Europeana Learning Scenario

Title:

Build your own autonomous robot.

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Abstract

The aim of the classes is to show young people a different source in their search for knowledge. Europeana.eu is a reliable and proven source where universities, libraries, schools and museums publish their resources. All the materials published there are of the highest quality, so the teacher does not have to worry about it. In this learning scenario, the teacher presents the evolution of computing machines, using Europeana materials, ending with modern educational machines and the possibilities of virtual coding in educational programs and portals.

Keywords

Robot, Coding, New Tech, Standard Learning, Distance Learning

Table of summary

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Subject	**Extra-curricular activities in Mechatronics** (Extra-curricular activities in Technical School)
Topic	Mechatronics and robotic laboratory, Electric Laboratory, Robotics, miniSUMO.
Age of students	15-20 years old (Technical School)
Preparation time	45 min information about robotics (Europeana & own website) 45 min coding with the teacher 45 min programming in pairs by the participants of the workshop
Teaching time	Minimum 675 min – 5x laboratory block of 3 lessons
Online teaching material	Teacher's own website, example: 1. Version PL, version EN 2. Version PL, version EN Site about miniSUMO robots
Offline teaching material	Laptop/notebook with Mechatronics free softwere: Arduino, Fusion360, Repetier_Host, Teacher's computer with software and LED screen or projector, Mechatronics Workshop with basic tools

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Europeana resources used	Types of robots: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, .

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Integration into the curriculum

The learning scenario is supposed to develop the STEM skills: mathematical introduction to PCB, programming, spatial imagination, saving and sending a program code, checking the program code on Fritzing software and sending the correct program to print. Students will expand their knowledge of math, physics, coding and vocabulary related to this topic. Students will also practise how to describe the Cartesian coordinate system in Fritzing App and how to react in typical situations in PCB makers. Students will learn how to look for and use online sources of information in a foreign language which also constitutes an essential element of the national curriculum.

Aim of the lesson

Students will:

- enrich their knowledge of STEM,
- develop their STEM skills: math & physics, coding,
- develop their vocabulary connected with the topic of electronics, mechatronics & robotics,
- practice describing the Cartesian system,
- practice using ICT tools.

Outcome of the lesson

The lesson will result in an introduction to the programming of modern microcomputers along with the knowledge of the history of personal computers. A simple and inexpensive Arduino coding system with a wide range of applications for student projects will be presented. At this point, I present how to use a microcontroller to build an autonomous miniSUMO robot.

Trends

- Project-Based Learning,
- Collaborative Learning,
- Learning and planning with computers app,
- Combination of lecture and workshop issues,

Key competences

- Creativity and Innovation - Students create new ideas using ICT tools and work creatively with others,

- Critical Thinking and Problem Solving - Students analyze information from STEM,
- Communication - Students present their ideas, listen effectively, use communication for a range of purposes (combination of lecture and workshop issues),
- Collaboration - Students work in pairs to accomplish a common goal and share responsibility for collaborative work (one didactic device for two students),
- ICT Literacy - ICT tools are used to research, organise, communicate and evaluate information.

Activities

Name of activity	Procedure	Time
Stage 1	Starting classes, checking the presence of students.	5 min
Introduction to the Europeana Collections	Students browse the website as an introduction to the lecture part of the class. Basic information about Europeana is discussed.	5 min
Introduction to Europeana	From the computer the teacher displays information about the lesson topic from Europeana.	5 min
Lecture about robotics	Basic STEM issues concerning PCB, theoretical foundations of operation, schemes and implementation in industry are discussed. Specific solutions of PCB, such as Fritzing program, production processes performed by them as well as programming methods are shown. Information from Europeana and www.marcinjablonski.rwbb.pl website.	20 min
Questions and answers	Students ask questions about issues that their don't understand during the lecture on PCB issues	10 min
Stage 2 **combination of lecture and workshop issues**	The teacher explains the operation of the "Fritzing" program, individual functions and their application. Each student has the "Fritzing" program enabled on their computer. During these classes, you can teach 15 students at the same time, one computer with software for one student (maximum 15 student in one LAB group).	10 min
Searching for information about coding	Each pair of students enters the website www.marcinjablonski.rwbb.pl in the tab laboratory instructions, opens topic 24 - "Płytki PCB" – a) Polish version, b) English version	5 min
First student programming	Together with the teacher students solve a simple coding problem, check the program code in the Fritzing. They ask questions while doing things.	30 min

Stage 2 **the students themselves program**	During this part of the class, students start to program themselves. They mark the program of their own robot. They can use the same modules of autonomous robots or make their own project.	45 min

Assessment

After conducting a series of classes in the laboratory, a test of a given topic is planned. Students will also receive lectures on those elements of the course on which more emphasis should be placed. The questionnaire will be carried out anonymously.

****************************** **AFTER IMPLEMENTATION** ******************************

Student feedback

After completing the course based on the acquired knowledge, own notes, access to websites, students perform a report on their work during laboratory classes. In the report, they enter their achievements, attach a screen of the program code. They develop applications for further work. Even if the goal is not achieved, there is room for error analysis and making corrections to the next programming activities. The report is sent in an electronic form to the email address of the teacher.

Teacher's remarks

The lesson presented above is the first in a series of exercises in the laboratory, the next lessons are the continuation of programming. At the first classes, more emphasis should be placed on the theoretical introduction and interest of the young person in new technologies and making their own robot structures. More practical applications should be provided.

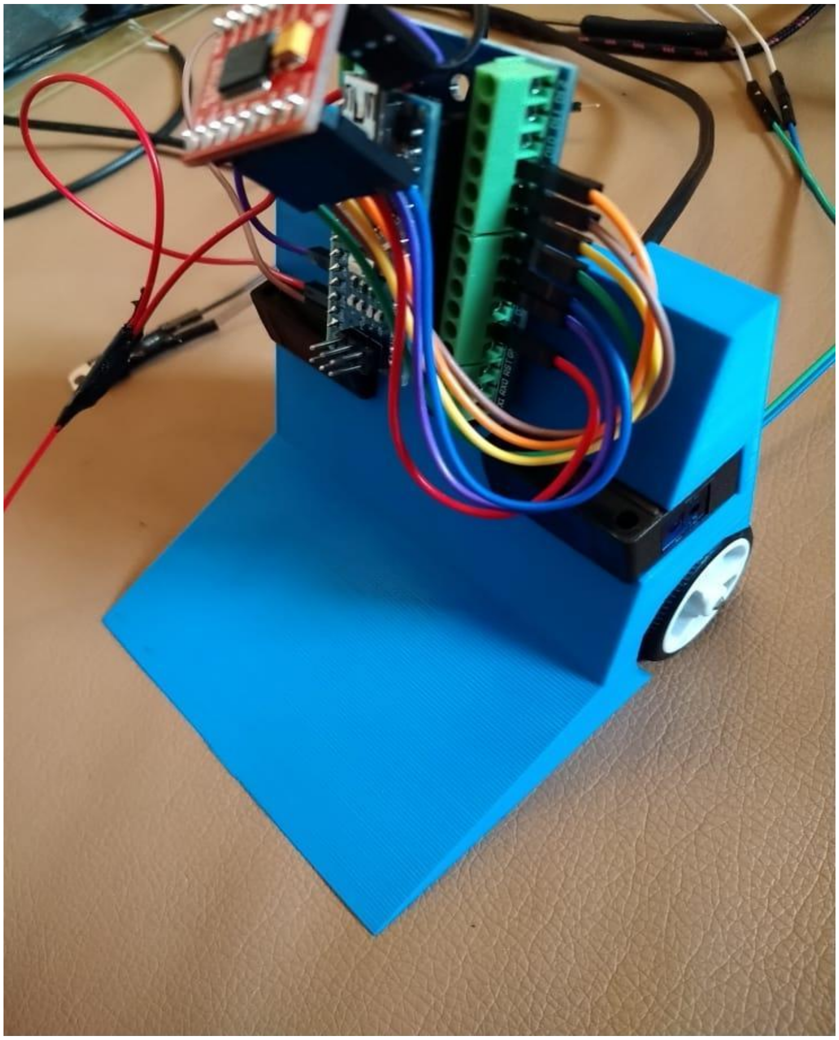
About the Europeana DSI-4 project

Europeana is Europe's digital platform for cultural heritage, providing free online access to over 53 million digitised items drawn from Europe's museums, archives, libraries and galleries. The Europeana DSI-4 project continues the work of the previous three Europeana Digital Service Infrastructures (DSIs). It is the fourth iteration with a proven record of accomplishment in creating access, interoperability, visibility and use of European cultural heritage in the five target markets outlined: European Citizens, Education, Research, Creative Industries and Cultural Heritage Institutions.

European Schoolnet (EUN) is the network of 32 European Ministries of Education, based in Brussels. As a not-for-profit organisation, EUN aims to bring innovation in teaching and learning to its key stakeholders: Ministries of Education, schools, teachers, researchers, and industry partners. European Schoolnet's task in the Europeana DSI-4 project is to continue and expand the Europeana Education Community.

Annex

Report of the work of students:



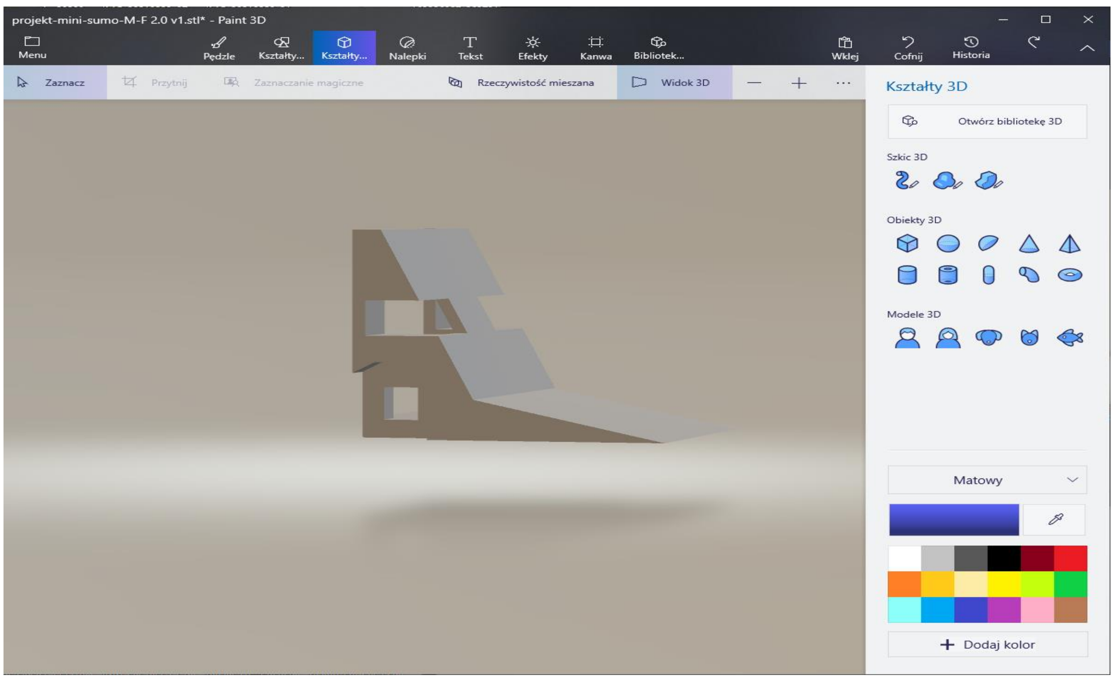
(a) robot MaćkoBOT (photo by Marcin Jablonski, CC-BY-SA)

1. Introduction

The report includes a detailed description of the minisumo robot MaćkoBOT and a report on the course of design and construction works for this project.

The team supervisor, supervising the design works, was Marcin Jabłoński. The purpose of the robot was to take part in the minisumo competition.The construction of the robot was under time pressure and with a limited budget of PLN 200-300. The robot was designed and assembled at home apart from the housing, which was printed with a 3D printer at school.

2. Development

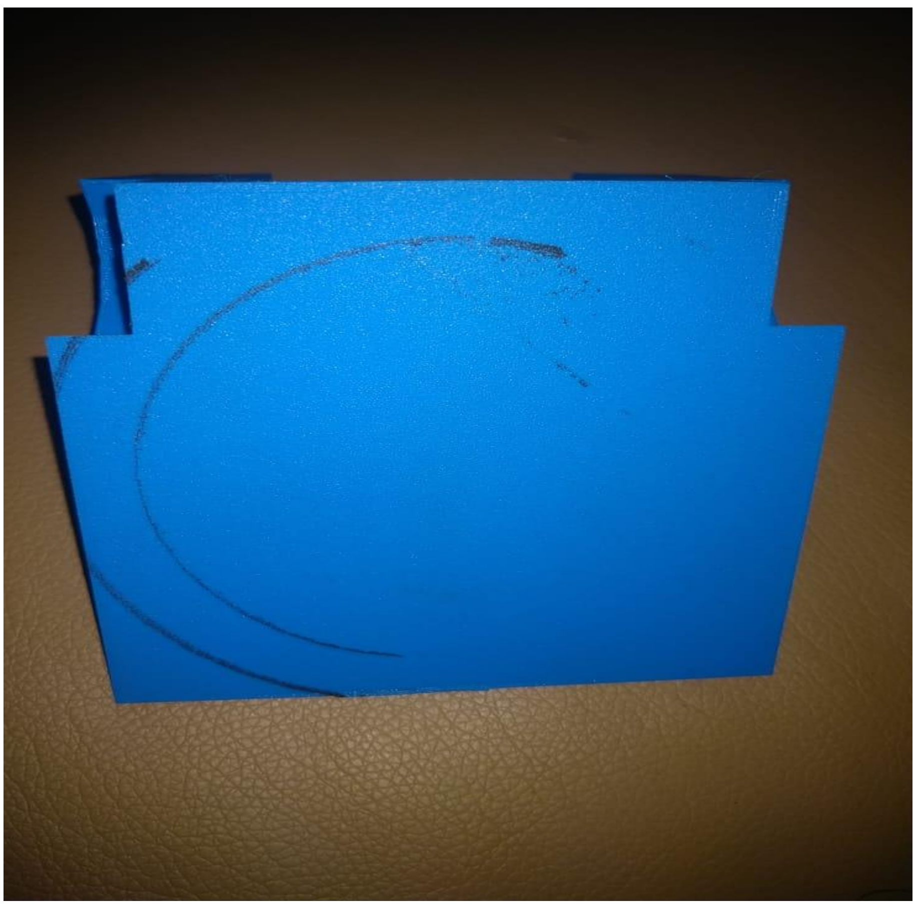


(a) Robot project in Fusion 360 (photo by Marcin Jablonski, CC-BY-SA)

2.1 Mechanics

The mechanics of the robot was assumed to have a balanced speed and strength. The design of the robot was to ensure a lot of pressure on the front knife by properly mounting all components and moving the axis of the wheels to the rear. Such a procedure was to make it difficult for the opponent to lift the robot.

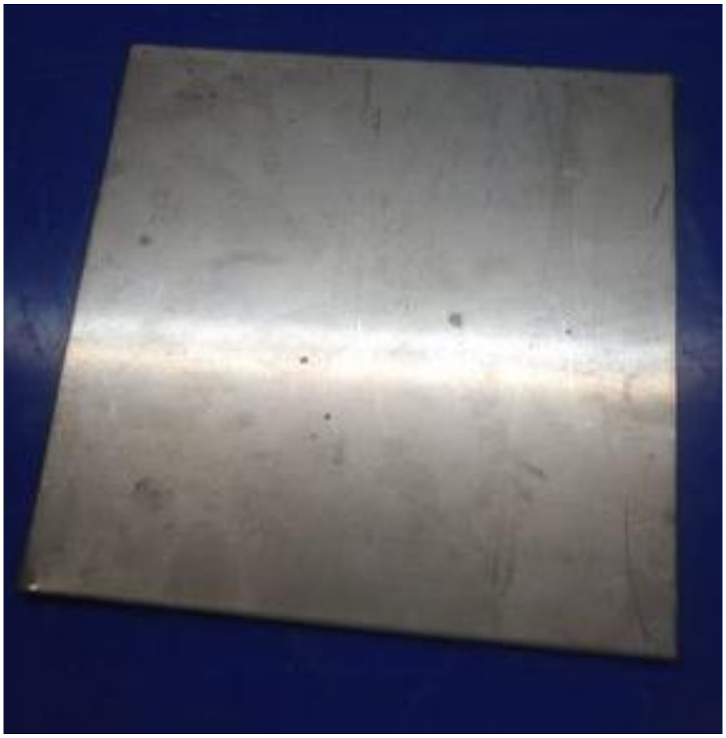
Most of the elements were attached with glue, which made it easier and faster to assemble the robot. The glue used for the assembly is hot glue, which is reasonably strong, but in case of incorrect sticking it allows to detach and correct. Only the front knife was attached with screws, which allowed a quick replacement in case of damage. The design of the mechanics was made in Autodesk Fusion 360, which enables precise planning of the structure and easy correction. The robot was assembled at home using simple tools, while the housing was made at school using a 3D printer.



(a) Robot chassis (photo by Marcin Jablonski, CC-BY-SA)

2.1.1 Chassis

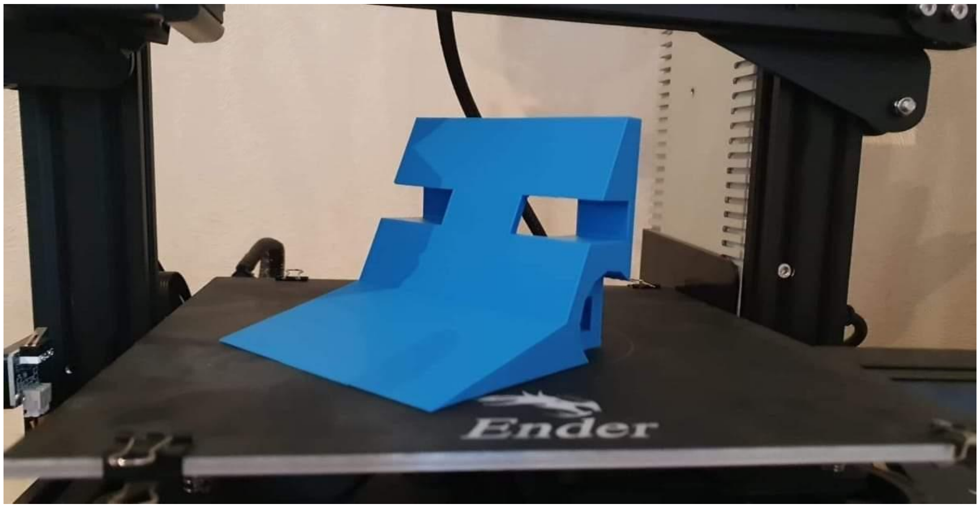
The chassis was made of filament using a 3d printer. The use of a printer allowed for a very precise design of the chassis. The undercarriage has been designed to protect the most sensitive components and to lower the robot and prevent it from tipping over. The chassis printed with a 3d printer is connected to the rest of the casing with a filament, which gives high strength and lightness of the structure.



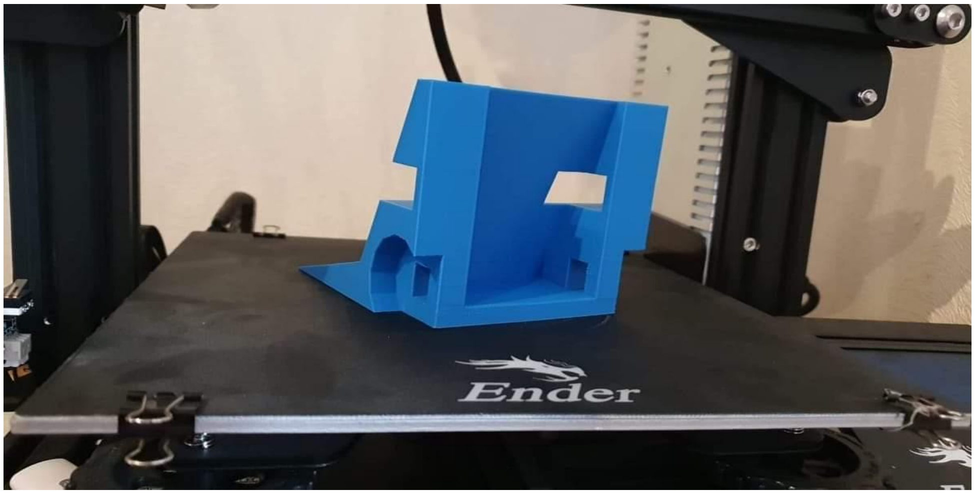
(a) robot front knife (photo by Marcin Jablonski, CC-BY-SA)

2.1.2 Front Knife

The front knife is made of aluminum sheet, which provides it with high durability and fairly easy processing. It is attached to the front part of the chassis with screws, which allows easy replacement in case of damage. Mounting the knife at the front of the robot makes the front of the robot heavier, which makes it difficult for the opponent to lift it. The knife itself has been ground and fixed in such a way that the gap between the robot and the ground is as small as possible. Such a procedure makes it possible to lift the opponent so that it loses grip with the ground.



(a) front housing (photo by Marcin Jablonski, CC-BY-SA)



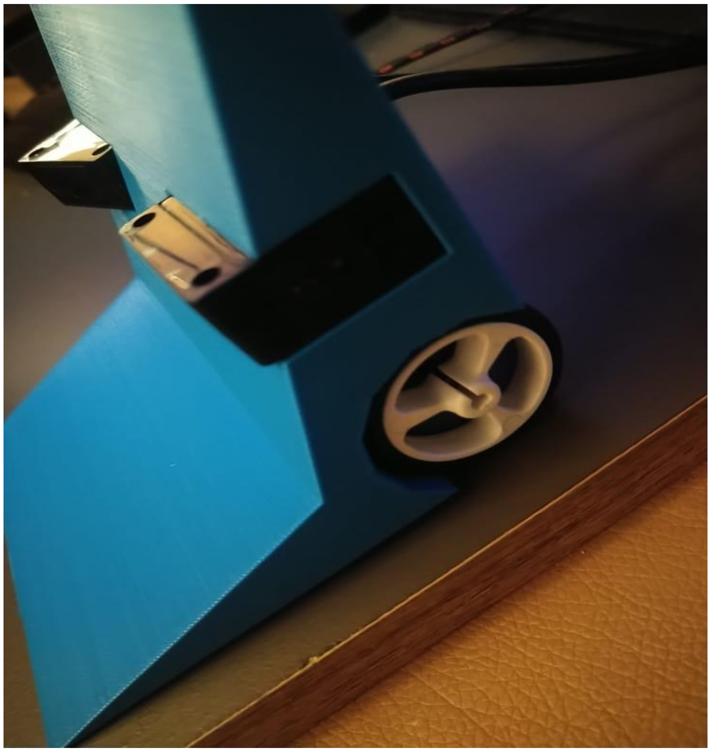
(b) rear housing (photo by Marcin Jablonski, CC-BY-SA)

2.1.3 Housing

The photo casing (a) and (b) was made of blue filament using a 3D printer. The use of a printer allowed a very precise design and then printing of the housing. The housing is placed in front of the robot to protect the most important components from the enemy. The front part is designed in such a way as to allow the opponent to fall over.

2.1.4 Drive

Two Bringsmart motors powered by 12 V were used to drive the robot. The motors were attached to the structure with hot glue, which ensures a durable connection. The choice of engines was based on the price and experience of colleagues. The gears are positioned for a balanced speed and torque. The motors are mounted in one axis at the maximum rear of the robot, which causes oversteer, but provides more pressure on the front of the robot. Plastic wheels with rubber tires are attached to the engines. Rubber tires provide good grip and prevent skidding. The driveline was installed so as not to exceed the permitted dimensions.



(a) robot mounted drive (photo by Marcin Jablonski, CC-BY-SA)

(c) wheel with tire (photo by Marcin Jablonski, CC-BY-SA)

2.1.5 Structural elements

1. Description and justification

Hot glue was used to connect the housing, chassis and other elements with each other, which works well as a material for joining various types of elements together, it is easy to use and cheap. The only downside of the glue is that when any of the mechanical or electrical components are damaged, it may be difficult to disassemble the entire structure for repair or modification. Electrical connections were made with male-male, female-female and male-female cables. This is due to the willingness to use the materials you already have.

2. Construction and repair process

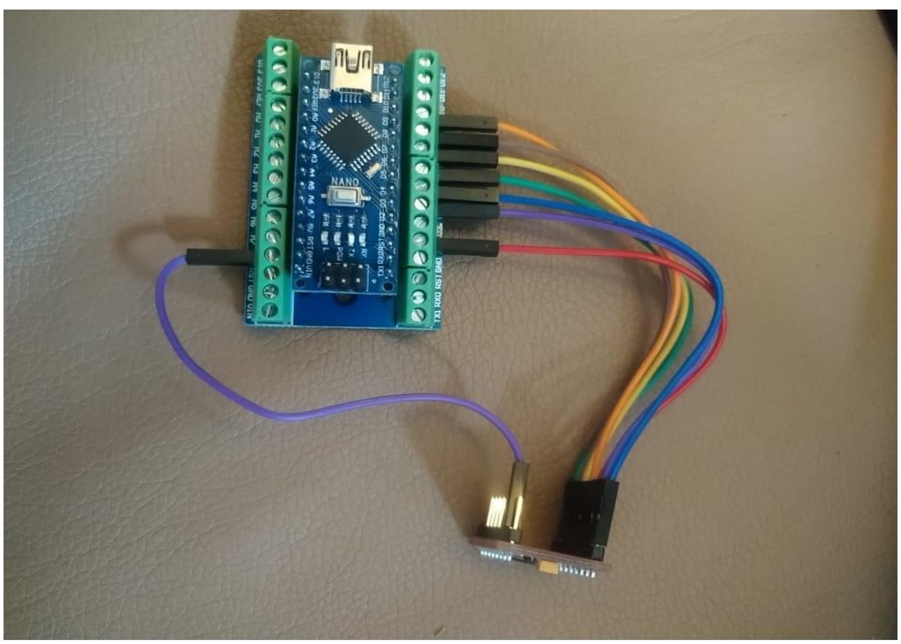
Many design elements were used because they were available on site and were doing the job. Some elements were additionally bent, cut or ground to fit.

2.1.6 Summary

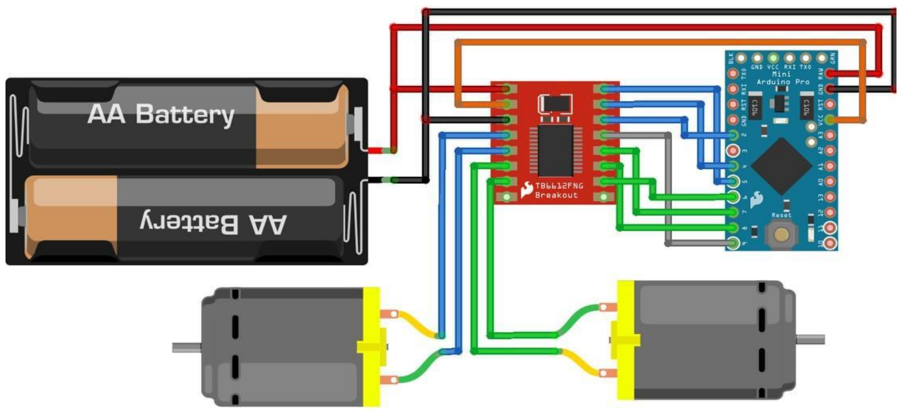
All the mechanics were made precisely thanks to the use of the three-dimensional Autodesk Fusion 360 program. The biggest problem is the use of glue to connect almost all elements, which made it difficult to disassemble the robot and replace or change the position of components in order to improve the structure or complete reconstruction. After all, the whole thing works without any major problems.

2.2 Electronics

The electronics were designed in the FluidSim program , with which we had contact with our professor during the lessons, thanks to which we had already had the knowledge that we used when designing electronics. The information needed for the electrical connections and for programming the Arduino microcontroller was obtained on the internet and from colleagues with more experience.



(a) robot electronics (photo by Marcin Jablonski, CC-BY-SA)



(b) electronics diagram by TinkerCAD (design by Marcin Jablonski in TinkerCAD - screenshot, CC-BY-SA)

2.2.1 Power

1. Description and justification

   The robot is powered by 3 Sony VTC5 lithium -ion batteries with a capacity of 2600mAh each, and a supply voltage of 4.2V, 3 batteries were used to obtain a voltage of 12V to power the motors. These batteries have a constant linear discharge current characteristic of 20A, with no perceptible impulse differences. A stabilizer 7809 was used to obtain the appropriate voltages. Such batteries were used, due to their efficiency and earlier use of identical ones, which seemed to do their job, so we decided to buy these batteries again.

2. Construction and repair process

The batteries were connected in series by wire. They were placed in such a way as to facilitate easy and quick replacement in the event of a failure and during charging. There is no reverse polarity protection provided in the system.

2.2.2 Microcontroller

1. Description and justification

As a microcontroller for our robot, we used a module compatible with the popular Arduino Nano v3.0 system, it has an ATmega328 microcontroller with an installed bootloader (this means that it can be programmed via the Arduino IDE environment using available libraries). The ATmega328 microcontroller is equipped with 14 digital inputs / outputs, 6 of which can be used as PWM outputs (e.g. for motor control) and 8 as analog inputs.

The system is clocked with a 16 MHz clock signal. The module also has: a miniUSB connector, a RESET button and ISP connector. This module was chosen because of the simple way of its programming (ideal for people who assemble their first robot) and because of its low price and high availability in online stores.

2. Specification:

- Supply voltage: 5 V to 12 V
- Leads work with a voltage of 5 V.
- Arduino Nano bootloader installed _
- Microcontroller: ATmega328

- Maximum clock frequency: 16 MHz
    - SRAM memory: 2 kB
    - Flash memory: 32 KB (4 KB is reserved for bootloader)
    - EEPROM memory: 1 kB
    - I / O Ports: 14
    - PWM outputs: 6
    - Number of analog inputs: 8 (channels of A / C converter)
    - Serial interfaces: UART, SPI, I2C
- Connector: miniUSB socket type B:
- Dimensions: 43 x 18 mm
- Weight: approx. 6 g

3. Construction and repair process

The assembly of the microcontroller as well as the connection of the motor and other elements was successful without any problems. Thanks to the selection of such an easy-to-build microcontroller, time was saved, which was devoted to other elements.

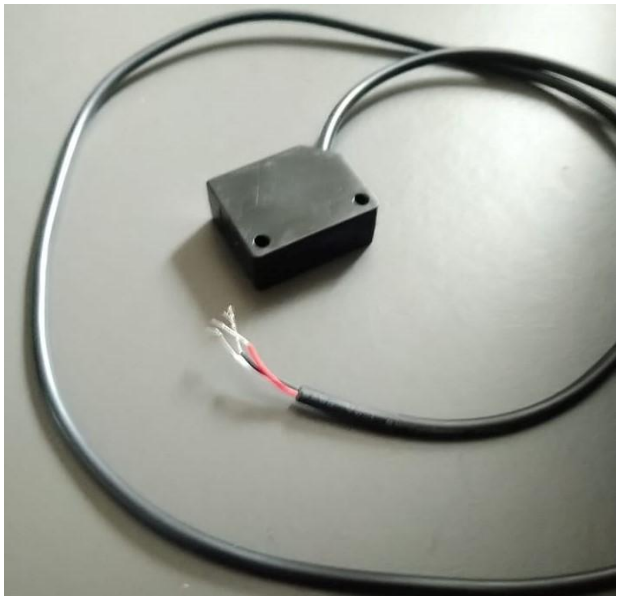
2.2.3 Sensors

1. Description and justification

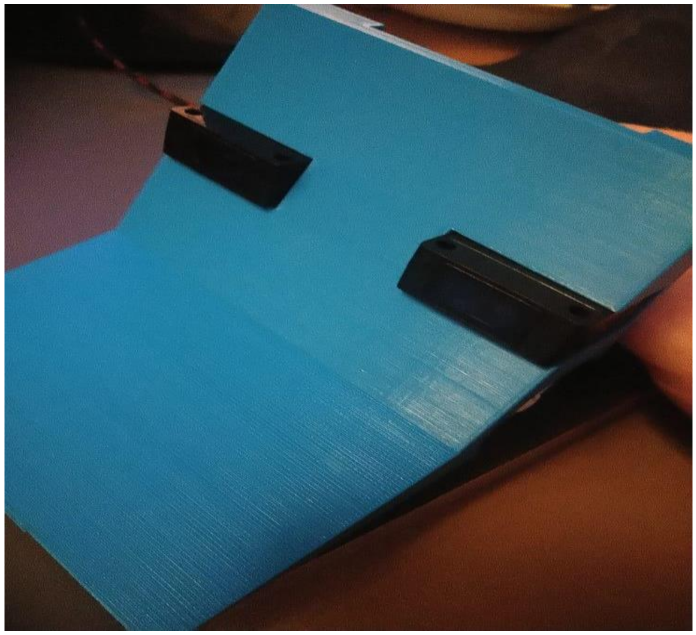
Two pieces of an optical sensor from AliExpress , XIN NUO QI model E18-D50NK, controlled with 5V, were used as sensors for the robot. They were chosen due to their low cost and fast response time of only <2 ms. The sensors are mounted on the front of the housing to best detect the enemy, their range is 3-80cm.

2. How the sensors work

When the duel starts, the robot starts spinning in order to detect the opponent by one of the sensors, when the first sensor detects the opponent, the robot is positioned in such a way that both sensors detect the opponent and then the robot drives towards the opponent to push him out.



(a) robot sensor (photo by Marcin Jablonski, CC-BY-SA)



(b) sensors placed on the robot (photo by Marcin Jablonski, CC-BY-SA)

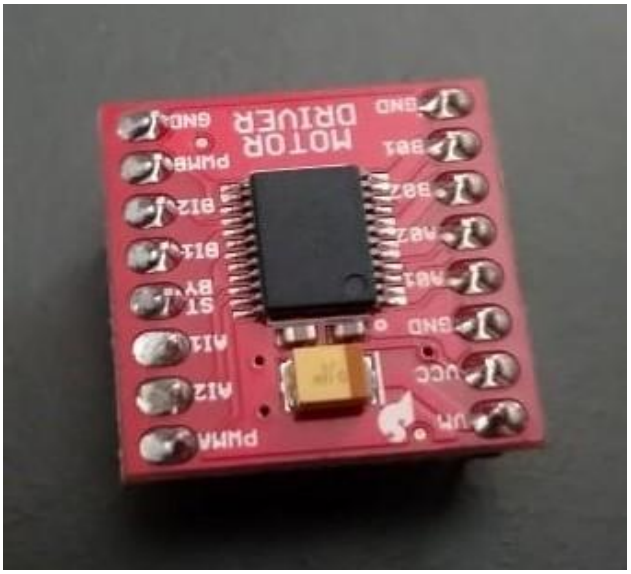
2.2.4 Engine control

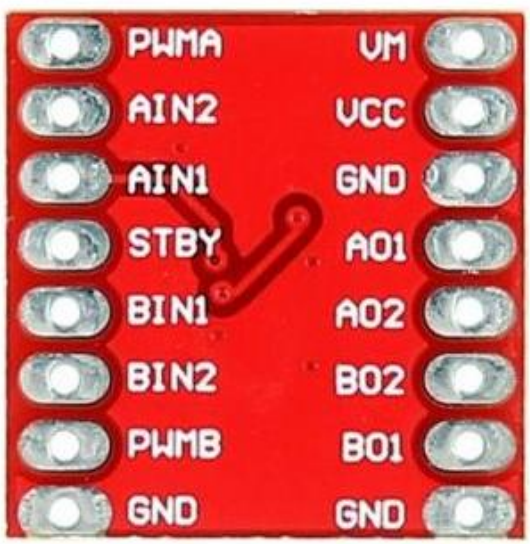
1. Description and justification

The motors were controlled by the Mostek H TB6612FNG module with a two-channel DC motor driver. It is supplied with the voltage from 2.7 V to 15V. The logic of the bridge is supplied with the voltage from 2.7 V to 5.5 V. The continuous current per channel is 1.2 A. The bridge has two logic inputs that control the direction of rotation of the motor axis, and one PWM interface. The motors were connected to the controllers using gold pins and cables with male-male, female-female and male-female terminals soldered to them.

2. Specification:

- Power supply of motors (VMOT): from 2.7 V to 15 V
- Logic circuit power (VCC): 2.7 V to 5.5 V
- Maximum output current: 3.2 A per channel
- Continuous output current: 1.2 A per channel
- Maximum PWM frequency: 100kHz
- Built-in thermal cut-off circuit
- Filter capacitors on both feed lines
- Reverse current protection from motors





(a) engine control unit (front) (b) engine control unit (rear)
(photo by Marcin Jablonski, CC-BY-SA)

PIN	Opis: (PL)	Description: (EN)
VCC	ZASILANIE CZĘŚCI LOGICZNEJ	POWER SUPPLY OF THE LOGICAL PART
VMOT	ZASILANIE SILNIKÓW	POWER SUPPLY OF MOTORS
GND	MASA / POTENCJAŁ ZEROWY	MASS / ZERO POTENTIAL
A01, A02	WYJŚCIE KANAŁU „A”	OUTPUT CHANNEL "A"
B01, B02	WYJŚCIE KANAŁU „B”	OUTPUT CHANNEL "B"
PWMA	STEROWANIE PWM KANAŁ-A	CHANNEL-A PWM CONTROL (Pulse-Width Modulation)
PWMB	STEROWANIE PWM KANAŁ-B	CHANNEL-A PWM CONTROL (Pulse-Width Modulation)
STBY	STAN UŚPIENIA	STANBY
AIN1, AIN2	STEROWANIE KIERUNKOWE KANAŁ -A	DIRECTIONAL CONTROL CHANNEL -A
BIN1, BIN2	STEROWANIE KIERUNKOWE KANAŁ -B	DIRECTIONAL CONTROL CHANNEL -B

driver pin description (schedule by Marcin Jablonski, CC-BY-SA)

2.3 Program

The robot controlling program was written in C ++ in the Arduino IDE program. It was difficult to create the program due to the lack of experience in writing this type of program, so we prepared several versions. The final version, after thorough testing, turned out to be correct and was uploaded to the microcontroller.

2.3.1 Control algorithm

The algorithm is based on a simple "find and destroy" principle. The robot spins in place until the distance sensors find the enemy. This has been done by functions that return logical values. If the function returns false, the program runs in a loop constantly checking sensors. If an opponent is found (true), the program works in another loop, which checks if the opponent is still ahead. If so, the robot moves forward at full speed. The program provides for waiting for the start from the startup module and reaction to the killswitch command . No white line sensor has been added to prevent the front of the ring from running out of the ring. The robot searches for an opponent on the left front sensor (seek () function), and when it finds it, it moves at full speed forward (engage () function).

3. Summary

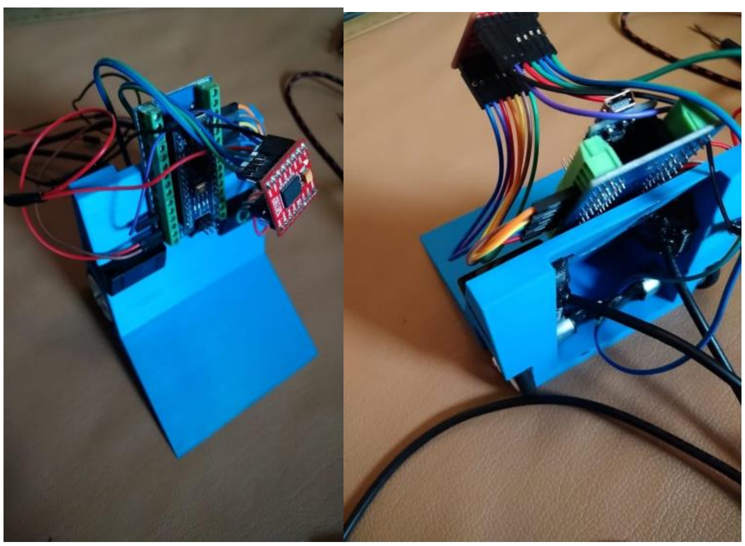
The document contains a detailed description of the construction and operation of the " MaćkoBOT " minisumo robot , as well as the process of its construction. The result of the work is a robot that can drive and find an opponent. The robot was created in order to take part in the minisumo competition. The robot did not meet our expectations and had several imperfections that were caused by a limited budget, inexperience and precise tools. The main aspect of a robot that should be done better is its drive, which is oversteer. Secondly, in future projects, the method of attaching components to the housing should be changed, as the assembly of components with glue makes it difficult to replace components in the event of damage or the desire to improve the robot. In future projects, it is worth considering installing additional white line sensors to improve the robot and changing the materials of the housing and chassis to increase the weight and strength of the robot. Programs written for the robot could be better optimized. The next point in further work on the project will be to create another project on the basis of the first with more experience. There are plans to improve the mechanics of the robot, install components with greater accuracy and optimize the software.

Lessons and lessons learned from building the robot:

- How to build a robot
- support for autodesk Fusion 360

- tons of new practical skills
- experience in programming Arduino board
- cheap items ordered from China will never be the best
- patience is the key to success
-human learns by their mistakes
- it is worth pursuing the goal and not giving up
- the first time is always the hardest
- proper organization of work
- ability to work in a group

The robot has not participated in any tournaments yet due to the prevailing conditions, but we hope to be able to put the robot into battle at one of the tournaments in the future.



(a) front of the robot (b) rear of the robot
(photo by Marcin Jablonski, CC-BY-SA)