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PRACA DYPLOMOWA
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Smartfon z systemem Android
jako wysokopoziomowy sterownik robota

Android smartphone
as a high-level controller of a robot

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Chapter 1

Introduction

1.1 Description of problem

Nowadays, popularity of robots is on the raise. It's not hard to built a simple one, and Internet is full of tutorials how to build them. They are built using specially programmed microcontrollers (MCUs), and simplest ones even without any. However, MCUs have some limitations:

1. They have limited memory and computational capability.
2. They require a lot of low-level configuration and programming.
3. Each MCU model requires (at least) slightly different configuration.
4. It's hard to look for help (e.g. on Stack Overflow, [7]) for specific MCU.

Therefore, usage of Android smartphones as high-level controllers, sending commands to MCU as low-level one, should be worth considering, because of:

1. Lot of memory and powerful processors.
2. Many built-in sensors.
3. Many ways to communicate with surroundings, most important - with MCU.
4. Popularity of Android platform:
 - tutorials,
 - devices,
 - solutions on Stack Overflow,
 - external libraries.
5. Compatibility between smartphones and Android versions.
6. High-level programming and reduced low-level configuration.

1.2 Goal of a project

Goal of this project is to check, if Android smartphone:

- can communicate with microcontroller,
- can extend functionality of robots using its built-in sensors.

Found solutions should be analyzed with attention to:

- compatibility,
- performance,
- difficulty of implementation.

Two Android smartphones (with different performance and Android version) will be used: Sony Ericsson Xperia Neo and Motorola Moto G LTE. They will communicate with MCU through USB cable, and face detection using built-in camera will be used as an example of extending MCU's capabilities - it requires both computing power and sensors not available in MCU, and there exists several ways to implement this.

As MCU, a Freescale FRDM KL26Z will be used. [1] is a blog dedicated to development on Freescale platform (mostly KL25Z, predecessor of KL26Z), and even contains an article how to build a mobile robot on that platform (img. 1.1). It has articles how to use most of those MCUs features, however from smartphone's point of view, only communication using USB port (KL25Z and KL26Z have two of them) is required.

1.3 State of art

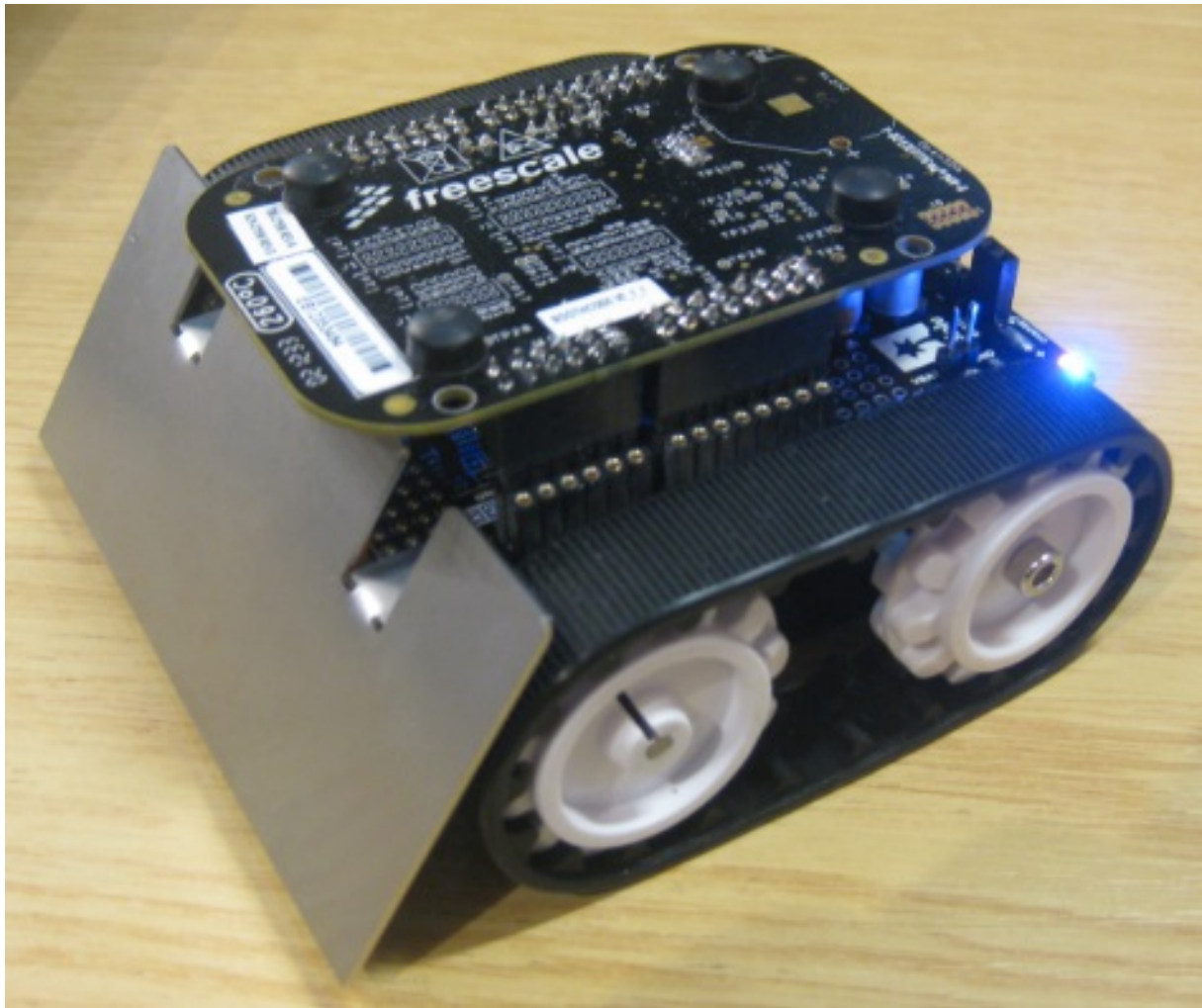


Figure 1.1 FRDM Zumo Robot, [1]

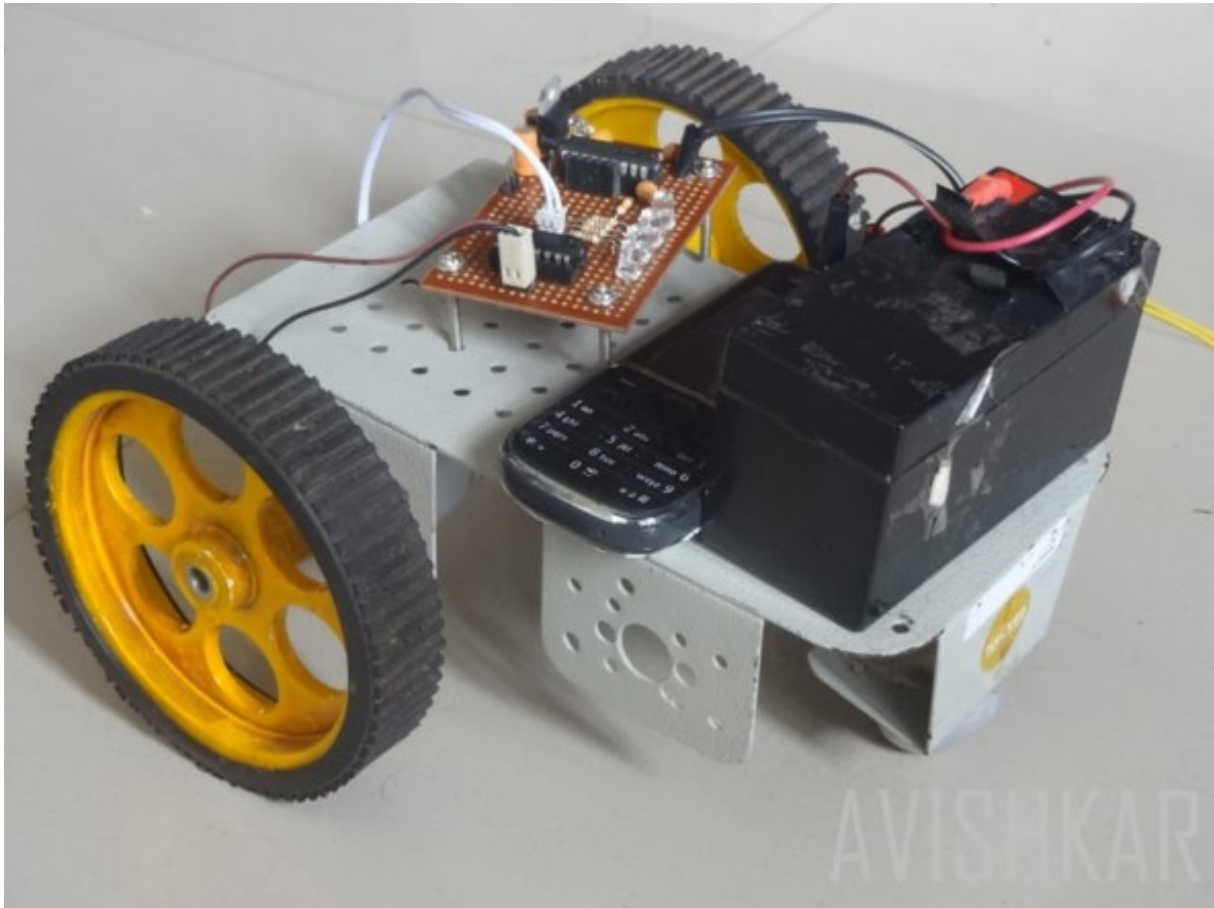


Figure 1.2 Mobile Controlled Robot by Ganeev Singh, [2]



Figure 1.3 Mobile Controlled Robot by Robotics Bible, [3]



Figure 1.4 Mobile Controlled Robot by Mayoogh Girish, [4]



Figure 1.5 FaceFollower by Michał Kowalski and Adam Ćwik

Chapter 2

Platforms

2.1 Android

2.2 MCU

Chapter 3

Communication

3.1 Introduction

3.2 Communication through USB cable - MCU

3.2.1 UART

3.2.2 CDC

3.3 Communication through USB cable - Android

Three ways to communicate over USB were found:

- USB Host API [5],
- usb-serial-for-android library by mik3y [8],
- UsbSerial by felHR85 [9].

Because of similar names of projects, they will be referenced as Host API, mik3y and felHR85.

3.3.1 USB Host API

3.3.2 mik3y

3.3.3 felHR85

3.4 Summary

Chapter 4

Sensors

4.1 Introduction

Modern smartphones has many sensors, and most of them can extend robot's functionality. Sensors differ between phones, and new (or more advanced) ones can be connected using possible connections (mostly USB and Bluetooth). Most popular ones are:

- touch screen,
- accelerometer,
- gyroscope,
- microphone(s),
- front and rear camera(s),
- position sensors:
 - GPS,
 - multilateration based on GSM and/or WiFi,
- magnetometer,
- light sensor,
- proximity sensor.

Some (mostly high-end, or specialized ones) have also sensors like electronic compass, humidity/temperature sensors, fingerprint scanner, or even thermal camera.

4.2 Face detection

Available implementations of face detection includes:

- FaceDetector API,
- Camera API,
- openCV for Android,
- openCV NDK.

4.2.1 FaceDetector API**4.2.2 Camera API****4.2.3 openCV for Android****4.2.4 openCV NDK****4.3 Summary**

Chapter 5

Summary

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