Master Thesis Presentation
Future Electric Vehicle on Lego

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Overview

- Objective
- Lego Car
- Wifi Interface to Lego Car
- Lego Car FPGA System
- Android Application
- Conclusion

Objective of Thesis

- Interfacing the Lego car with an Wi-Fi Module and controlling it remotely via Smart-Phone/Tab
- Configure the Wi-Fi Module as an Access point
- Re-engineer the Lego Technic 9398 into 4-wheel independent steering/driving
- Develop an Android Application to Implement control based on the Android device inbuilt sensors
- Implement a closed loop control for Car speed measurement using BEMF

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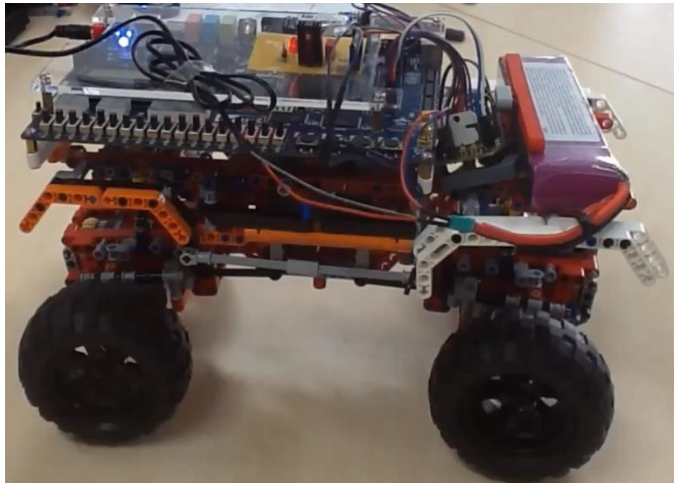
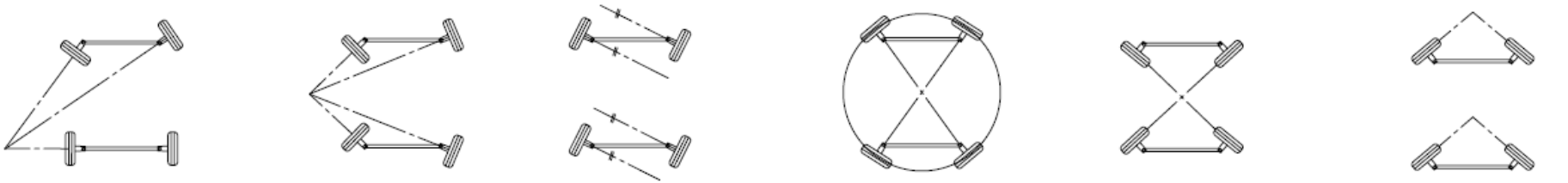
Lego Car

Currently Being Used
It has one DC and one
Servo Lego Motors



New Configuration
It has Four DC and Four
Servo Lego Motors

Driving Modes



(a) default mode (b) slow mode (c) parallel mode (d) rotational mode (e) parking mode (f) emergency mode

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Why WiFi?

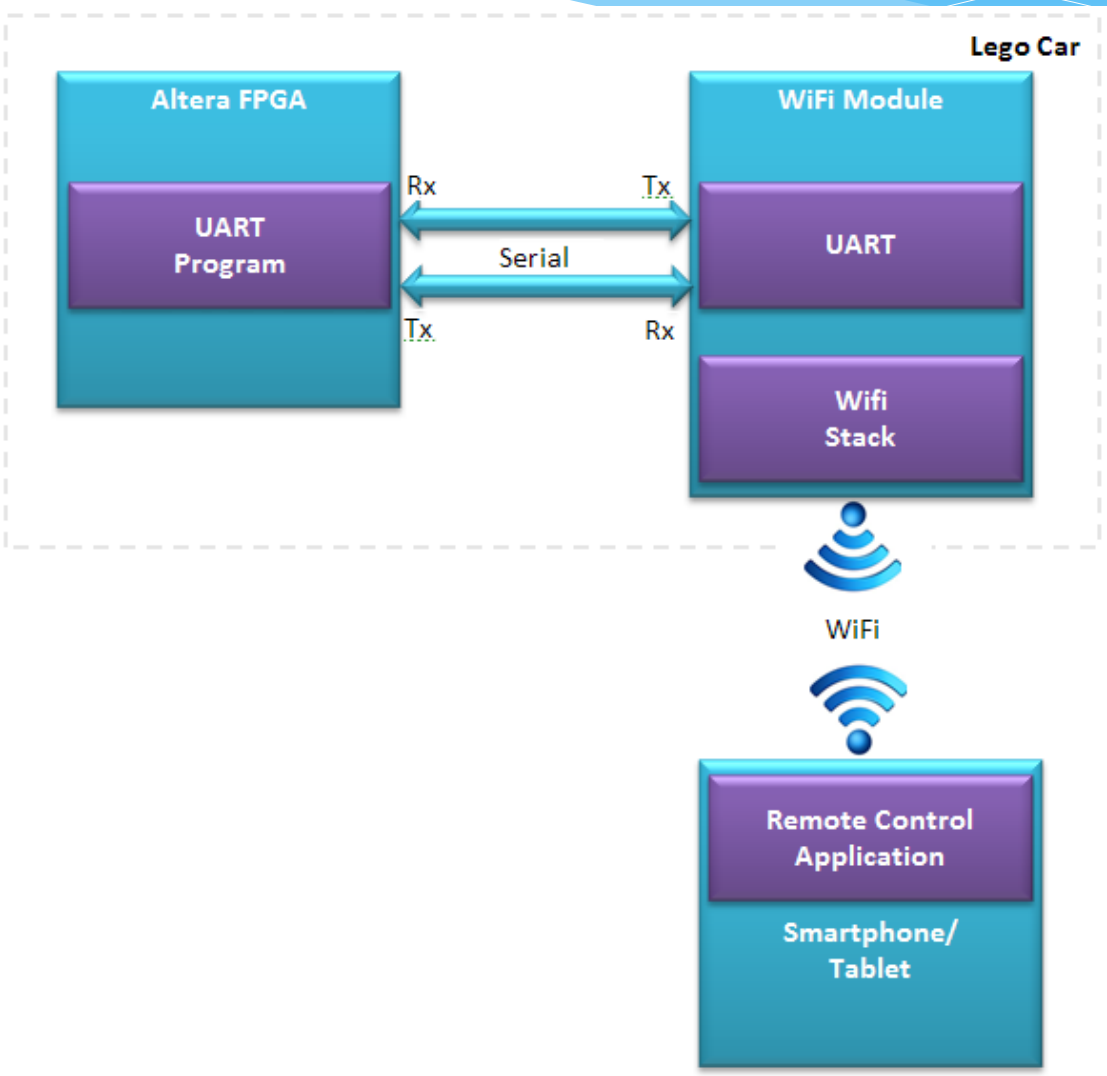
- Better range than most other wireless protocols
- More secure
- Easily available today
- Many hardware options available
- Wifi has higher bitrate so it is more suitable for transferring the camera video signal
- Some Smartphone OS like Apple iOS requires special chip to be put in the application circuit for it to be Bluetooth enabled

Wifi Module : RN134

Features:

- Hardware interface: UART and SPI slave
- Full onboard TCP/IP stack (no external drivers required)
- Supports Adhoc and infrastructure networking modes
- Real-time clock for time-stamping, auto-sleep, and auto-wakeup modes
- Runs directly from batteries or regulated power supply
- Configuration over serial or wireless ir
  commands
- Over the air firmware upgrade
- Secure Wi-Fi authentication schemes
  (WEP / WPA / WPA2)

Wi-Fi Module -FPGA Interface over UART



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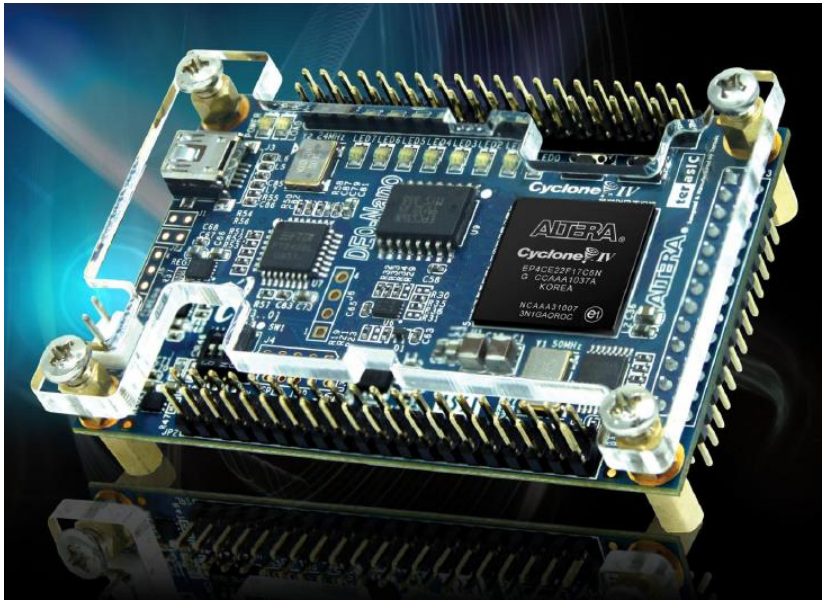
FPGA Board Used

The key features of the board :



Featured device

Altera Cyclone® IV EP4CE22F17C6N FPGA

Altera serial configuration – EPCS16(16Mbits)

Memory devices

32MB SDRAM

2Kb I2C EEPROM

General user input/output

8 green LEDs

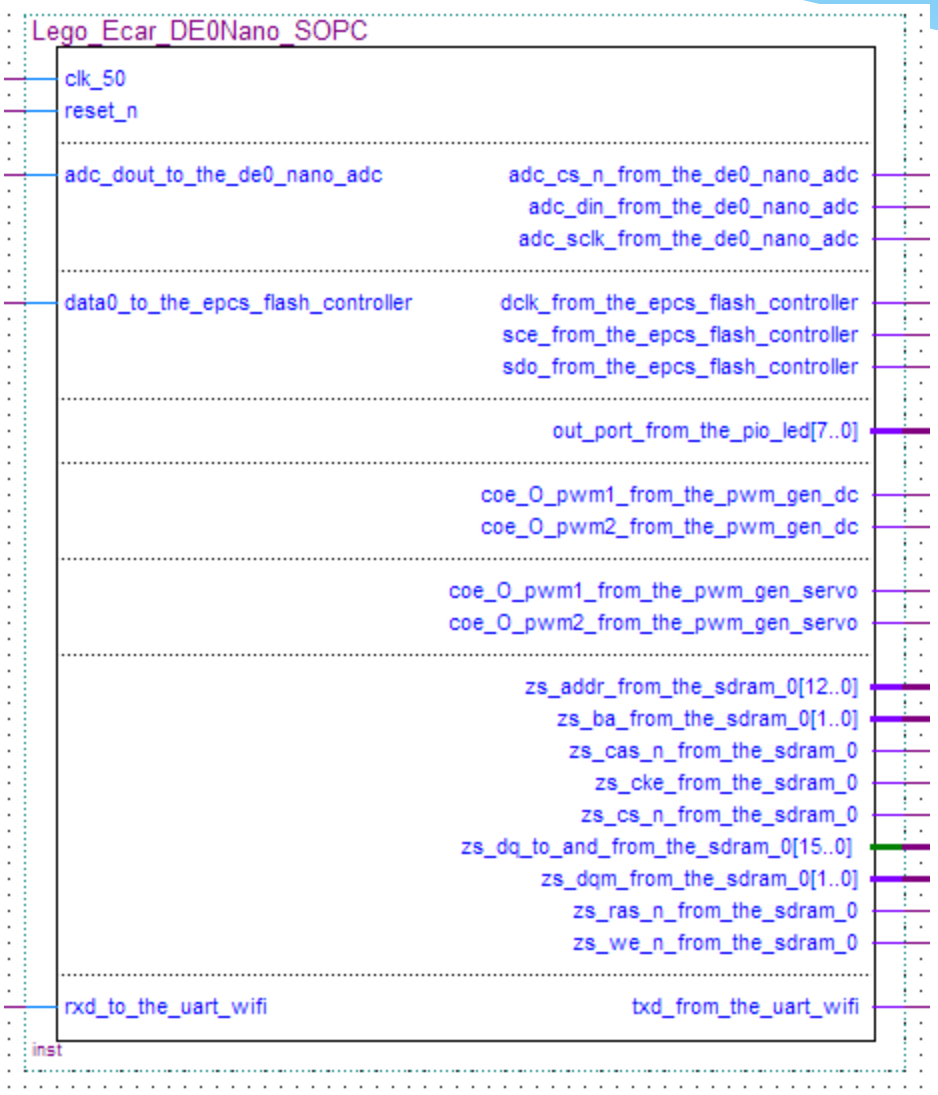
2 debounced pushbuttons

4-position DIP switch

A/D Converter

NS ADC128S022, 8-Channel, 12-bit A/D Converter

FPGA Hardware Configuration



Nios II Core Processor CPU

ADC Controller controls the
NS ADC128S022, 8-Channel, 12-bit ADC

EPCS Flash Controller

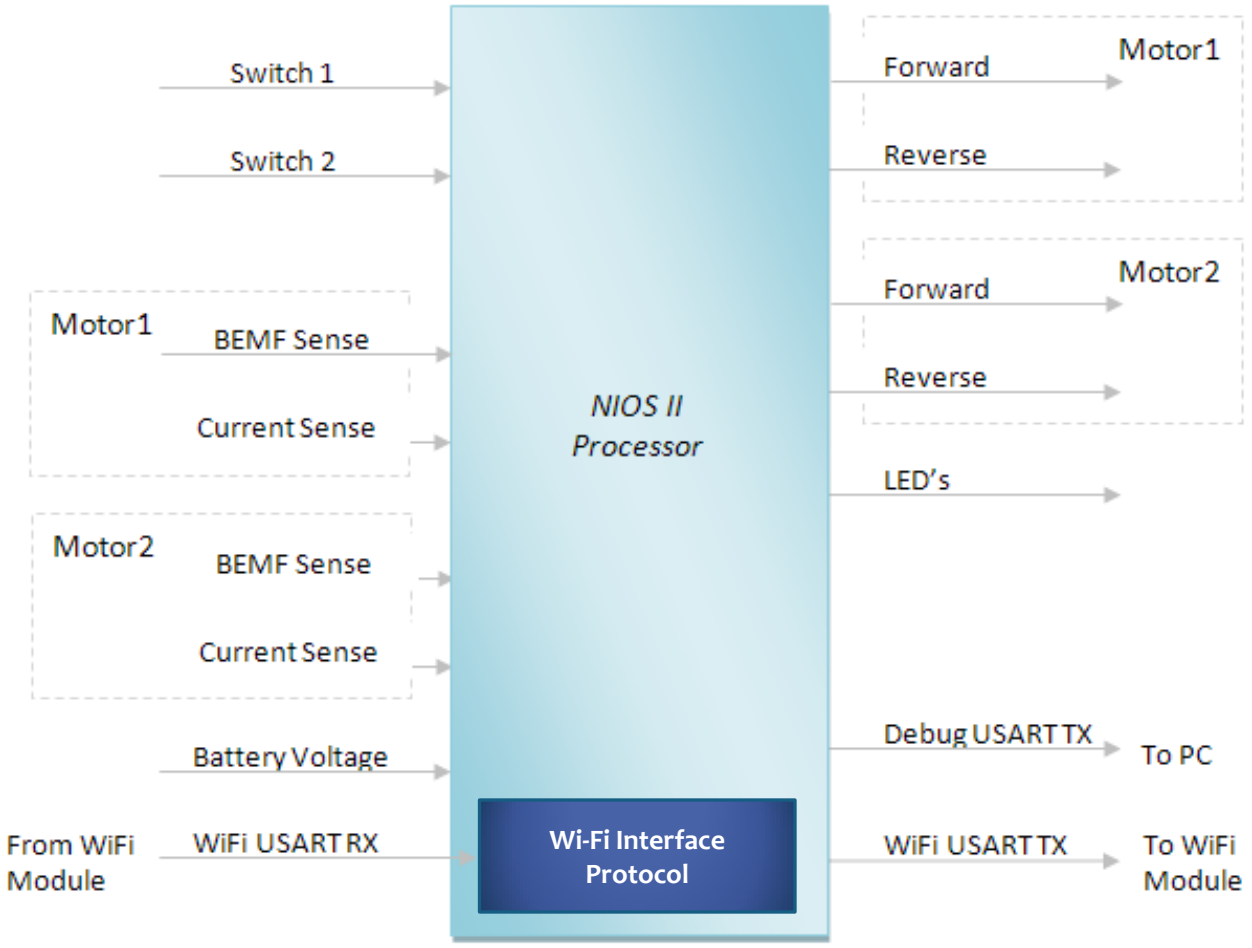
PIO LEDs

Motor Control IP
Controls the Motor Speed according to the PWM Duty Cycle

SDRAM Controller
Controls the 32Mb SDRAM

UART Module sets the UART to run at
Baud rate: 115200 bps
8 Data bits, No Parity, 1 Stop bit.

FPGA Software- NIOS II



Wi-Fi Interface Protocol

In order to make the communication secure the following message structure is used

Message Structure

Message ID||Vehicle id||MAC ID||COMMAND||Data||

* Start of message

* end of message

|| Delimiter

Vehicle ID

AGxxxxxx: Vehicle ID is made using the ip assigned to the Wifi module

eg: ip 192.168.5.5 has Vehicle ID AG005005

So ip 192.168.xxx.xxx has Vehicle ID AGxxxxxx

Message Exchange

If Acknowledgement is not received the Message is resend

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Sensors In Android

The Android platform supports three broad categories of sensors:

Motion sensors

These sensors measure acceleration forces and rotational forces along three axes. This category includes accelerometers, gravity sensors, gyroscopes, and rotational vector sensors.

Environmental sensors

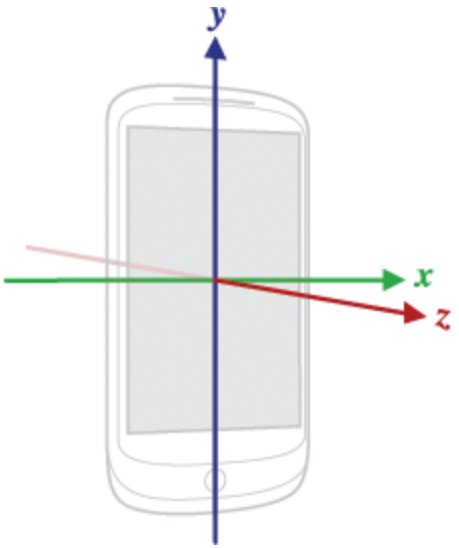
These sensors measure various environmental parameters, such as ambient air temperature and pressure, illumination, and humidity. This category includes barometers, photometers, and thermometers.

Position sensors

These sensors measure the physical position of a device. This category includes orientation sensors and magnetometers.

Android Orientation Sensor

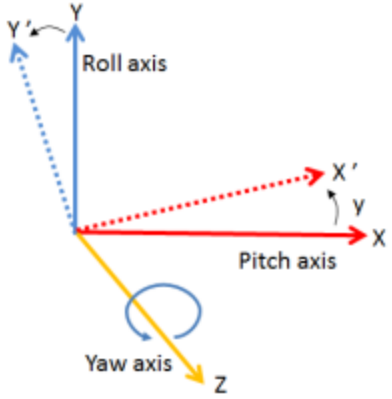
Definition of the coordinate system used by the Sensor Event API.

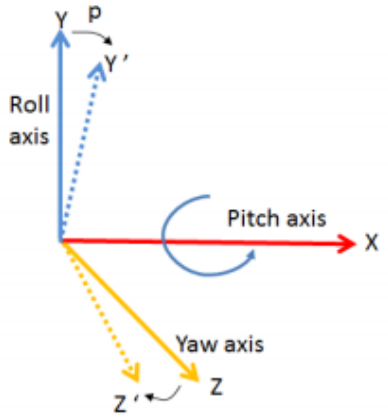


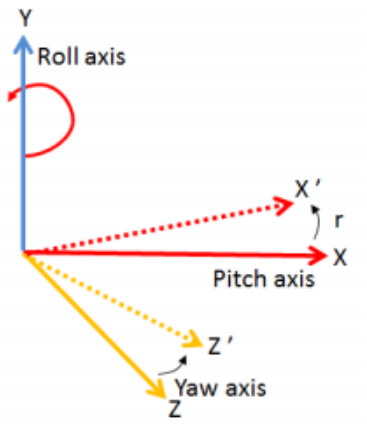
The orientation sensor is software-based and derives its data from the accelerometer and the geomagnetic field sensor.

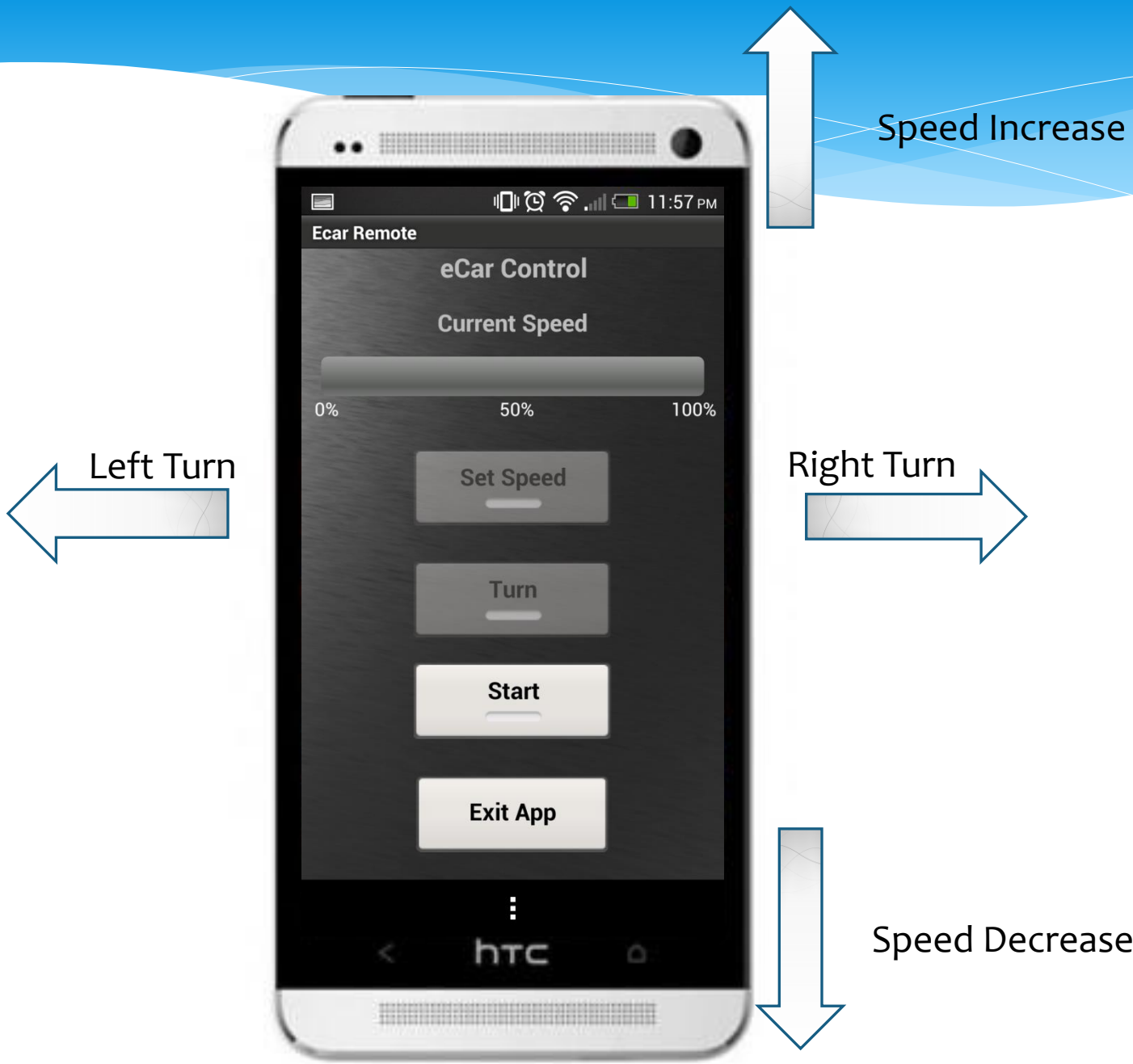
The orientation sensor lets you monitor the position of a device relative to the earth's frame of reference (specifically, magnetic north)

The orientation sensor provides azimuth (yaw), pitch, and roll values

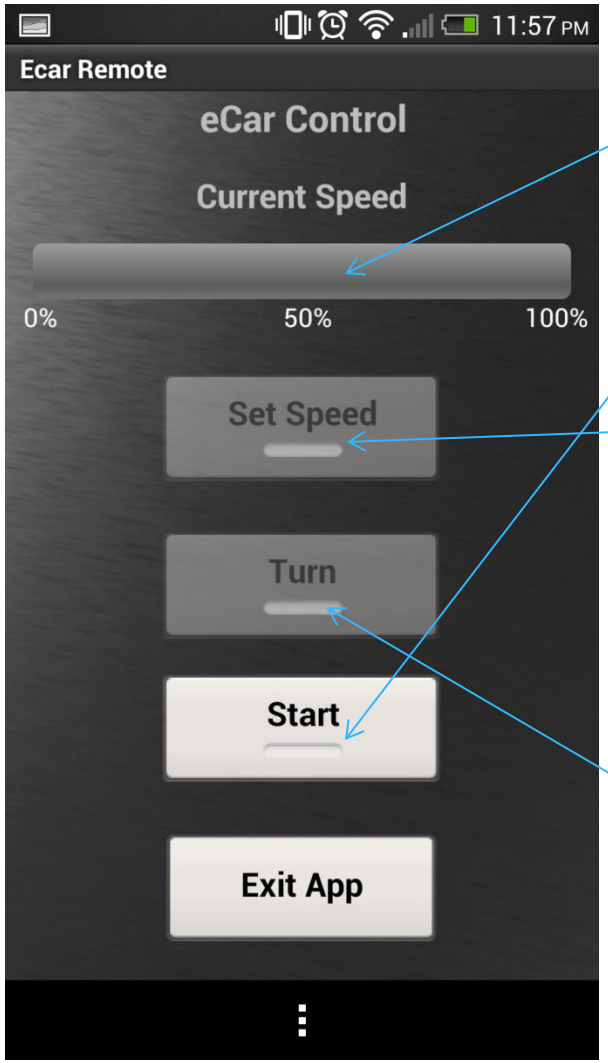







Speed Increase
11:57 PM
Ecar Remote
eCar Control
Current Speed
0%
50%
100%
Left Turn
Set Speed
Right Turn
Turn
Start
Exit App
htc
Speed Decrease

Android Ecar Remote Application



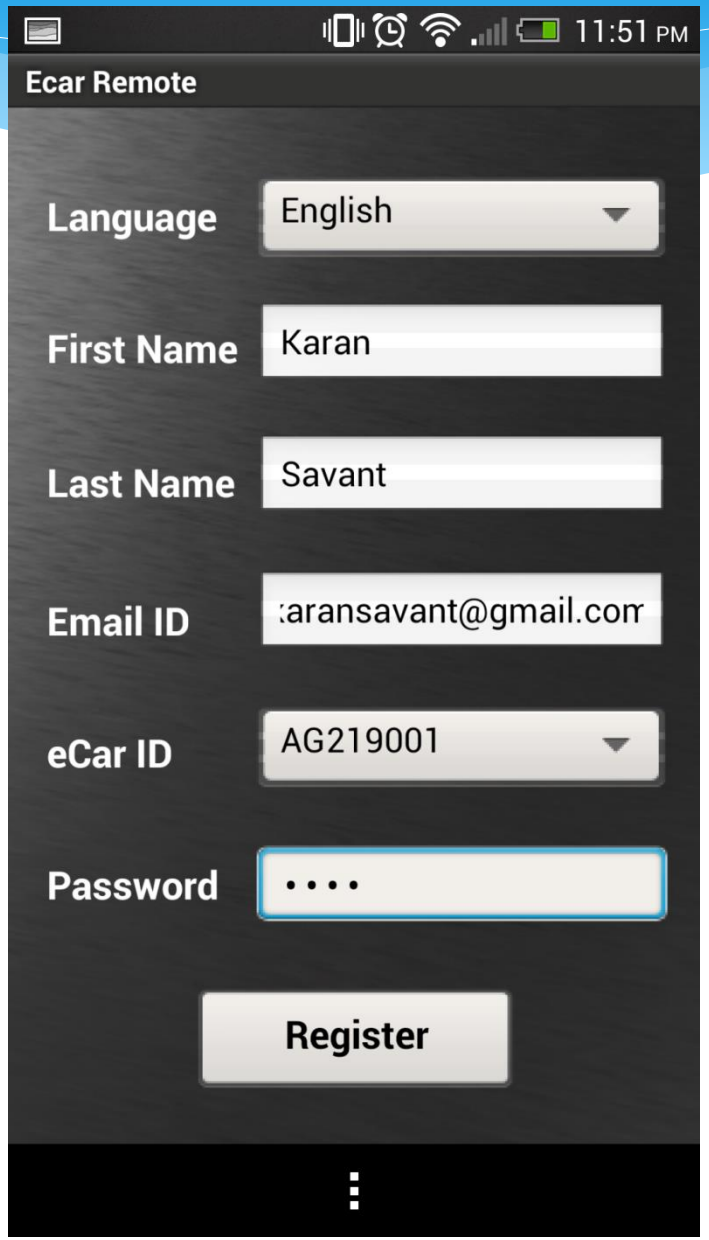
Displays the Current Speed

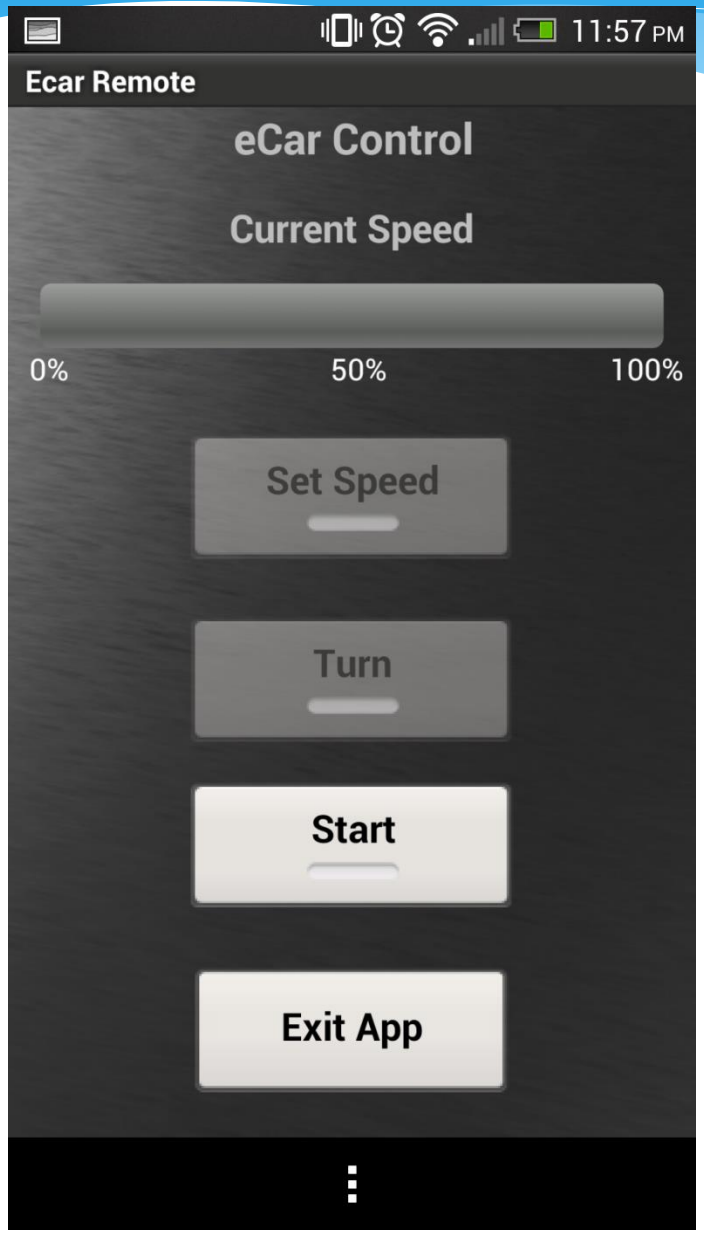
At Start button Press
Record the Device Coordinates as the Reference Coordinates

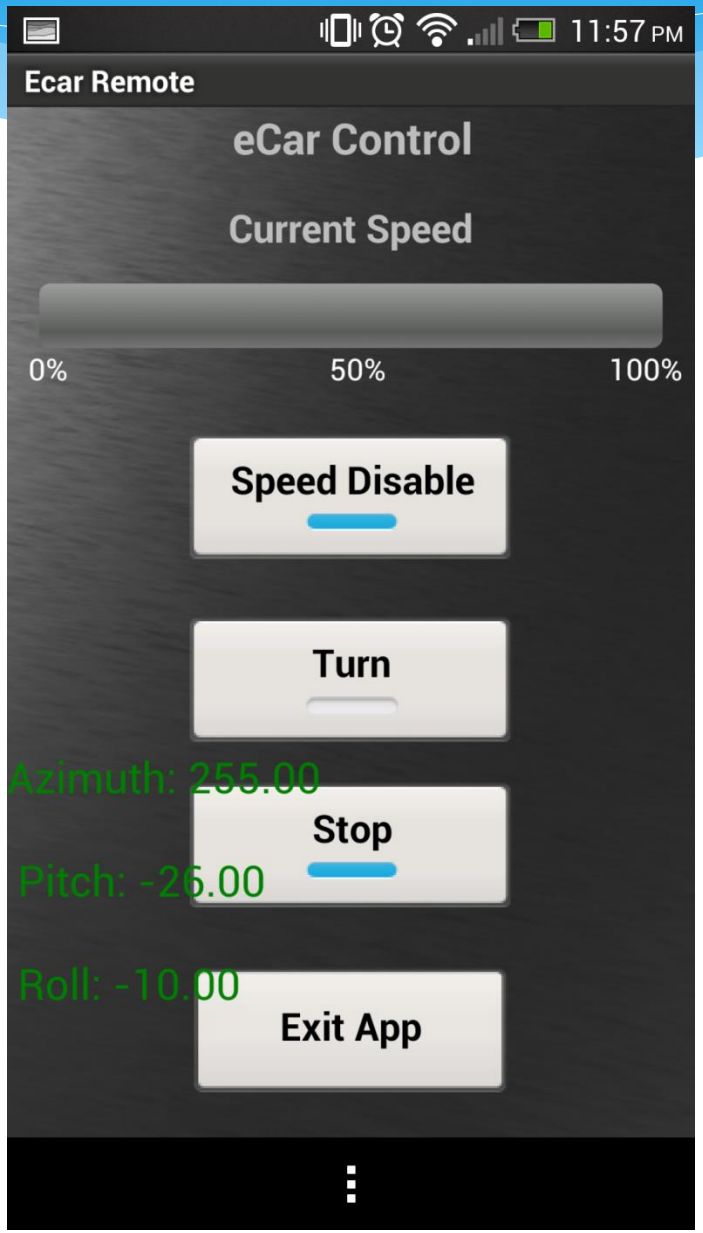
At Set Speed button Press
Record the Pitch Value
Keep Calculating the Difference:
Pitch = Reference Pitch – Current Pitch
PWM Duty= Constant * Pitch
PWM is used to control the Ecar Speed

At Turn button Press
Record the Roll Value
Keep Calculating the Difference:
Turn = Reference Roll – Current Roll


11:52 PM
Ecar Remote
searching device


11:51 PM
Ecar Remote
Language
English
First Name
Karan
Last Name
Savant
Email ID
:aransavant@gmail.com
eCar ID
AG219001
Password
Register


11:57 PM
Ecar Remote
eCar Control
Current Speed
0%
50%
100%
Set Speed
Turn
Start
Exit App


11:57 PM
Ecar Remote
eCar Control
Current Speed
0%
50%
100%
Speed Disable
Turn
Azimuth: 255.00
Stop
Pitch: -26.00
Roll: -10.00
Exit App

Andriod Programming Links

Here is the link i found which gives a step by step tutorial for setting up the android tools.
If you do not have Eclipse IDE or JRE(Java Runtime Environment) installed please follow this tutorial first.
http://www.vogella.com/articles/Eclipse/article.html

Then you have to install the ADT. The follwing link describes how to install and configure
the ADT(Android Development tools). Please only follow the steps mentioned under "Updating an existing Eclipse installation"
http://www.vogella.com/articles/AndroidInstallation/article.html

There are also tutorials for android development and common problems you can find on this link.
http://www.vogella.com/android.html