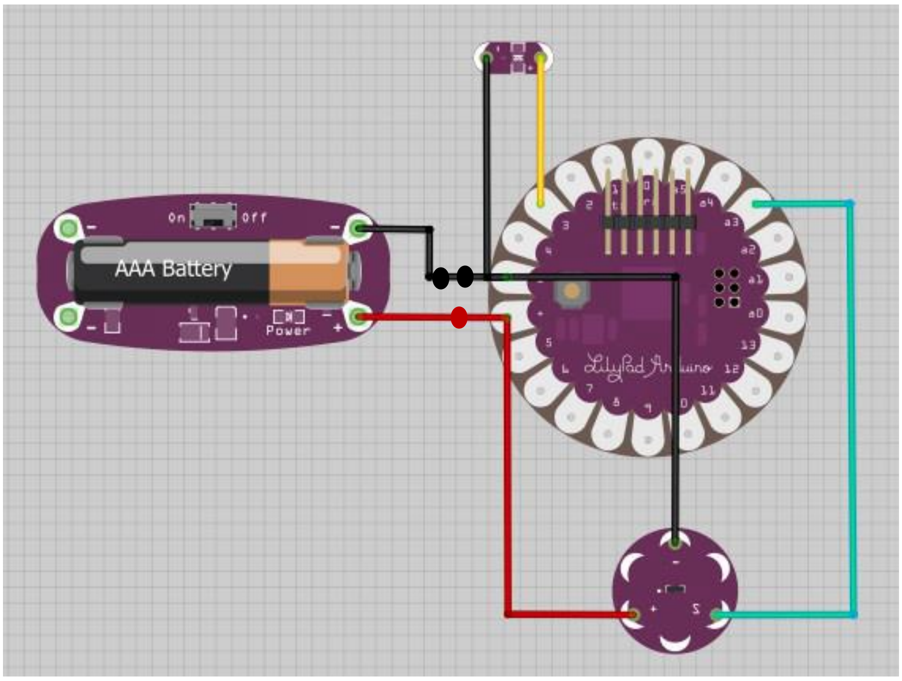


Figure 25: Circuit arrangement with light sensor

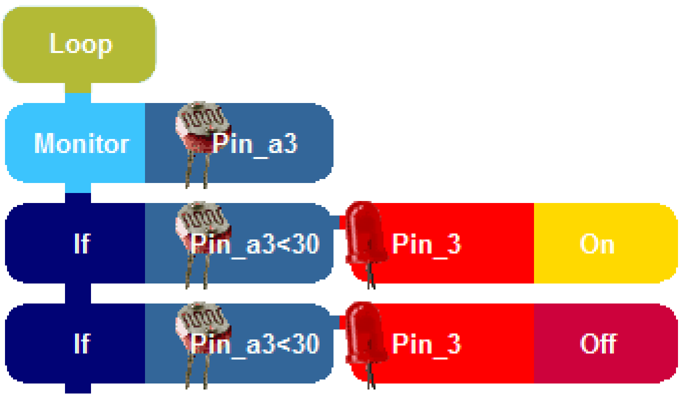


Figure 26: Programming of light-dependent circuit

4.4 Structure and programming of a motion-dependent circuit

Wiring and programming of a motion-dependent circuit are analogous to wiring and programming of a temperature-dependent circuit (see Section 4.2)

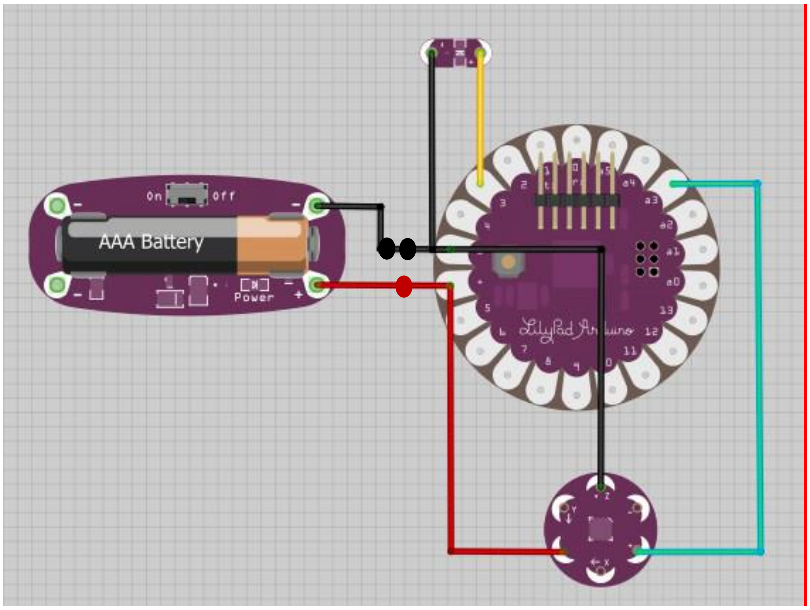


Figure 27: Motion-dependent circuit arrangement

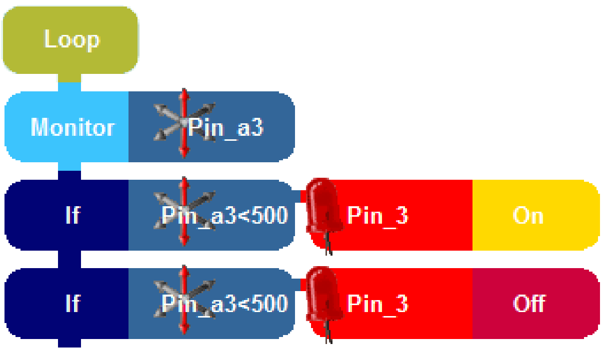


Figure 28: Programming of motion-dependent circuit

5. Troubleshooting/ problem solving

ATTENTION: The battery compartment must not be connected while the LilyPad is connected to the PC ➔ because in the case of a short circuit, the USB port or microcontroller on the LilyPad could be damaged!

1. Check settings of the serial port and board (highest serial port and board: LilyPad 328) each time prior to programming. In the case of further problems, please refer to the details below.

2. To test a sensor or query values for further programming, enter as shown below, upload, and read out values:

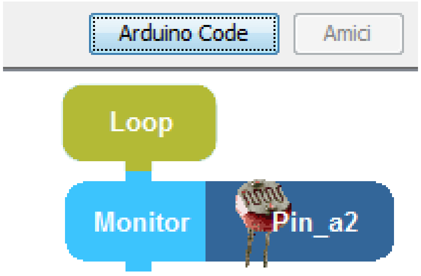


Figure 29: Readout of sensor values

3. **Understanding** the queried limiting values: These values are queried by means of the “Empfangen” (receive) button. Please always check during which action which limiting value is received. Whereas a value of 500, for example, is reached when the movement sensor does not move, the value is below 500 when the sensor moves in one direction and above 500 when it moves in the opposite direction. It must not be wrongly assumed that the sensor only moves at values higher than 500. Please make sure to test thoroughly prior to programming.
4. **Sensor system:** The movement sensor has three levels with different limiting values.
5. **Problems** that can occure while working with Amici:

– In case that the serial port cannot be adjusted, download driver software. Download and install: http://arduino.cc/en/Main/Software

The driver software provides the drivers. For installing the latter, please refer to: http://www.kriwanek.de/arduino/wie-beginnen/233-arduino-board-zum-ersten-mal-anschliessen.html

(this example refers to an Arduino Mega 2650 but is generally applicable if one adapts the relevant settings to the respective board)

– If there is no reception, a short circuit may have occurred. Restart AMICI and restart computer, if necessary (short circuits may also be due to incorrect wiring).

– Since crocodile clips may impede reception as well, bunched conductors or conductive yarn should be tried alternatively.

– Assistance and further information:
http://arduino.cc/en/Guide/LilyPad/Windows
http://lilypadarduino.org/

6. List of figures

All figures can be accessed at: www.lilypadarduino.org

7. References

[1] www.kit.edu [August 2015]
[2] http://dimeb.informatik.uni-bremen.de/eduwear/wp-content/uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf
[3] www.arduino.cc, [August 2015]
[4] http://dimeb.informatik.uni-bremen.de/eduwear/tag/amici/, [August 2015]
[5] http://www.ibp.kit.edu/berufspaedagogik/media-art-edu.php [August 2015]
[6] http://www.watterott.com/de/Sensoren/ [August 2015]
[7] https://www.tinkersoup.de/ [August 2015]
[9] René Bohne: Making Things Wearable. Intelligente Kleidung selber schneidern. O'Reilly Verlag, 2012
[10] http://arduino.cc/en/Guide/LilyPadWindows
[11] http://web.media.mit.edu/~leah/LilyPad/ [August 2015]
[12] http://lilypadarduino.org/ [August 2015]
[13] http://dimeb.informatik.uni-bremen.de/eduwear/wp-content/uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf [August 2015]
[14] http://dimeb.informatik.uni-bremen.de/eduwear/753/amici-1-0-q/ [August 2015]

Figures:

Figure 1, 3: http://www.watterott.com/, [August 2015]

Figure 2, 5, 6, 7, 8, 13: http://www.watterott.com/, [08.12.2012]

Figure 4: http://www.watterott.com/de/FTDI-Breakout-Reloaded-V2 , [26.07.2016]

Figure 9, 10, 16, 17, 18, 19, 20, 22, 23, 24, 28, 29: screenshots copied from Software Amici

Figure 11, 12, 14, 15, 21, 25, 27 created with the tool Fritzing, http://fritzing.org/, [11.12.2012] by Christian Schneider, KIT research assistant

LilyPad products were invented by Leah Buechley, MIT.http://leahbuechley.com/

Literature Tutorial:

Rosales, A.: Wearable music. Creating sound effects and music by playing, project presented at Ars Electronica 2012, u19-create your world village, festival catalogue.

Tan, X.: Storytelling wearables, an alternative autobiography. 2005: http://www.xiaolitan.com/thesis/thesis.htm [19.2.2010]

Trappe, C.: Creative Access to Technology: Building Sounding Artifacts with Children. In proceedings of IDC 2012, Bremen, short paper. 2012

Scenario for a Workshop/for tuition with interactive textiles

Interactive textiles, which are also referred to as smart textiles or wearables, represent a new generation of clothes and accessories with embedded microcomputers and offer various possibilities of creatively dealing with so-called intelligent media that can perceive their environment by means of sensors. Using e.g., conductive yarn (as cable), sensors, motors, LED lights, and sewable circuit boards (Arduino LilyPad), smart textiles create a link between sensual-haptic materials, precise computer control, and creative concepts. New interfaces – sewed, woven or stitched – can be experienced between body, clothing, and the environment.

1. Objectives

The scenario intends to arouse interest in dealing with the different media, initiate processes of understanding, and excite a critical reflection regarding computers and software. Moreover, creative technical understanding is supported to enable the creative handling of digital and non-digital media. Students are to be given the opportunity of hands-on dealing with self-made interactive textiles and their specific potentials (e.g., conductive yarn, conductive fabric).

In addition, cross-professional skills are applied and practiced. By working independently as part of project teams, the students' social and individual skills, e.g., structured planning and designing, are encouraged.

Moreover, a new approach to (electrical) engineering and informatics based on artistic and textile design is implemented in an interdisciplinary way. Gender-specific ideas on professions are broken up and made attractive to the opposite gender. Based on the Lilypad Arduino technology, the participants learn to develop an interactive system by means of the iconic programming software AMICI whose modular principle and drag-and-drop features enable use also by younger students.

2. Potential topics

The project should comprise an ambitious and motivating topic and be related to the world and environment of the participants. Target groups dealing with career choice, for example, could be requested to make use of their knowledge of contemporary occupations to develop projects that facilitate certain activities or the pursuit of a profession or provide a useful extension of the equipment of an occupational group. Besides, it is possible to organize a fashion show or to modify individual pieces of clothing e.g., in accordance with the subject of "clothing of the future" or "pimp up your fashion".

3. A possible procedure

In the first instance, the subject of interactive textiles as well as the hardware components and software should be introduced in a playful and explorative way. This introduction could be followed by a phase of brainstorming regarding technology f the future, occupations which might be in need of smart clothing, and interactive textiles that could be useful or could facilitate the work of the respective occupational group. The ideas found can be discussed in more detail in the project groups, and first considerations regarding their implementation can be outlined. During this phase, each group develops its own topic. In the course of the project, the respective topic will be implemented.

The groups will provide creative designs and engineering drawings.

Cooperative project development is comprised of the following stages: Planning, design, construction, wiring, programming, revision, presentation. The entire process, from the idea to the final product, can be captured and reflected in portfolios, posters or project diaries. This ensures that the project and working processes are traceable and transparent and that different variants and refined project versions remain reproducible and visible afterwards.

Different forms of presentation can be tried out by introducing the projects to other project groups. Moreover, explanatory video clips can be produced in which participants describe their project, its functions, and the relevant approaches.

To present and stage the group's achievements, a final exhibition may be organized in a particular place related to the project and selected by the group.

4. Additional remarks and information

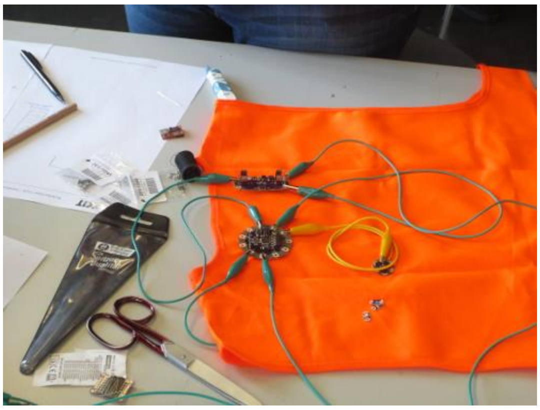
- suitable for students from primary school level on (4^{th} grade)
- suitable for project work
- Wiring the hardware and learning to program an interactive system requires at around 8 lessons (at 45 minutes each).

LilyPad products were invented by Leah Buechley, MIT.http://leahbuechley.com/

5. Impressions

Impressions from the Smart Textile workshop (BMBF-project “MediaArt@Edu” in May 2015).



Materials and Media

The core of the system consists of microcontroller LilyPad, which was developed on the basis of microcontroller Arduino. The LilyPad was developed by Leah Buechley (MIT Media Lab) especially for use in clothing.

Mainboard and voltage supply

- 1 LilyPad mainboard, item number DEV-09266
- 1 LilyPad voltage supply, item number DEV-08466
- 1 Battery/AKKU AAA
  - **Alternative**: 1 LilyPad button cell retainer with switch, item number DEV-11285
  - 1 button cell 20 mm

Connection to PC (reusable because not sewn in clothing)**:**

- -FTDI basic breakout 5 V, item number DEV-09716
  - **Alternative**: FTDI Breakout Reloaded V1.1
- Cable USB A **–** mini USB B 5-pole

Sensors:

- 1 LilyPad light sensor, item number DEV-08464
- 1 LilyPad temperature sensor, item number DEV-08777
- 1 LilyPad acceleration sensor, item number DEV-09267

Connectors:

- Ca. 10 crocodile clips (reusable because not sewn in clothing)
  Please note that colors may be of help to differentiate e.g., + and –
- 1 LilyPad bobbin (conductive yarn), item number DEV-10867

Actuators:

(Please consider your project planning needs to decide which actuator should be used. Please note that LEDs are chosen much more often than sound and vibration motors and that programming of LEDs is easiest.)

Light

- LilyPad white LED (je item) Item number: 2008440
- LilyPad red LED (je 5), Item number: DEV-10044
- LilyPad green LED (je 5), Item number: DEV-10046
- LilyPad yellow LED (je 5), Item number: DEV-10047
- LilyPad blue LED (je 5), Item number: DEV-10045
- LilyPad yellow LED (je 5), Item number: DEV-10047
- LilyPad blue LED (je 5), Item number: DEV-10045

Vibration

- Vibration motor, Item number: DEV-11008

Sound

- Piezo/Loudspeaker Item number: DEV-08463

Making of Buttons/Switches/Button Cell retainers
(Instructions e.g., in: Rene Bohne: Making Things Wearable. Intelligente Kleidung selber schneidern. O’Reilly Verlag, 2012.)

- 1 sheet of conductive fabric, item number DEV-10056
- Several sheets of felt of different colors
- Foam material

Additional items required:

- Notebooks
- Needle
- Yarn
- Textiles
- Scissors
- Seam ripper
- paper
- -Pencils/Colored pencils

Please note that this is only a choice of required items. Further articles are found at:

http://www.watterott.com/index.php?page=search&page_action=query&desc=on&sdesc=on&keywords=lilypad+&x=0&y=0

Smart Textiles list of links (as of August 2015)

LilyPad Arduino:

- www.arduino.cc
- http://arduino.cc/en/Guide/LilyPadWindows
- http://web.media.mit.edu/~leah/LilyPad/
- http://lilypadarduino.org/

AMICI Software:

- http://dimeb.informatik.uni-bremen.de/eduwear/753/amici-1-0-q/
- http://dimeb.informatik.uni-bremen.de/eduwear/tag/amici/

Drivers:

- http://arduino.cc/en/Main/Software
- http://www.kriwanek.de/arduino/wie-beginnen/233-arduinoboard-zum-ersten-mal-anschliessen.html

EduWear Handbuch der Arbeitsgruppe Digitale Medien in der Bildung der Universität Bremen (dimeb):

- http://dimeb.informatik.uni-bremen.de/eduwear/wpcontent/
- uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf

Order material: In Germany the products can be ordered vis Watterott electronics.

- www.watterott.com

LilyPad products were invented by Leah Buechley, MIT.http://leahbuechley.com/

Further readings

Arbeitsgruppe Digitale Medien in der Bildung, Universität Bremen (2008): Eduwear Construction Kit, online verfügbar unter: http://dimeb.de/eduwear/wp-content/uploads/amici/EduwearKit_manual_oct_2010_de.pdf [17.09.2015]

Bauer, H.; Brater, M.; Büchele, U.; Dufter-Weis, A.; Maurus, A., Munz, C. (2010³): Lern(prozess)begleitung in der Ausbildung. Wie man Lernende begleiten und Lernprozesse gestalten kann. Ein Handbuch. Bielefeld.

Bohne, Rene (2012): Making Things Wearable. Intelligente Kleidung selber schneidern. O'Reilly Verlag.

Brater, M., Haselbach, D., Stefer, A. (2009): Kompetenzen sichtbar machen. Zum Einsatz von Kompetenzportfolios, München: Peter Lang

Buechley, Leah et. al. (2007): Towards a Curriculum for Electronic Textiles in High School Classroom. Online verfügbar unter: http://web.media.mit.edu/~leah/publications/buechley_ITiCSE_07.pdf [17.09.2015]

Corbett, J. M./Rasmussen, L. B./Rauner, F. (1991): Crossing the border. The social and engineering design of computer aided manufacturing. London: Springer.

Daniela Reimann, Simone Bekk, Martin Fischer (Hg.) (2015): Gestaltungsorientierte Aktivierung von Lernenden: Übergänge in Schule – Ausbildung – Beruf, Hamburg

Eng, Diana (2009): Fashion Geek. Clothing. Accessories. Tech. North Light Books.

Häcker, Thomas H. (2006): Ein Medium des Wandels in der Lernkultur. In: Ilse Brunner (Hg.): Das Handbuch Portfolioarbeit. Konzepte, Anregungen, Erfahrungen aus Schule und Lehrerbildung. 1. Aufl. Seelze-Velber: Kallmeyer, S. 15–18.

Häcker, Thomas H. (2006): Vielfalt der Portfoliobegriffe. Annäherungen an ein schwer fassbares Konzept. In: Ilse Brunner (Hg.): Das Handbuch Portfolioarbeit. Konzepte, Anregungen, Erfahrungen aus Schule und Lehrerbildung. 1. Aufl. Seelze-Velber: Kallmeyer, S. 33–39.

Häcker, Thomas H. (2007): Portfolio: ein Entwicklungsinstrument für selbstbestimmtes Lernen. Eine explorative Studie zur Arbeit mit Portfolios in der Sekundarstufe I. 2. Aufl. Baltmannsweiler: Schneider-Verl. Hohengehren.

Häcker, Thomas H. (2011): Portfolio revisited - über Grenzen und Möglichkeiteneines vielversprechenden Konzepts. In: Torsten Meyer, Kerstin Mayrberger, Stephan Münte-Goussar und Christina Schwalbe (Hg.): Kontrolle und Selbstkontrolle. Zur Ambivalenz von E-Portfolios in Bildungsprozessen. 1. Aufl. Wiesbaden: VS-Verl., S. 161–184.

Häcker, Thomas H.; / Winter, Felix (2006): Portfolio - nicht um jeden Preis! Bedingungen und Voraussetzungen der Portfolioarbeit in der Lehrerbildung. In: Ilse Brunner (Hg.): Das Handbuch Portfolioarbeit. Konzepte, Anregungen, Erfahrungen aus Schule und Lehrerbildung. 1. Aufl. Seelze-Velber: Kallmeyer, S. 227–233.

Odendahl, Manuel; Finn, Julian und Wenger, Alex (2009): Arduino. Physical Computing für Bastler, Designer & Geeks. O'Reilly Verlag.

Pakchyan, Syuzi (2008): Fashioning Technology. A DIY Intro to Smart Crafting. O`Reilly.

Reimann, Daniela (2015): Digital media in creative processes with young people in vocational preparation, paper for the International Symposium on "Youth as Visual Culture Producers: Artistic Skills and Knowledge in Secondary Education", 22-23 November 2013, Public University of Navarra, Pamplona/Spain.

Reimann, Daniela et.al. (2013): Künstlerisch-technische Medienbildung - Ästhetische Zugänge zu digitalen Technologien mit Projektportfolios in der außerschulischen Berufsvorbereitung. In: bwp@ Spezial 6- Hochschultage Berufliche Bildung 2013, Fachtagung 13, hrsg. v. Axel Buether & Ulrich Heinen, S. 1-13.

Reimann, Daniela et.al. (2014): Digitale Medien als ästhetische Erfahrungsräume für Jugendliche in berufsvorbereitenden Bildungsmaßnahmen, in: Rudolf Kammerl, Alexander Unger, Petra Grell, Theo Hug (Hrsg. 2013): DGfE, Jahrbuch Medienpädagogik 2013, Diskursive und produktive Praktiken in der Digitalen Kultur, S. 209-230

Reimann, Daniela et.al.(2014): Künstlerisch-technische Medienbildung zur Förderung digitaler Medienkompetenz von Jugendlichen: Theoretische Grundlage und didaktische Position eines Forschungsprojekts, in: Dichtung Digital, Online Journal für Kunst und Kultur Digitaler Medien, Sonderheft Nr. 43, "Grundlagen der Medienbildung. Szenarien und Potentiale", hrsg. v. Roberto Simanowski, Petra Missomelius.

Reimann, Daniela: MediaArt@Edu - Artistic approaches to digital media technology in vocational preparation: New concepts to support media literacy of young people, paper proposal for the 8th International Conference on the Arts in Society, 24-26 June 2013, Budapest (Abstract)

Reimann, Daniela; Bekk, Simone (2014): Introducing artistic processes with digital media in vocational preparation, in: Leonardo Electronic Almanac , issue: The Culture of Digital Education: Innovation in Art, Design, Science and Technology Practices, Senior Editors for this volume: Lanfranco Aceti, Nina Czegledy and Oliver Grau, in review/to appear 2015

Reimann, Daniela; Bekk, Simone (2014): Künstlerisch geleitete Medienbildung mit Portfolios: Potenziale für Jugendliche in berufsvorbereitenden Bildungsmaßnahmen. Herausforderungen beim Übergang Schule – Beruf und das Konzept der berufsbiografischen Gestaltungskompetenz. In Medienimpulse. Potenziale digitaler Medienkunst. 2/2014. http://medienimpulse.at/articles/view/659 (zuletzt kontrolliert am 02.07.2014)

Reimann, Daniela; Bekk, Simone (2015): Artistic approaches to media technology in interdisciplinary education – Innovative portfolios in digital media art projects. in: LARRY O'FARRELL, SHIFRA SCHONMANN, ERNST WAGNER (EdS.,2015), "The Wisdom of the Many - Key Issues in Arts Education, International Yearbook for Research in Arts Education, Münster: WAXMANN

Reimann, Daniela; Bekk, Simone (2015): GamesLab ON/OFF- game development as an artistic approach to digital media education and portfolio work in vocational preparation, contribution to: Creative Technologies - Create and Engage Using Art and Play, edited by Nelson Zagalo and Pedro Branco.

Reimann, Daniela; Bekk, Simone: Facing the technology challenge: art education concepts and innovative media (2014), in: Revista Informática na Educação – Teoria e Prática , vol. 17, n. 1 (2014): "Tecnologias Assistivas, Aprendizagem e Inclusão Social" of the PPGIE – Graduate Program of Informatics in Education, PHd level, at the Universidade Federal do Rio Grande do Sul – UFRGS, Brazil./Bundesuniversität/ Federal University of Rio Grande Do Sul, Brasil (peer reviewed journal paper) , to appear 2015

Reimann, Daniela; Himmelmann, Kathrin: Praxisbeispiel: Interaktive Kleidung. Ein Projekt zur Stärkung der digitalen Medienkompetenz in der beruflichen Qualifizierung von Mädchen, in: Praxishandbuch Lust auf MINT, herausgegeben von der Jugendstiftung Baden-Württemberg, Stuttgart, 3/2013

Reimann, Daniela; Wüst, Andrea (2013): Ästhetisches Handeln als Lernprinzip im Fach Technik: Konzepte für eine ästhetisch-künstlerisch geleitete Berufsorientierung mit interaktiven Textilien, im Erscheinen in den BDK-Mitteilungen 2014

Rosales, A.: Wearable music. Creating sound effects and music by playing, project presented at Ars Electronica 2012, u19-create your world village, festival catalogue.

Schwarz, Johanna; Volkwein, Karin; Winter, Felix (Hg.) (2008): Portfolio im Unterricht. 13 Unterrichtseinheiten mit Portfolio. Seelze-Velber: Klett, Kallmeyer.

Schwarz; Volkwein; Winter (2008): Unterricht mit Portfolio. In: Schwarz; Volkwein; Winter: Portfolio im Unterricht. 13 Unterrichtseinheiten mit Portfolio. Seelze-Velber.

Tan, X.: Storytelling wearables, an alternative autobiographie. 2005: http://www.xiaolitan.com/thesis/thesis.htm [19.2.2010]

Trappe, C.: Creative Access to Technology: Building Sounding Artifacts with Children. In proceedings of IDC 2012, Bremen, short paper. 2012

Winter, Felix (2006): Etwas, worauf man stolz sein kann. In: Ilse Brunner (Hg.): Das Handbuch Portfolioarbeit. Konzepte, Anregungen, Erfahrungen aus Schule und Lehrerbildung. 1. Aufl. Seelze-Velber: Kallmeyer, S. 19–26.

Winter, Felix; Schwarz, Johanna; Volkwein, Karin (2008): Unterrichts mit Portfolio. Überlegungen zur Didaktik der Portfolioarbeit. In: Johanna Schwarz, Karin Volkwein und Felix Winter (Hg.): Portfolio im Unterricht. 13 Unterrichtseinheiten mit Portfolio. Seelze-Velber: Klett, Kallmeyer, S. 21–56.