PROJECT AND IMPLEMENTATION OF A COLLISION AVOIDANCE SYSTEM FOR URBAN BICYCLES USING A DOPPLER RADAR.

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AGENDA

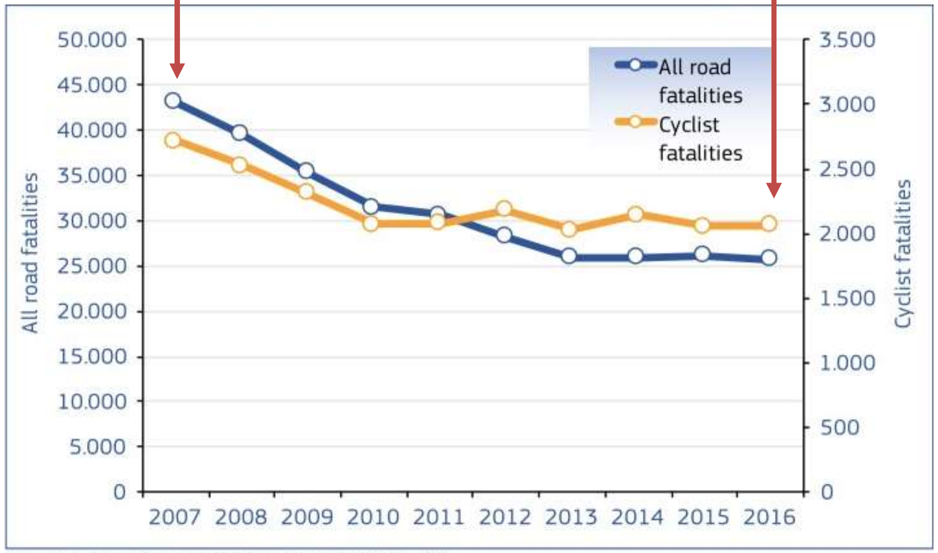
- Introduction
- Project goal
- Method
- Hardware Architectures
- Algorithm Methodology
- Results
- Demonstration
- Conclusion

INTRODUCTION

- **Growing population requires smarter dislocation**
- **Bicycle is the solution**
- **Number of accidents tends to increase**

- **Total fatalities ≈ 43.000**
- **Cyclist fatalities ≈ 2.700**
- **Proportion: 6%**

- **Total fatalities ≈ 25.000**
- **Cyclist fatalities ≈ 2.100**
- **Proportion: 8,4%**



Source: CARE database, data available in May 2018

INTRODUCTION

- **Main causes of accident involving bicycles:**

Table 10: Ten most frequent links between causes – bicycle riders

Links between causes	Frequency
Faulty diagnosis - Information failure (driver/environment or driver/vehicle)	13
Observation missed - Faulty diagnosis	6
Observation missed - Inadequate plan	6
Observation missed - Temporary obstruction to view	5
Observation missed - Distraction	4
Observation missed - Permanent obstruction to view	4
Faulty diagnosis - Communication failure	4
Inadequate plan - Insufficient knowledge	4
Observation missed - Inattention	3
Information failure (driver/environment or driver/vehicle) - Inadequate information design	3
Others	22
Total	**74**

Source: SafetyNet Accident Causation Database 2005 to 2008 / EC
Date of query: 2010

- In a **total of 74** accidents, **28** are caused by missed observation, representing **37%** of the total causes.

PROJECT GOAL

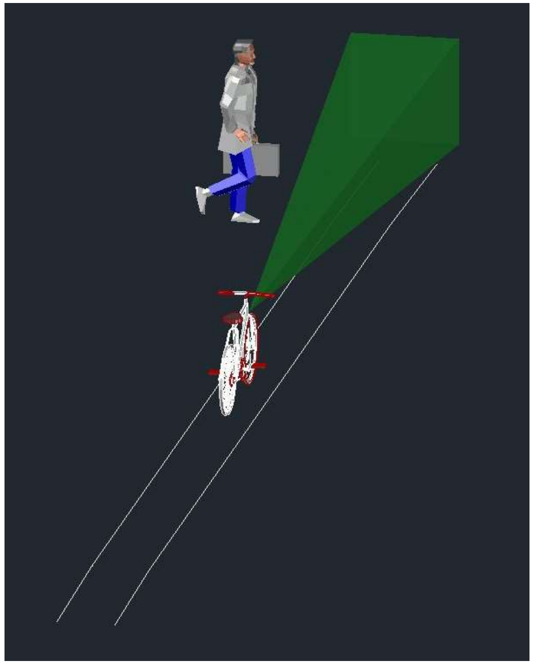
Motivation:

- Implement collision avoidance system (CAS)
- Increase general situational awareness of the user
- Decrease the number of incidents caused by weather, light conditions or distractions.

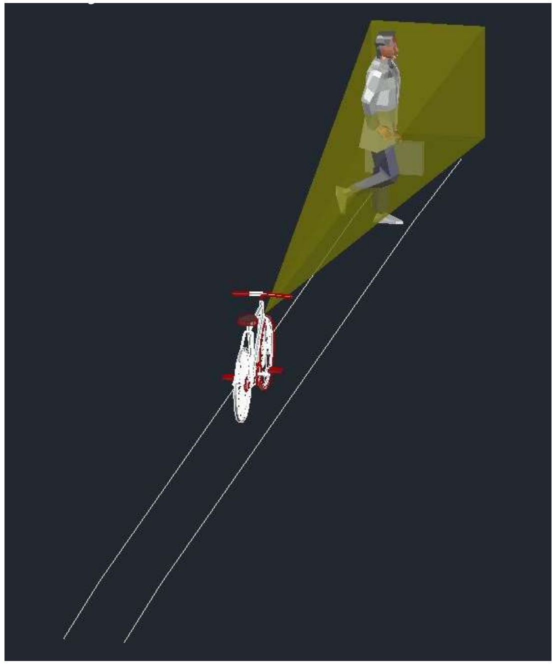
PROJECT GOAL

Proposed idea:

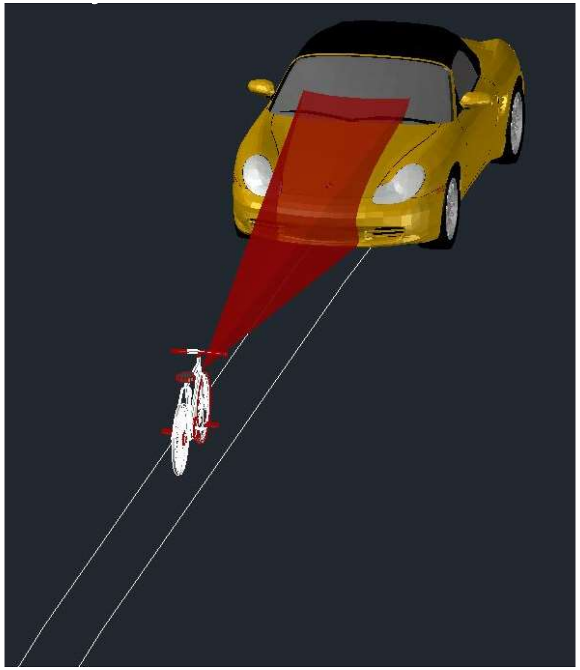
- Monitor the "future point" of the bicycle



- Detect and alert about a static obstacle



- Detect and alert about an incoming obstacle



PROJECT GOAL

Why radar?

Robustness

- Don't depend on light condition
- Maintains operation through harsh weather conditions

Permeability

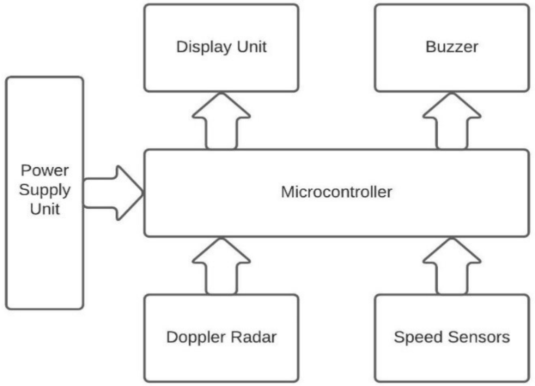
- Electromagnetic waves
- Antenna design flexibility
- Long range detection of moving objects

Implementation

- Don’t require high-resolution camera image computation
- 24GHz ISM operation

METHOD

Architecture of the proposed system:

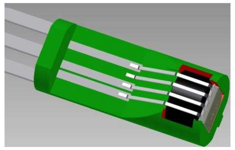


- Average consumption of 2,4 Watts
- 12 hours of autonomy

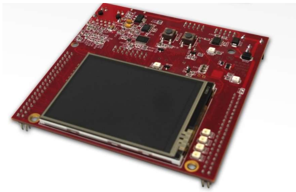
- **Power Supply Unit:**

- **Doppler radar:**

- **Speed sensor**



- **Development board:**
  (Microcontroller, Display, Buzzer)



HARDWARE ARCHITECTURE

Microcontroller: KIT_A2G_TC397_5V_TFT

AURIX TC397A 2G microcontroller

- **6 cores** running at **300MHz**
- CAN, FlexRay, ASCLIN, QSPI, I2C
- Safe DMA

Summary of Features

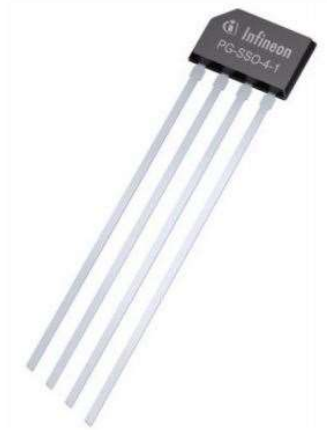
- LCD XGA Display 320x240
- USB to **UART bridge**
- USB miniWiggler JDS for **easy debugging**
- Acoustic beeper
- Wide variety of connectors

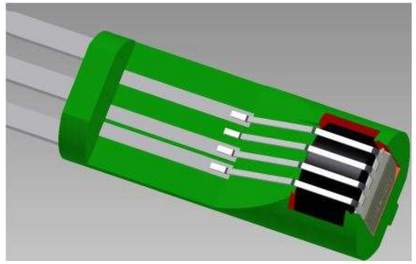
HARDWARE ARCHITECTURE

Speed Sensor

TLE4922

- Mono-cell **Hall sensor**
- Suited to **detect motion and position**
- Able to sense very small magnetic signals
- **ADC** converts the analog in a digital one
- **Two sensors** attached to opposite sides of the wheel





HARDWARE ARCHITECTURE

Doppler radar:

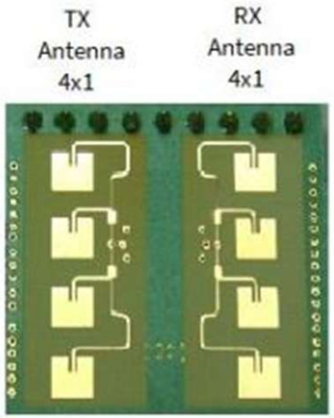
Sense2GoL

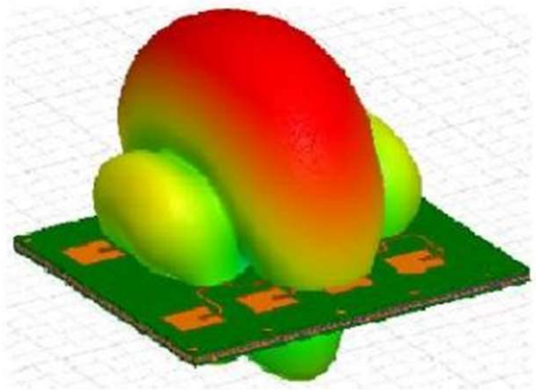
- BGT24LTR11 **Doppler radar**
- **24 GHz** ISM band
- Measurement of speed of single target **up to 15 m**
- Integrated patch antennas
- Integrated processor
- On-board debugger

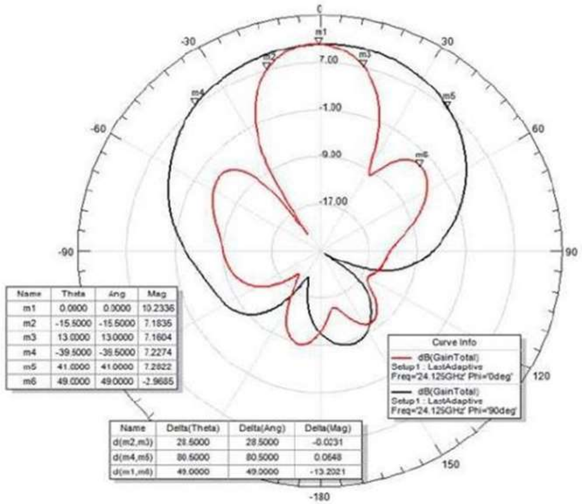
HARDWARE ARCHITECTURE

Patch antenna:

- **Integratted 2,5cm x 2,5cm antennas**
- **No directed radiation pattern**



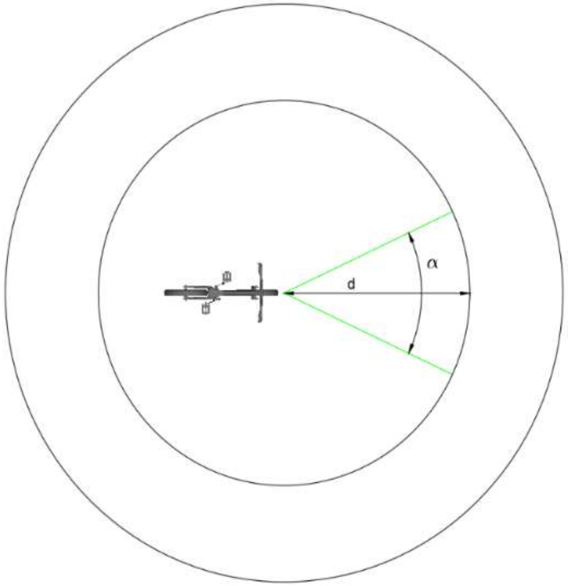


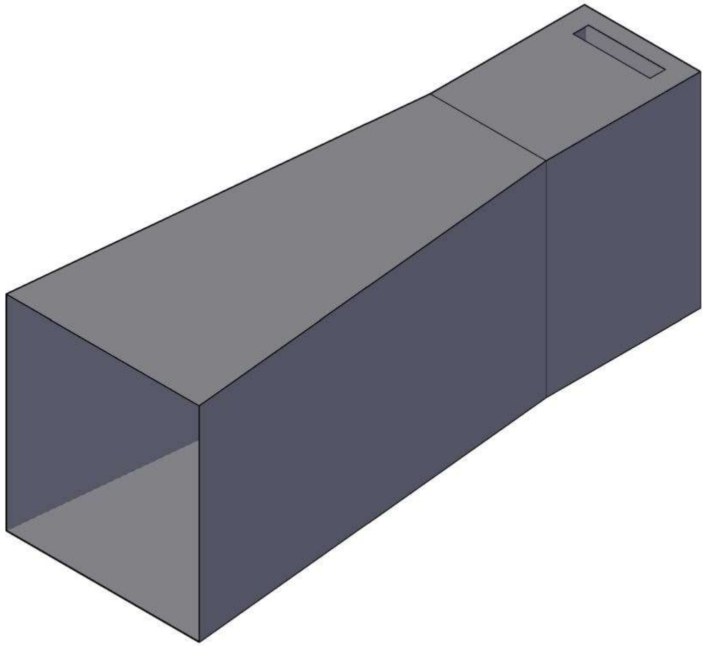


HARDWARE ARCHITECTURE

Antenna

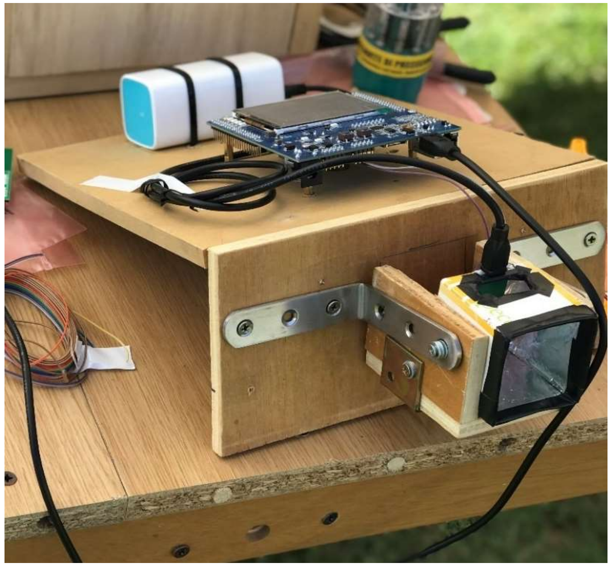
- Redirect electromagnetic waves
- Limit angle of action of the doppler radar
- Aluminum interior

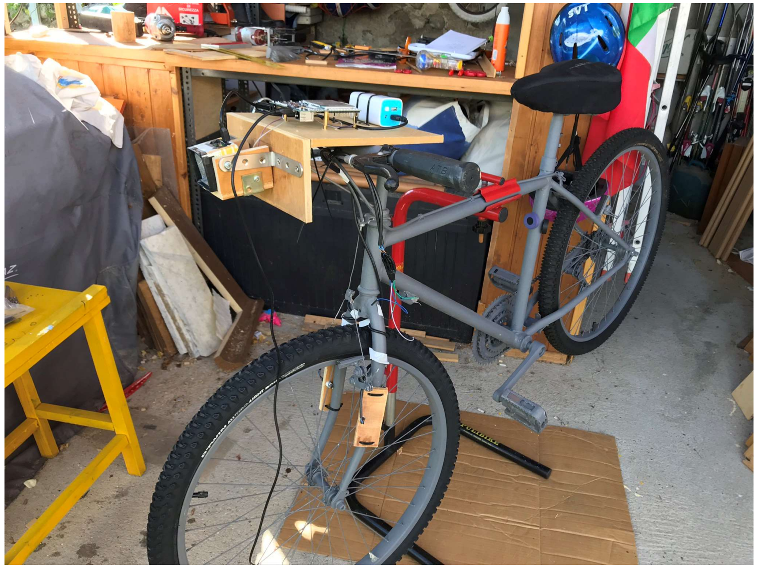




HARDWARE ARCHITECTURE

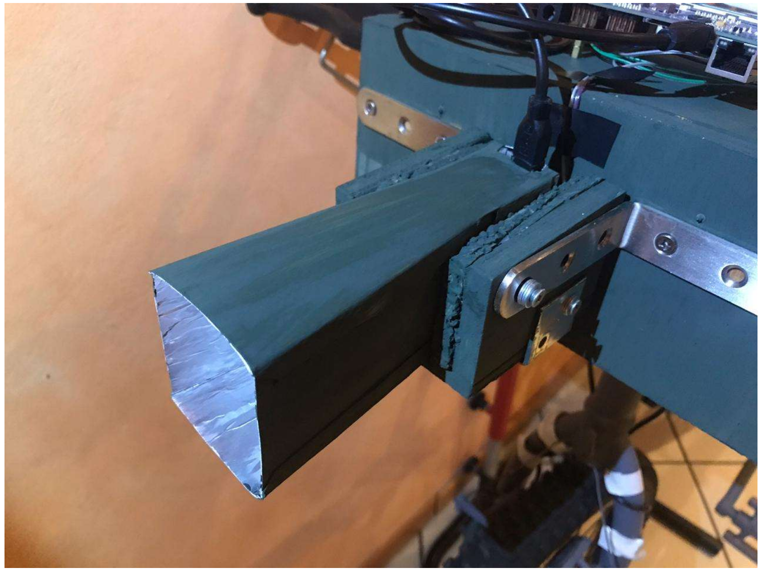
Final prototype:





HARDWARE ARCHITECTURE

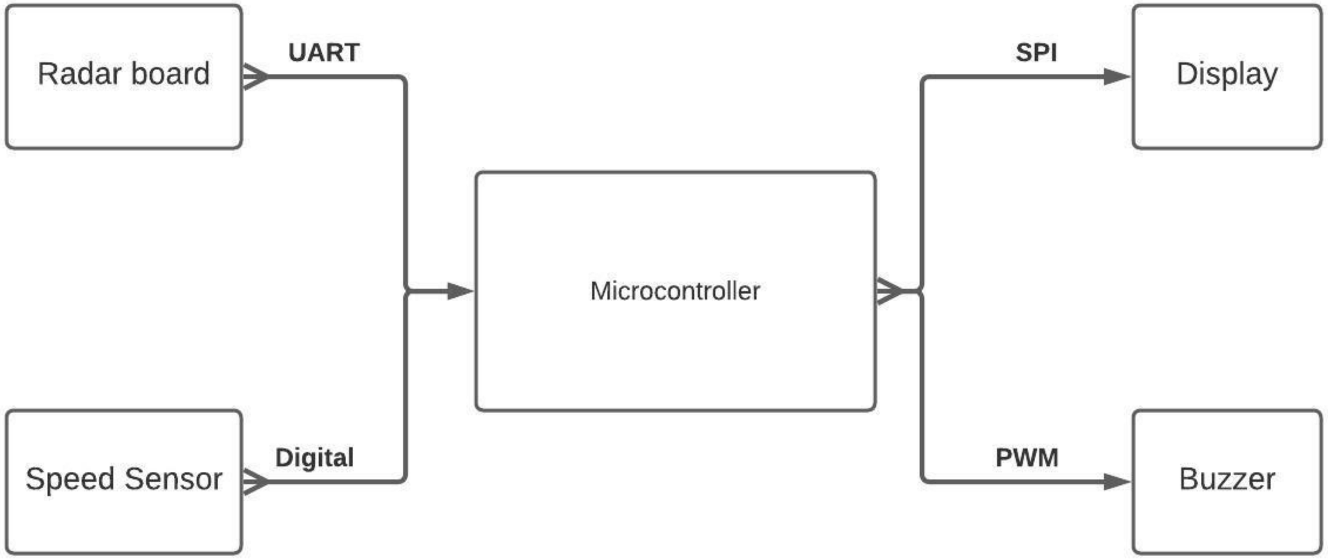
Final prototype:



ALGORITHM METHODOLOGY

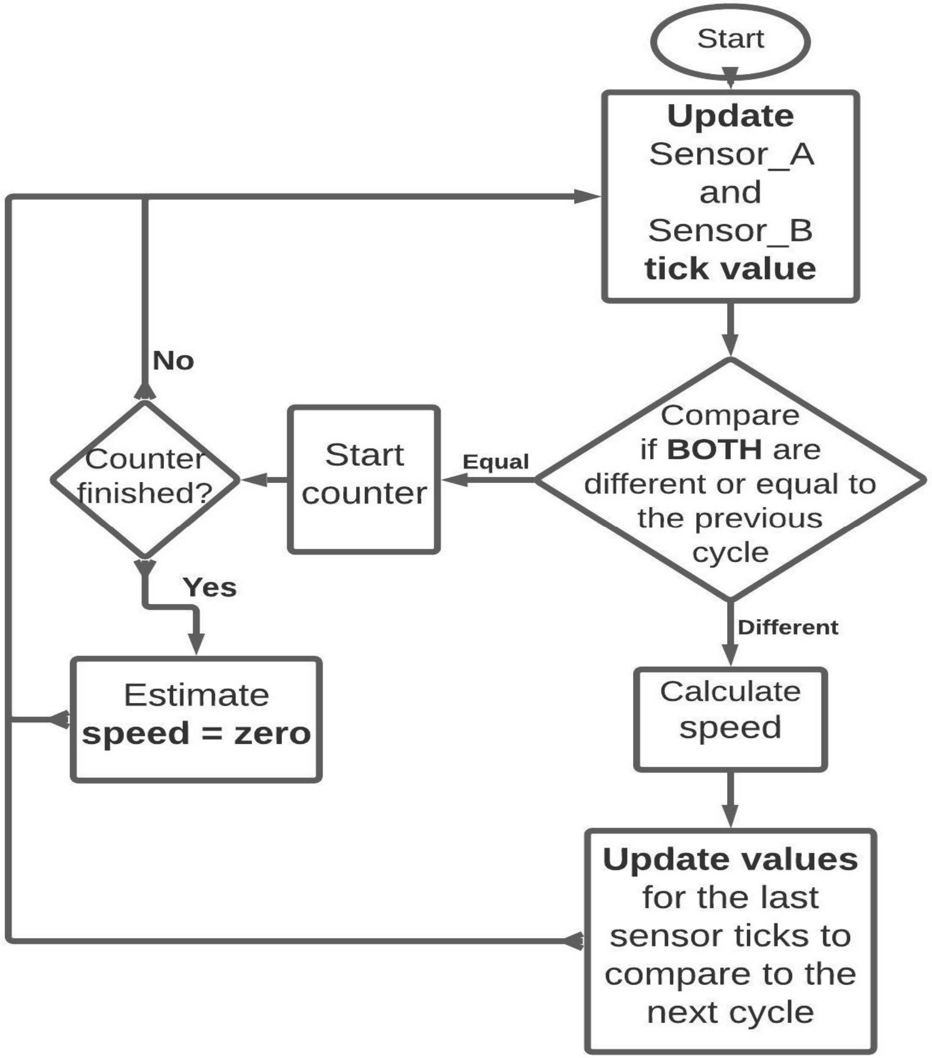
Overall:

- **Programmed using C-code**
- **3 cores used to process the information**
- **3 cores in sleep mode**



ALGORITHM METHODOLOGY

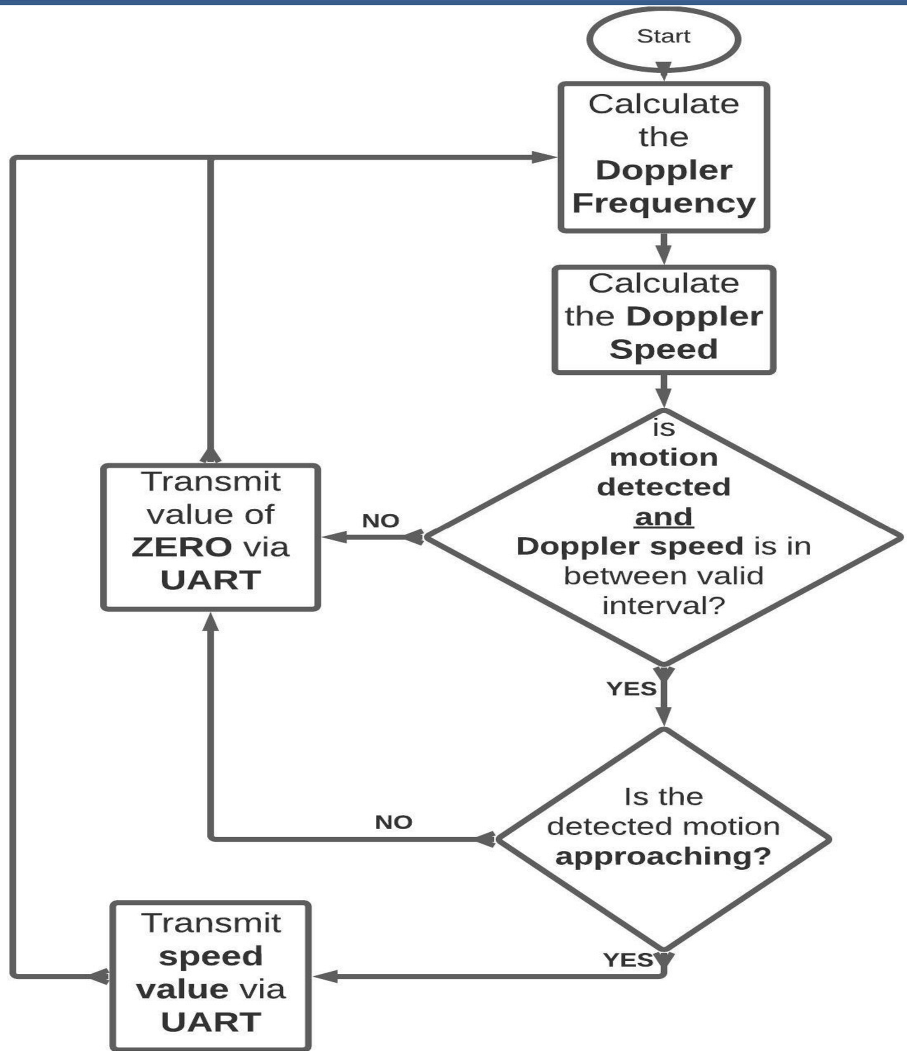
Speed Sensor:



- **Collect data** from sensors
- Check If **both** have new data (to avoid glitch)
- Calculate speed

ALGORITHM METHODOLOGY

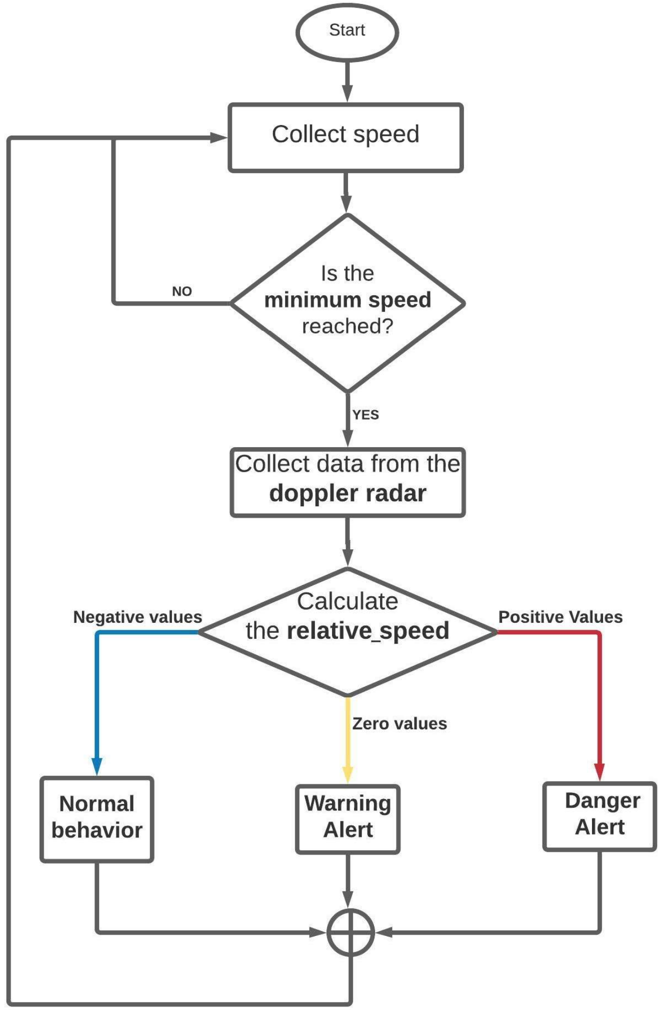
Radar Sensor:



- Calculate the Doppler speed
- Check if the speed consists in **an approaching**
- Send speed via UART

ALGORITHM METHODOLOGY

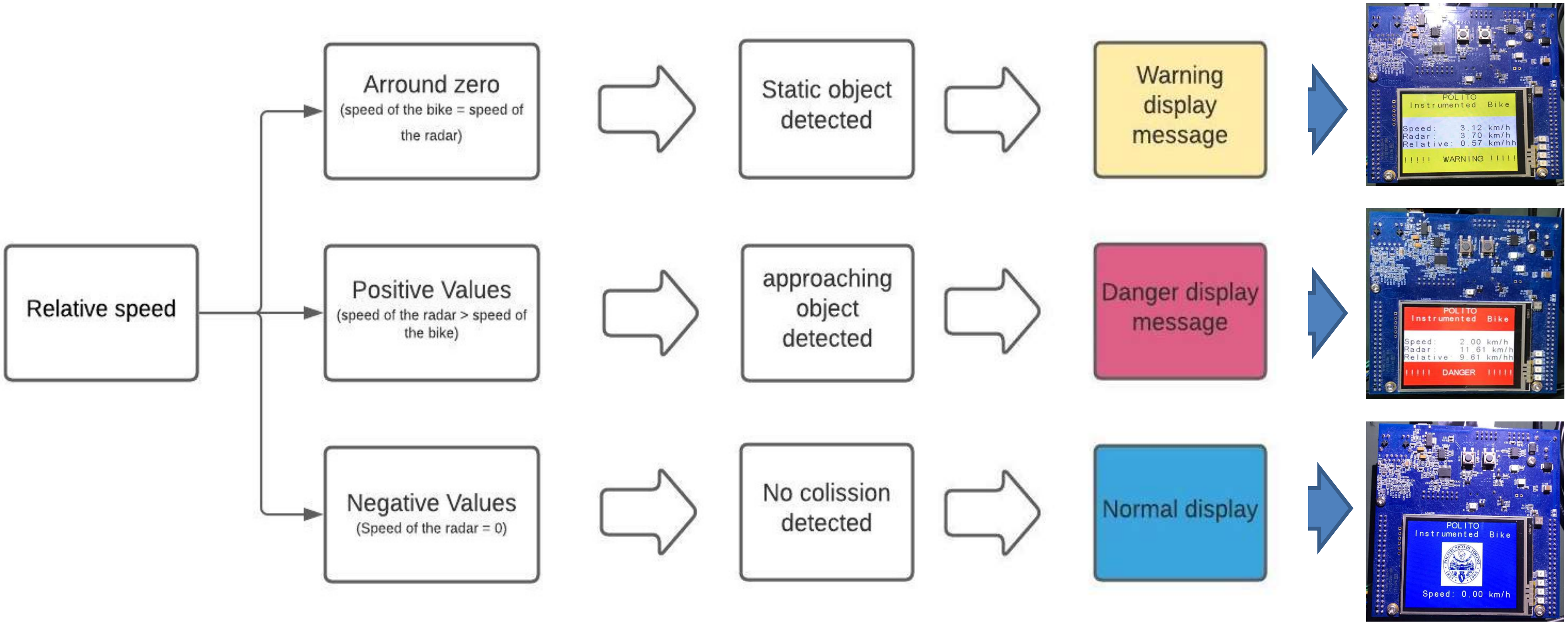
Collision Avoidance System (CAS):



- Collect data from Speed Sensor
- **If trigger speed is reached**, collet data from radar
- Calculate relative speed
- Relative speed = Speed of radar – Speed of bicycle
- Estimate **possible collision**

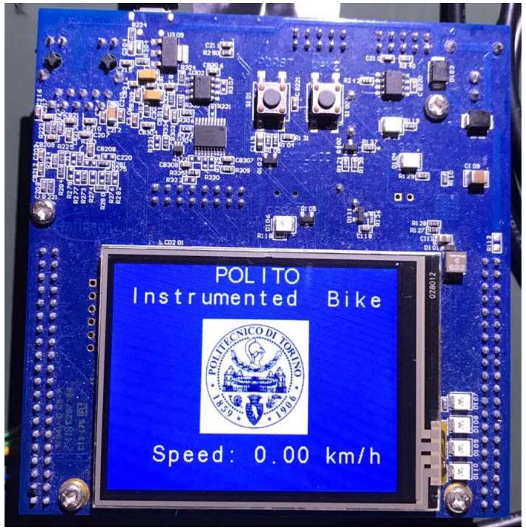
ALGORITHM METHODOLOGY

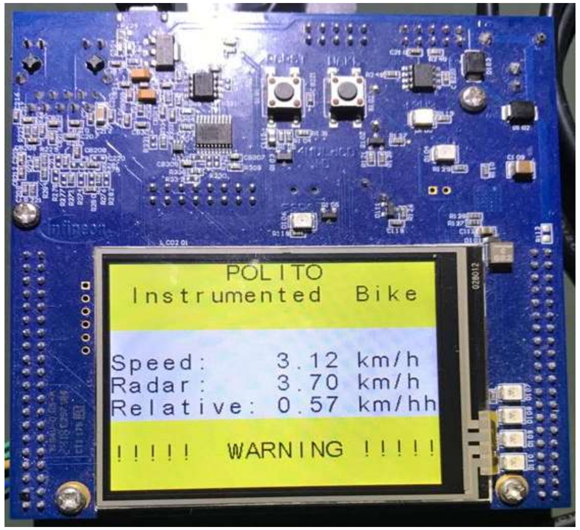
Display Algorithm:



RESULTS

Experimental results:





Thank you for your attention.