Introduction

Hardware

Microcontrollers
   Arduino Uno R3
   Atmega 328P
   Attiny 85
   Arduino Nano V3
   Pro Mini Atmega 168/328
   Arduino LilyPad 328

Single board computers
   Raspberry Pi 1 Model B
   Raspberry Pi 3 Model B
   Orange Pi One
   Orange Pi PC
   Orange Pi Plus 2E

OS
   Raspbian Wheezy/Jessie
   DietPi
   Armbian
   XBMC/Kodi
   RetroPie/RetrOrangePi

Software
   Arduino Programming Language
   Processing
   Python/PyGame

Examples

Conclusion
Microcontroller / Microprocessor

• **Microcontroller** is a computing system on a chip (SoC). Microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Microcontrollers are designed for embedded applications

• **Microprocessor** is a multipurpose, clock driven, register based, programmable electronic device which accepts binary data as input, processes it according to instructions stored in its memory, and provides the results as output. Microprocessors used in desktop PC's, laptops, notepads etc.
Atmel AVR microcontrollers

• **AVR** is a family of microcontrollers developed by Atmel Corporation, based in America in 1996

• To be mentioned, the **AVR** architecture was conceived by two students Alf-Egil Bogen and Vegard Wollan at the Norwegian Institute of Technology. It is commonly accepted that AVR stands for Alf and Vegard's RISC processor. RISC (reduced instruction set computing) is a CPU design strategy based on the idea that a simplified instruction set provides higher performance when combined with a microprocessor architecture. The original AVR microcontroller was developed in Norway, then the technology was sold to Atmel

• AVR was one of the first microcontroller families to use on-chip flash memory for program storage. The size of the program memory is usually indicated in the naming of the device itself (e.g., the ATmega32x line has 32Kb)

• **AVR microcontrollers** find many applications as embedded systems; they are also used in the Arduino line of open source board designs
Arduino Uno R3

- Single-board microcontroller
- CPU Atmel AVR (8-bit), Atmega 328P
- on-chip flash memory for program storage
- the efficient execution of compiled C code
- 16MHz, USB, 9-12V
Atmega 328P

• This microcontroller is used in Arduino Uno
  • 28-pin
  • 32Kb flash
  • 2Kb RAM
  • 1/8/16MHz
  • 5V
Attiny 85

- Arduino compatible microcontroller
  - 8-pin
  - 8Kb flash
  - 512b RAM
  - 1/8/16MHz
  - 5V
Pro Mini Atmega 168/328

- Atmel ATmega168/328
- 14 digital I/O pins (6 pins provide PWM)
- 6 analog input pins
- 16/32Kb flash (2Kb used by bootloader)
- 512b/1Kb EEPROM
- 1/2Kb SRAM
- 16MHz, 5V
Arduino Nano V3

- Atmel ATmega328
- 14 digital I/O pins (6 pins provide PWM)
- 8 analog input pins
- 32Kb flash (2Kb used by bootloader)
- 1Kb EEPROM
- 2Kb SRAM
- 16MHz, micro USB, 5V
Arduino LilyPad 328

- Atmel ATmega328
- 14 digital I/O pins (6 pins provide PWM)
- 6 analog input pins
- 16Kb flash (2Kb used by bootloader)
- 512b EEPROM
- 1Kb SRAM
- 8MHz, 5V
ARM microprocessors architecture

- ARM (Advanced RISC Machine) is a family of reduced instruction set computing (RISC) architectures for processors. A RISC-based design means processors require fewer transistors than the typical complex instruction set computing (CISC) x86 processors in most personal computers. This approach reduces costs, heat and power use.

- British company ARM Holdings develops the architecture and licenses it to other companies, such as Apple, Samsung, Broadcom, AllWinner, who design their own products including systems on chips (SoC). The 32-bit ARM architecture, such as ARMv7-A, is most widely used in smartphones.

- The first generation Raspberry Pi 1 holds the Broadcom BCM2835 SoC based on the 32-bit ARMv6 architecture. However, the Broadcom chip used in the Raspberry Pi 3 is BCM2837 with a quad-core ARM Cortex-A53 (64-bit ARMv8) cluster.

- The Orange Pi line is built on the AllWinner H3, quad-core ARM Cortex-A7 (32-bit ARMv7-A) SoC.
Raspberry Pi 1 Model B

- Broadcom BCM2835 SoC, 700MHz, 32-bit
- 512Mb RAM
- SD card (max 32Gb)
- 100M Ethernet 8P8C
- HDMI, 3.5mm Jack
- 26 GPIO Pins
- performance is like a 300MHz Pentium 2 with better graphics
Raspberry Pi 3 Model B

- Broadcom BCM2837 SoC, 1.2GHz, 64-bit
- 1Gb RAM
- micro SDHC
- 100M Ethernet 8P8C
- WiFi 802.11n
- Bluetooth 4.1
- HDMI, 3.5mm Jack
- 40 GPIO pins
Orange Pi One

- AllWinner H3 SoC, 1.3GHz, 32-bit
- 512Mb DDR3 SDRAM
- TF card (max 64Gb)
- 100M Ethernet RJ45
- HDMI
- 40 GPIO Pins
Orange Pi PC

- AllWinner H3 SoC, 1.3GHz, 32-bit
- 1Gb DDR3 SDRAM
- TF card (max 64Gb)
- 100M Ethernet RJ45
- HDMI, 3.5mm Jack
- mic, IR input
- 40 GPIO Pins
Orange Pi Plus 2E

• AllWinner H3 SoC, 1.3GHz, 32-bit
• 2Gb DDR3 SDRAM
• TF card (max 64Gb)
• 16Gb EMMC Flash
• 1000M Ethernet RJ45
• WiFi Realtek RTL8189ETV
• HDMI, 3.5mm Jack
• mic, IR input
• 40 GPIO Pins
Sensors

- piezo, obstacle sensor, LM393 mic-sensor, magnetron, HC-SR505 and HS-SR501 motion sensors
- DHT11 temperature-humidity sensor, LM393 light-diod sensor, KY-038 mic-sensor, HC-SR04 distance sensor, MQ-2 methan-butan sensor, MQ-3 ethanol sensor, MQ-7 CO-sensor, hygrometer sensor, and pulse/heart rate sensor
Raspbian Wheezy/Jessie

- [https://www.raspberry pi.org/downloads/raspbian/](https://www.raspberry pi.org/downloads/raspbian/)
- 4Gb SD-card or more
- Debian Linux, desktop GUI, Python, Scratch, Sonic Pi, Java, Mathematica, LibreOffice, WEB-browser ...
DietPi


- DietPi is a minimal Debian Jessie (400Mb) allows to get the maximum performance

- Ready to run software
  - LXDE – desktop
  - Chromium – browser
  - Deluge – BitTorrent
  - Apache2 – webserver
  - phpMyAdmin – SQL tool
  - ...

Armbian

- [https://www.armbian.com/](https://www.armbian.com/)
- Lightweight Debian Jessie or Ubuntu Xenial based Linux distribution for ARM development boards
- XFCE – desktop
- Pre-installed: Firefox, LibreOffice and others
- Can install various applications on the top of the basic image
XBMC/Kodi

- [https://kodi.tv/](https://kodi.tv/)
- Open source home theater software
  - weather
  - pictures
  - videos
  - music
RetroPie/RetrOrangePi

https://retropie.org.uk/
RetroPie allows to turn Raspberry Pi into a retro-gaming machine enabling play Arcade and classic PC games

http://www.retrorangepi.org/
RetrOrangePi is a gaming and media center distribution based on Armbian (Debian 8), compatible with H3 / Mali devices
Arduino Programming Language

https://www.arduino.cc/

```c
void setup() {
  // initialize the digital pin as an output.
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);  // set the LED on
  delay(1000);              // wait for a second
  digitalWrite(13, LOW);   // set the LED off
  delay(1000);              // wait for a second
}
```
Processing

https://processing.org/

Processing is a computer programming language and integrated development environment (IDE) built for the electronic arts
Python is a high-level interpreted programming language for general-purpose. The language allows writing clear programs on both a small and large scale.

https://www.python.org/

Pygame is a cross-platform set of Python modules designed for writing video games. It includes computer graphics and sound libraries designed to be used with the Python

https://www.pygame.org/
Ordnung und Chaos

- 2016 (15x21 cm)
- Installation: Arduino Uno, 2.4 inch touch TFT LCD screen, 4 Gb micro SD card with 10,000 images generated by various algorithms on Orange Pi PC
Mumbo Jumbo

• 2016 (21x15 cm), Kunstverein im Shamrock, Emmendingen, Germany

• Installation: Acrylic, Attiny85, RGB LEDs, smoke detection using MQ-2 gas sensor, the algorithm imitating an annoyance
The wrong reflection


- Installation: Acrylic, Attiny85, 3528 SMD RGB LED strip
Message

- 2017 (29x21 cm)
- Installation: Acrylic, Arduino Nano, MAX7219 dot matrix module, the text can be uploaded easy using a USB connection
Octopus

- 2015 (27x37 cm)
- Installation: Acrylic, Pro Mini Atmega 328, LEDs, motion detection using HC-SR501 PIR sensor, the algorithm imitating an animal's reaction to stress
It’s a sunny day

- 2016 (21x30 cm)
- Installation: Acrylic, Raspberry Pi 1 Model B, Raspbian Wheezy, 4.0 inch TFT LCD screen, WiFi, sound, images
Black & White

• 2017 (21x15 cm)
• Installation - "Tree" : hygrometer sensor, Arduino Uno R3, Orange Pi One, 7.0 inch TFT LCD screen, Processing 3.1, Lindenmayer-system algorithm
Rainbow

- 2017 (21x15 cm)
- Installation: Acrylic, Orange Pi PC, Loboris Ubuntu Mate, 7.0 inch TFT LCD screen, WiFi, Python 2.7, Processing 3.1, sound, images, videos
Symmetrical ensemble

- 2017 (180x115 cm)
- Installation: light projection, UC46 mini beamer, Orange Pi Plus 2E, Armbian, Processing 3.1, Bezier curves by Michael Pinn’s algorithm
More power, more peripherals

- Microcontrollers approach the computing power of microprocessors
- Electronics industry offers a lot of computing devices, sensors and actuators for artists
- Tiny electronics components can be naturally embedded in artworks
- Embedded electronic systems can provide a real-time interaction with viewers
- In general, microcomputers with adjusted peripherals can play a role of new visual media
- Artists need more diversified sensors and actuators
Reading