DEVELOPMENT OF AN INTELLIGENT, REMOTE / SELF-DRIVING CAR

An IAESTE Internship Project Report submitted by

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Karunya INSTITUTE OF TECHNOLOGY AND SCIENCES
(Declared as Deemed to be University under Sec.3 of the UGC Act, 1956)
A CHRISTIAN MINORITY RESIDENTIAL INSTITUTION
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AUGUST 2018

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Declared as Deemed-to-be University under sec. 3 of UGC Act, 1956
Karunya Nagar, Coimbatore 641 114, Tamil Nadu, India.

BONAFIDE CERTIFICATE

This is to certify that this report entitled, " **CREATING AND DEVELOPING OF THE INTELLIGENT ROBOT, REMOTE / SELF-DRIVING CAR**", is a bonafide work of the following candidate from Gdansk University of Technology, Poland, who carried out the IAESTE Internship project work under my supervision during the academic year 2018-19 / **Summer 2018**.

BARTŁOMIEJ BORZYSZKOWSKI (IS18ET019)

Dissertation submitted in partial fulfillment of the requirements for the completion of the

IAESTE INTERNSHIP PROJECT

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

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Abstract

Self-driving cars are vehicles in which human drivers are not required to take control to safely operate the vehicle. Also known as autonomous or „driverless" cars, they combine various sensors and software to control, navigate, and drive the vehicle. Self-driving technology is becoming increasingly common and could radically transform our transportation system (and by extension, our economy and society). The costs and benefits of self-driving cars are still largely hypothetical but in the past several years autonomous driving technologies have made a significant develop, giving a number of perspectives for the further progress.

Figure 1: Stanford Cart (1961) – the first „autonomous" vehicle

The idea of intelligent vehicle is multi-level, complex and contains a big number of different aspects. More information is needed to fully assess how autonomous cars impact drivers, the economy, equity environmental and public health. Recently, thanks to the artificial intelligence and deep learning methods, software engineers are able to develop solutions which give an answer for the big number of questions and difficulties.

As a result people create cars having different levels of intelligence and working with a diverse systems, sensors and environments. Partially-autonomous vehicles may require a human driver to intervene if the system encounters uncertainty or if the user simply wants to steer; fully-autonomous vehicles may not even offer a steering wheel.

Self-driving cars can be further distinguished as being „connected" or not, indicating whether they can communicate with other vehicles and/or infrastructure, such as next generation traffic lights.

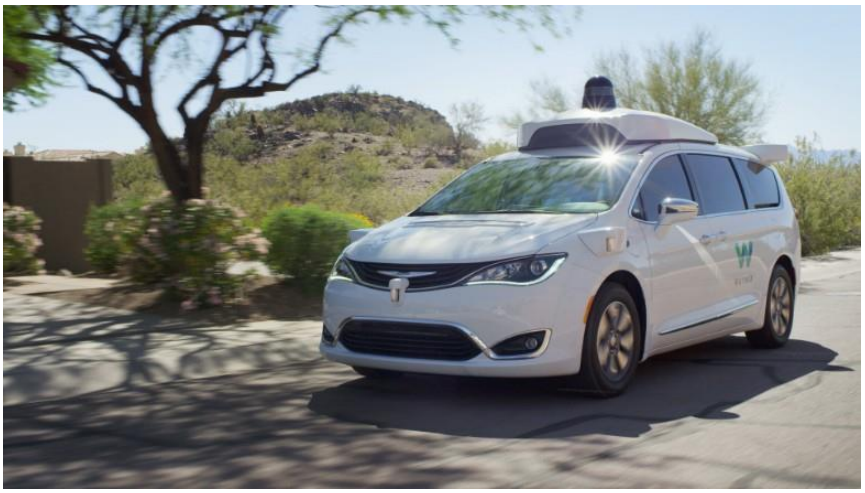


Figure 2: Waymo/Google – one of the most advanced self-driving cars

To make the development of self-driving cars easier, low cost, more accessible and prosperous small size models are widly used for the testing purposes. This solution guarantee the possibility to write the software working in the same way as in the real size models, compare the results and eliminate potential mistakes.

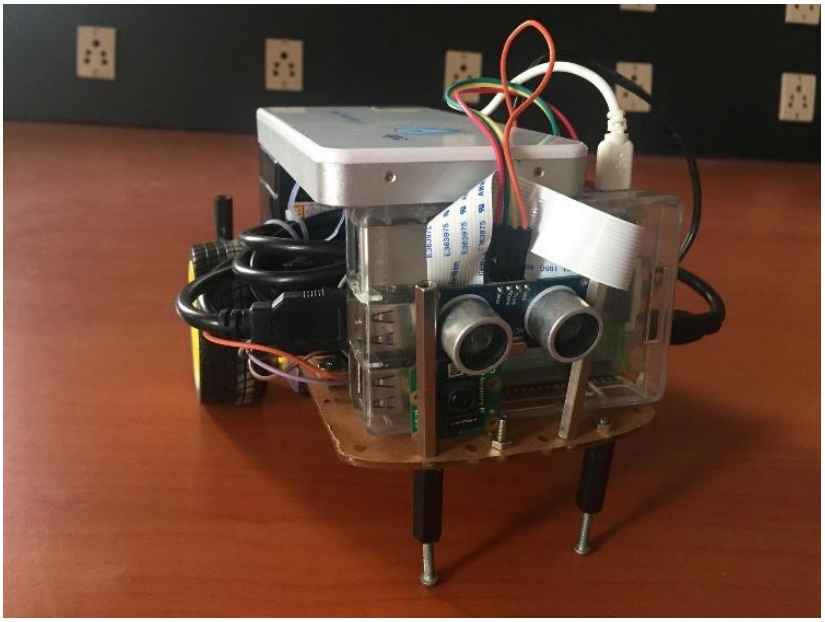


Figure 3: Intelligent Car project by Bartłomiej Borzyszkowski

Aim of the work

The aim of this project is to develop the model of partially-autonomous vehicle and reach the full-autonomous after future extensions.

The goal of the research is to design the construction of the intelligent car by using the Raspberry Pi, Arudino, ultrasonic sensor, camera and motor driver. Moreover, to write and develop the intelligent software using Python and C/C++ languages and design the „client – server" architecture between the used devices.

Robot overview

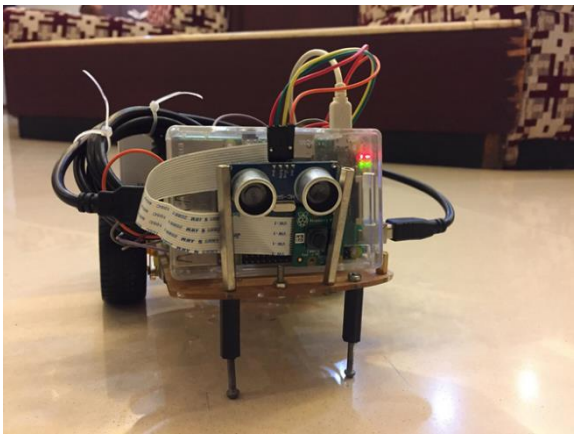


Figure 1: Front

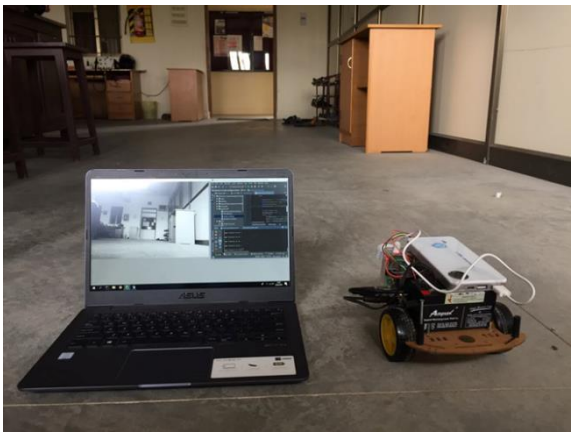


Figure 2: Back and display

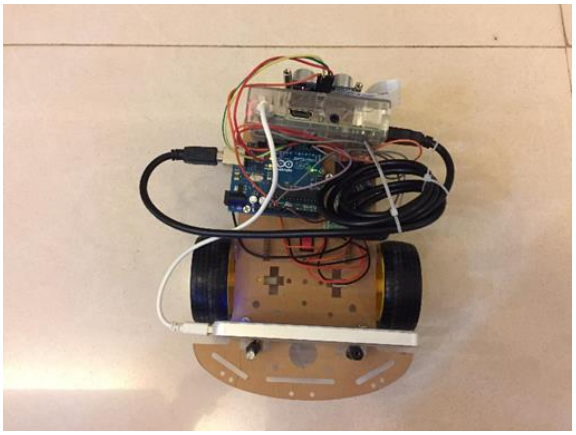


Figure 3: Top

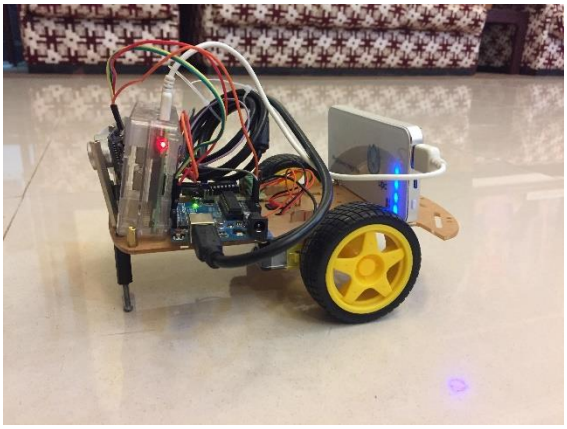
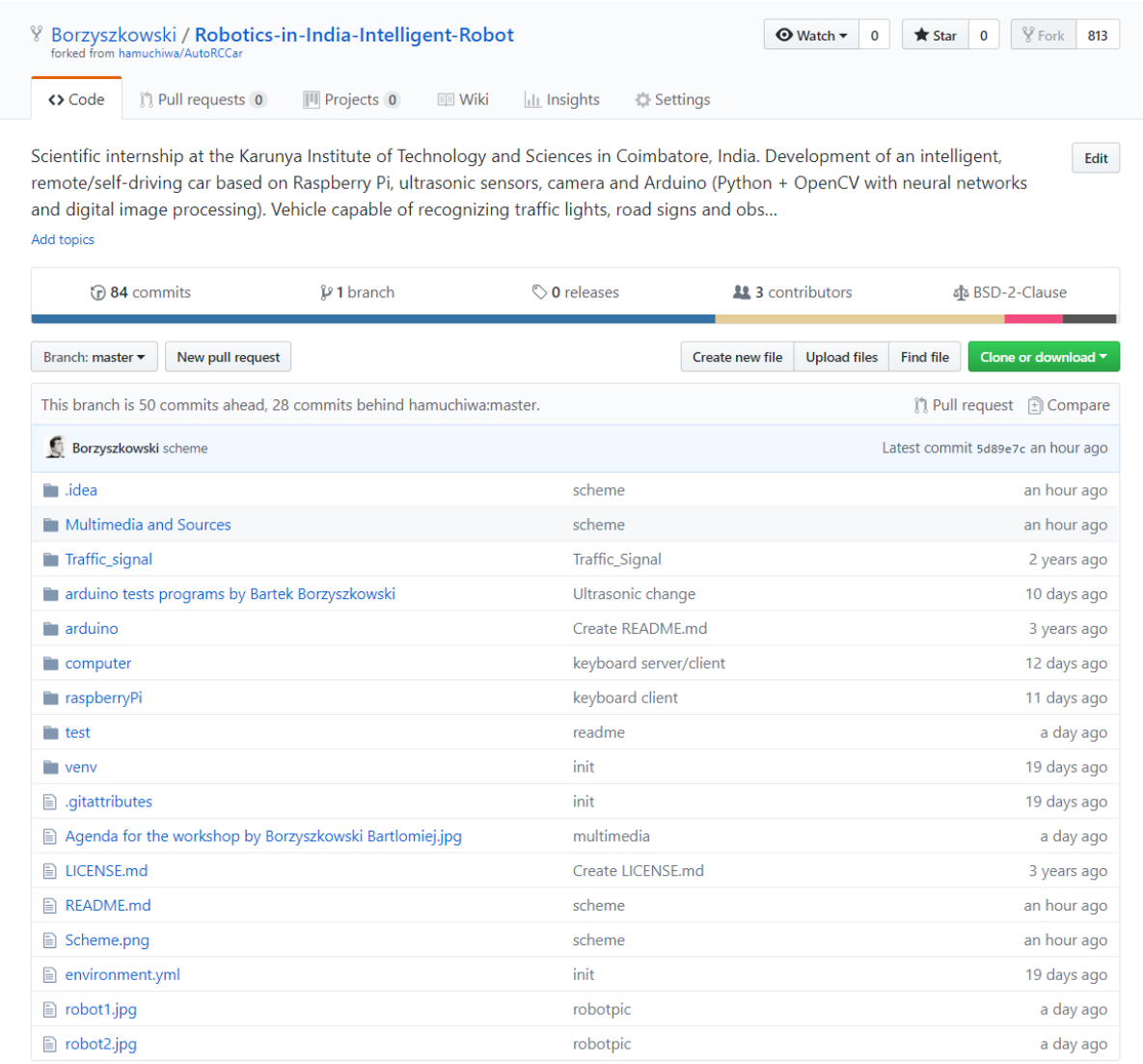


Figure 4: Side

Project repository

The complete project repository, including the software, programs and libraries, multimedia and sources (videos and pictures from the laboratory), explanation of the project, schemes, problem solutions, robot construction and description of every particular device in the project is free and open to access, available on the GitHub profile under the link below:

github.com/Borzyszkowski/Robotics-in-India-Intelligent-Robot



The project was inspired by the construction of autonomous car developed by Zheng Wang, available in the document below:

zhengludwig.wordpress.com/projects/self-driving-rc-car/

Functionality

The robot is an intelligent, partially-autonomous car, what means that user's interve is required in the process but at the same time information collected from the environment make the robot capable to decide on its own and take some actions by itself.

The vehicle is able to move in four different directions – forward, backward, right, left and stop after pressing a corresponding button. The main functionality is steering by the user from the laptop keyboard (wireless connection/remote control).

Furthermore, the equipment with the ultrasonic sensor enables the robot to measure the distance from obstracles in the front and stop in case of possible collision. Thanks to the Pi camera the user has a real time display from the front of the robot on the laptop/PC screen. This solution allows the robot to be independent and wireless but at once the user has an access to steer the robot. In following steps of the project total autonomous and possibility to choose between self-drive or remote control steering is also possible.

Equipment / Components

- Raspberry Pi 3 Model B
- Camera desired for the Raspberry Pi
- Arduino UNO
- Laptop/PC
- Ultrasonic sensor HC-SR04
- Motor driver L293
- 2 separate motors and 2 wheels
- Power supply (power bank and an additional rechargeable battery)
- Robot board – car frame
- Cords/wires
- Switch button
- Soldering equipement
- Wi-Fi network
- External display
- Programming environment and software

Architecture / Scheme

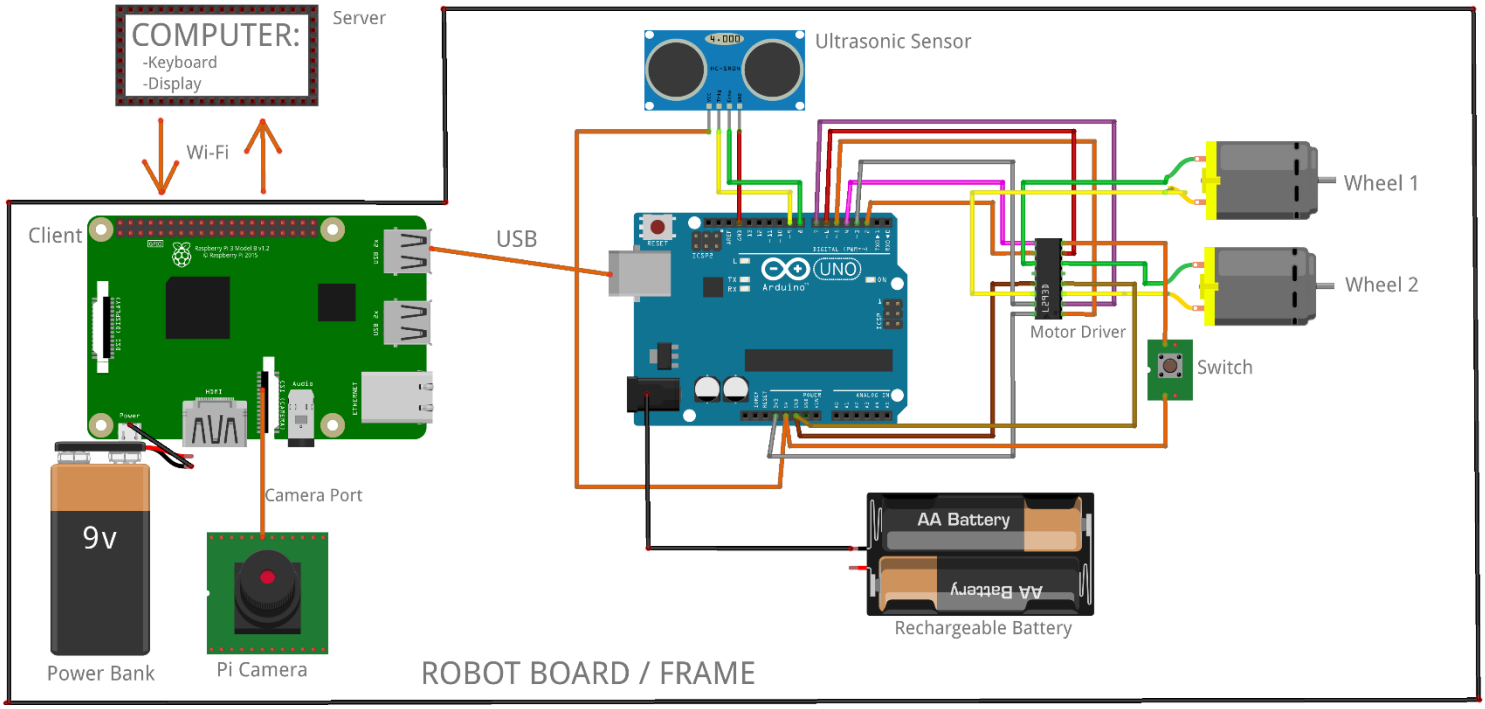


Figure 1: Full architecture scheme

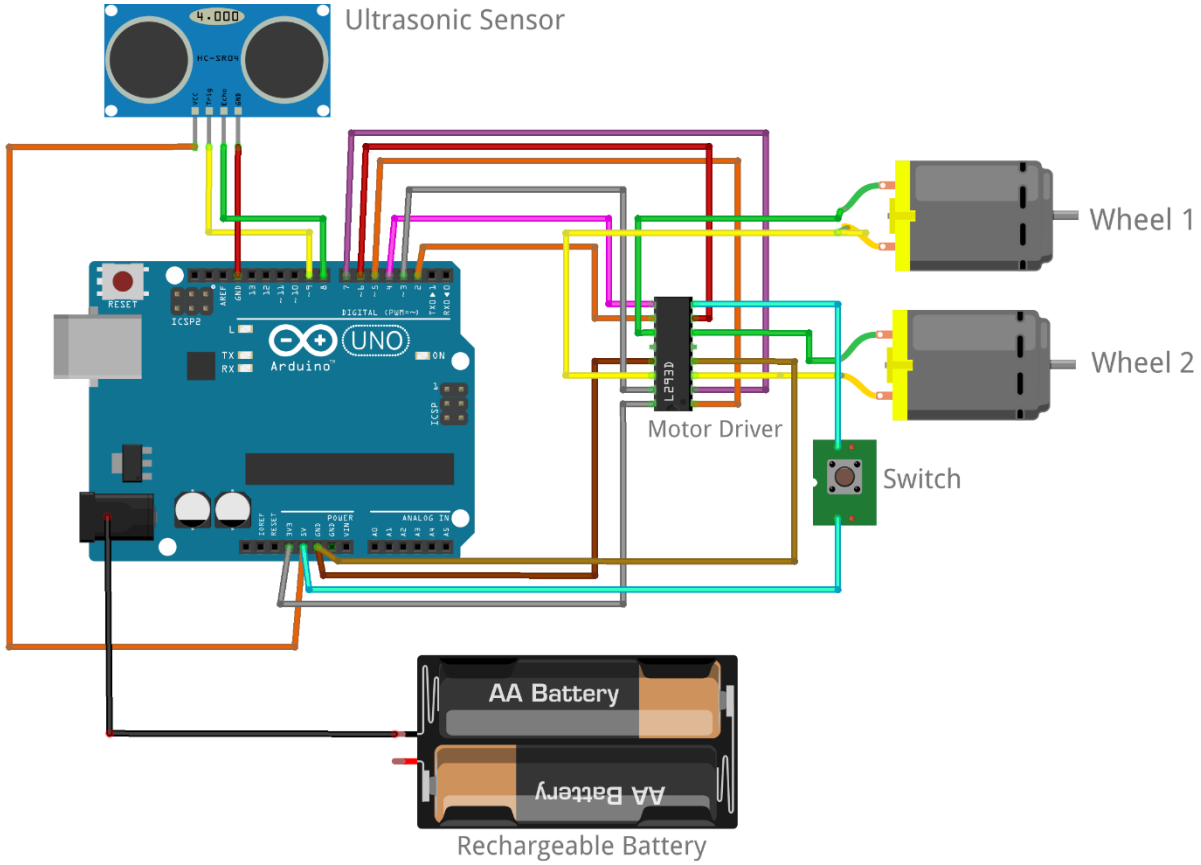


Figure 2: Arduino scheme

Hardware description

1. Computer

- Working as a server for the Raspberry Pi (client) via Wi-Fi
- Collecting information about steering from the keyboard and forwarding it to the Raspberry Pi
- Receiving video from the Raspberry Pi and showing the display

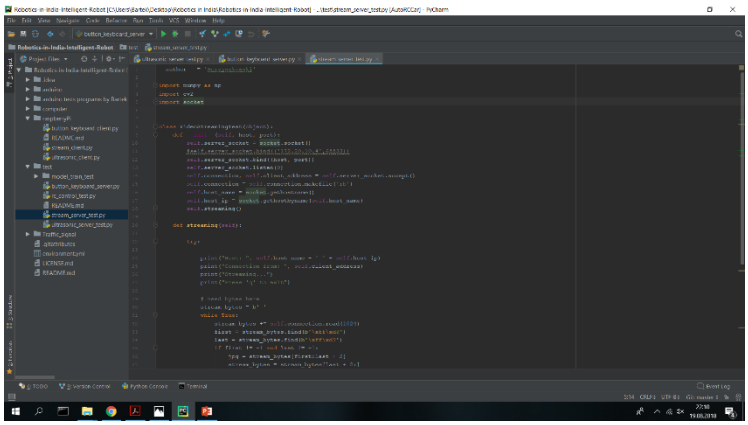


Figure 1: PyCharm Python Environment

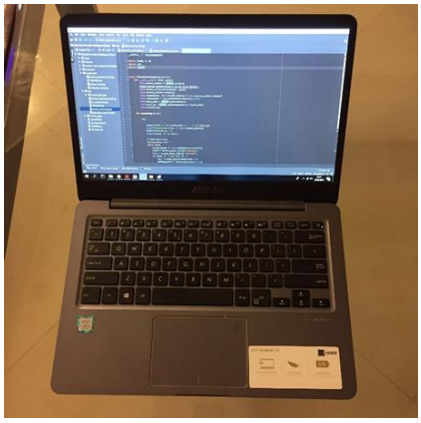


Figure 2: laptop used for the project

2. Raspberry Pi

- Working as a client for the computer (server) via Wi-Fi
- Connected to the Arduino via USB
- Connected with the Pi camera
- Collecting information about steering from the computer (keyboard) and forwarding it to the Arduino
- Collecting data from the camera and sending it to the computer

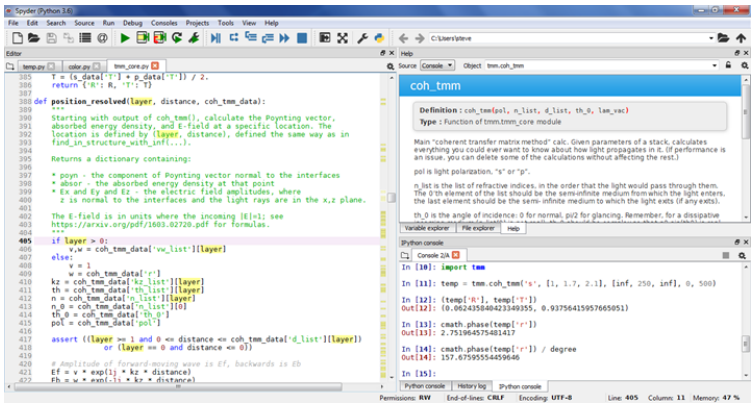


Figure 3: Spyder Python Environment

Figure 4: Raspberry Pi 3 model B with Pi Camera

3. Arduino

- Connected to the Raspberry Pi via USB
- Connected to the Motor Driver
- Connected to the ultrasonic sensor
- Receiving data for steering from the Raspberry Pi and forwarding information to the Motor Driver
- Receiving distance from the ultrasonic sensor and stopping the car in case of obstracle detection (front)

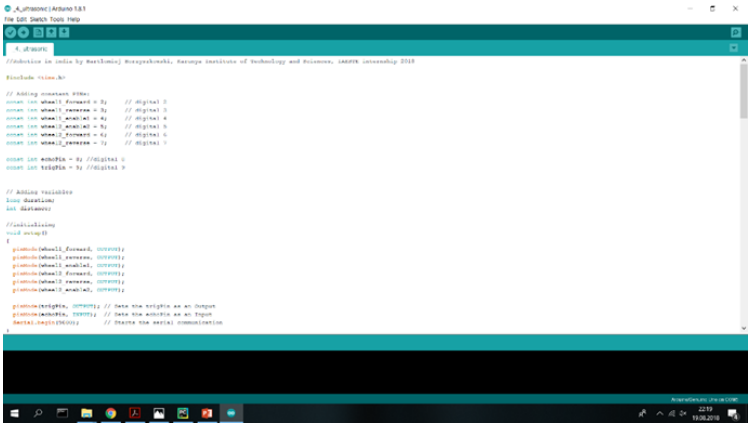


Figure 5: Arduino Programming Environment

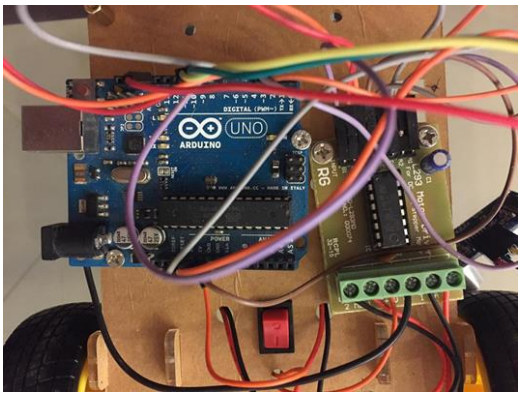


Figure 6: Arduino UNO

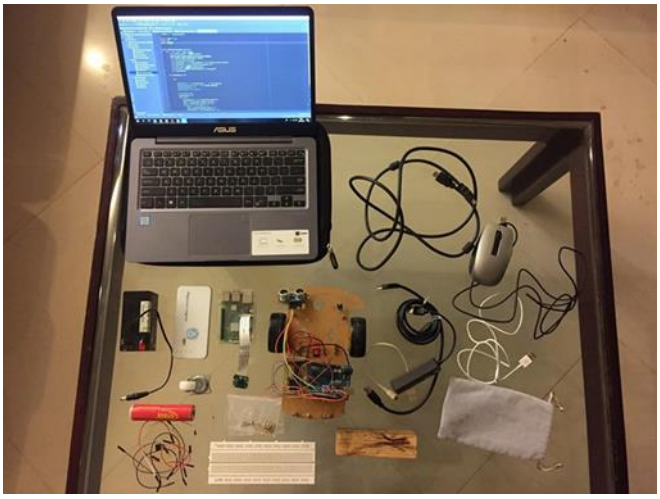


Figure 7: Project Components

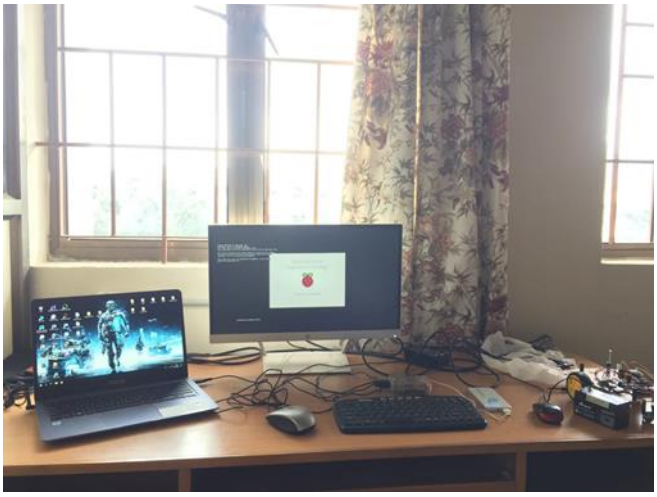


Figure 8: External display

Software description

In the current project version to achieve the required result five programs should run in the same time:

- Computer:
    1. „button_keyboard_server.py”
    2. „stream_server_test.py”
- Raspberry Pi:
    3. „button_keyboard_client.py”
    4. „stream_client.py”
- Arduino:
    5. „_7._steering.ino”

For exchange of the data between the Raspberry Pi and the computer connection „serwer – client” is required. The recieved information about steering (from the keyboard) is transfered from the Raspberry Pi to the Arudino and further to the Motor Driver.

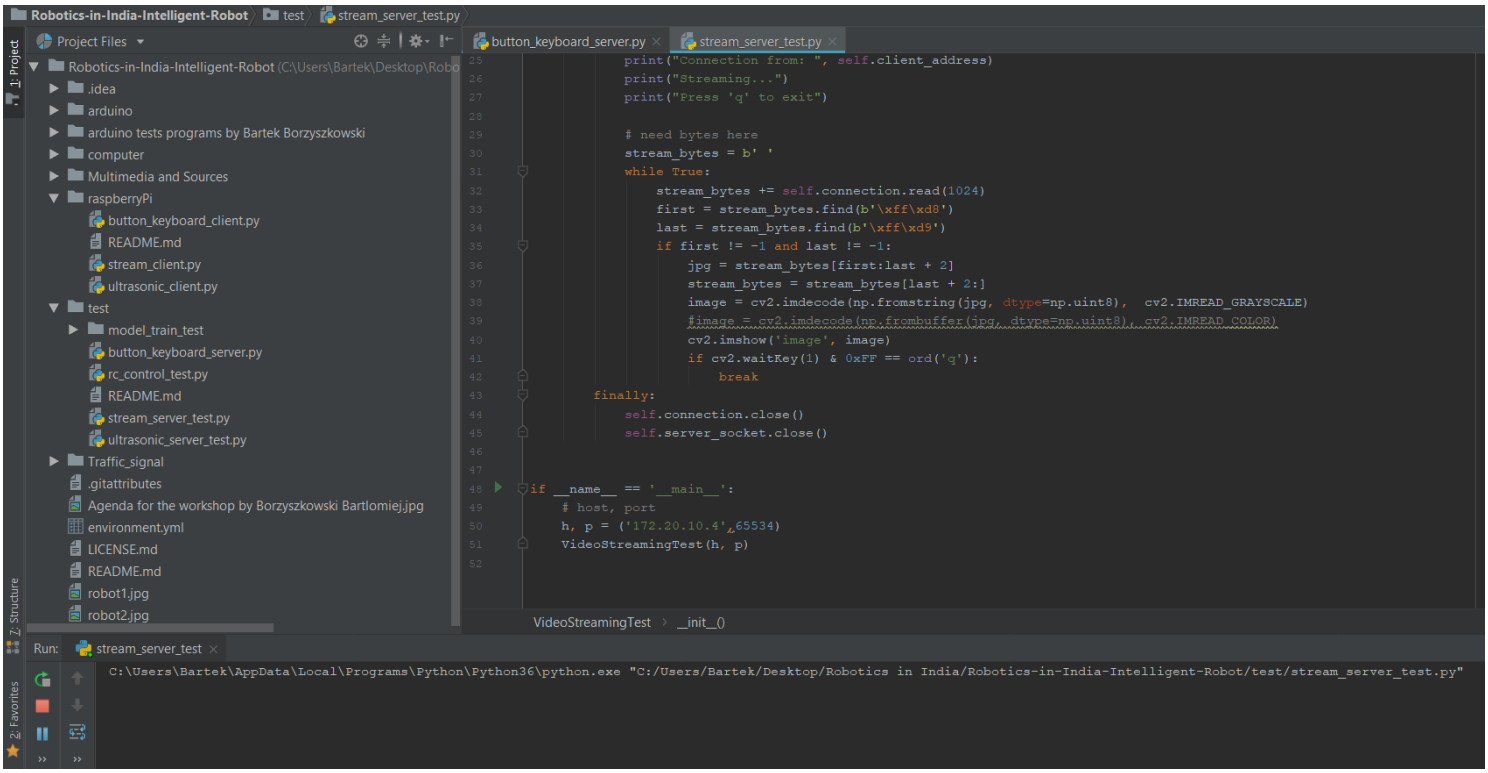


Figure 1: Project Software

Corresponding relation between devices allows to send the image from the camera to the Raspberry Pi and forward it further to the computer. Thanks to this solution, the user knows what is currently happening in front of the robot.

Besides the programs used in the project, GitHub repository is much more extended and gives more possibilities for different robot configurations (e.g. using the folder „arduino test programs by Bartek Borzyszkowski"). Moreover, folders including model training and programs developing and training the neural network allows the further evolution of the car.

Further develop

- Total autonomous
- Artificial intelligence, neural networks and image processing
- Road lines, signs and traffic lights recognition
- More advance steering (30, 45, 60 degree turn)
- Both kinds of control (self-drive and remote control) with balanced priorities or possibility to choose by the user

Conclusion / Sum up

To conclude, the aims of this internship were achieved successfully and are posted above as a result and source for future extensions and uses. Despite some difficulties, such as the camera streaming delay (solved by scaling down the resolution) the car works impressively.

Finally, intelligent vehicles are an important element in technological development and can contribute to the revolution on roads around the world. The design of the robot model created during the internship at the Karunya Institute of Technology and Sciences allows to observe the processes necessary to construct such a car, learn and draw the presented conclusions that will help in solving future potential problems.

Bartłomiej Borzyszkowski

Bibliography / References

Similar projects:

1. by Zheng Wang
    - *zhengludwig.wordpress.com/projects/self-driving-rc-car/*
    - *github.com/hamuchiwa/AutoRCCar*
2. by Ryan Zotti
    - *github.com/RyanZotti/Self-Driving-Car*
3. by Yazeed Alrubyli
    - *becominghuman.ai/building-self-driving-rc-car-series-5-serverless-control-using-computer-vision-fdf0d0136888*
    - *github.com/yazeedalrubyli/SDRC*
4. by Multunus
    - *github.com/multunus/autonomous-rc-car*

Guides and specifications:

L293 Motor Driver:

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- *components101.com/ultrasonic-sensor-working-pinout-datasheet*
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- *projects.raspberrypi.org/en/projects/getting-started-with-picamera*
- *opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_calib3d/py_calibration/py_calibration.html*

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