Ultrasonic Sensor Modelling for Mobile Robots

About me

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Mobile Roboting

We can define mobile robot as an automatic machine that is capable of movement in any given environment.

- Classification
  - The environment in which they can travel
  - The device they use to move
- Navigation

Manually teleoperated, line-following car, autonomosouly randomized robot and autonomosouly guided robot .

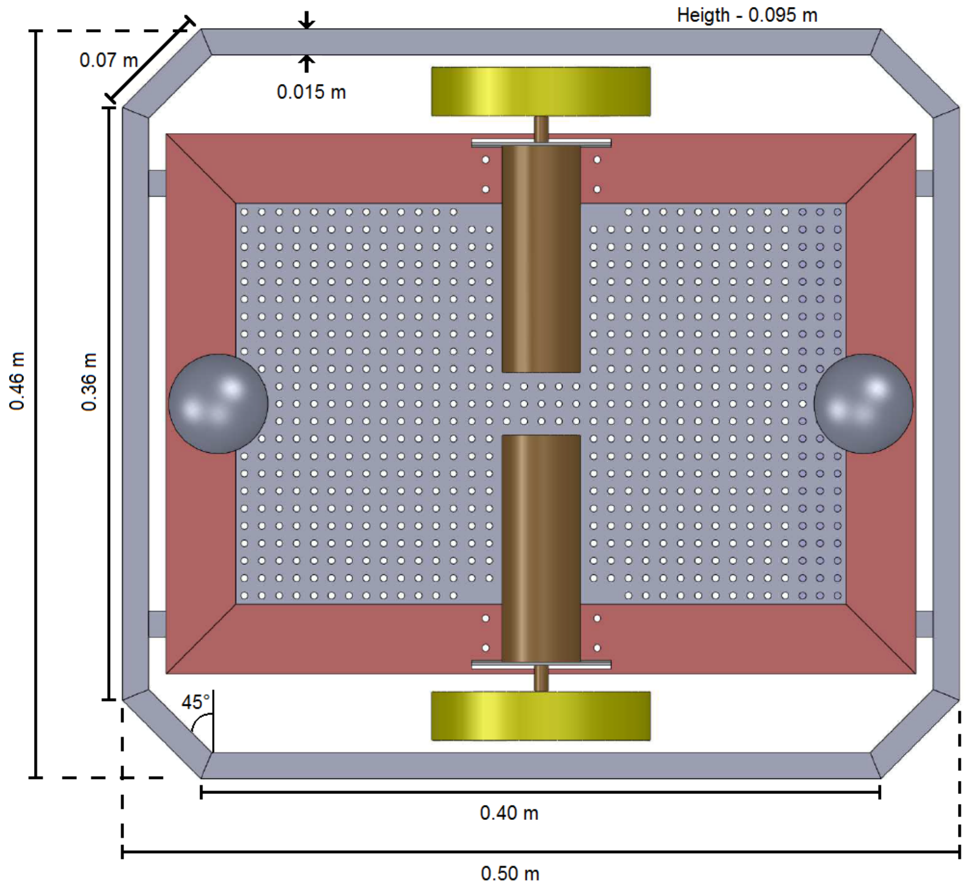
The Task

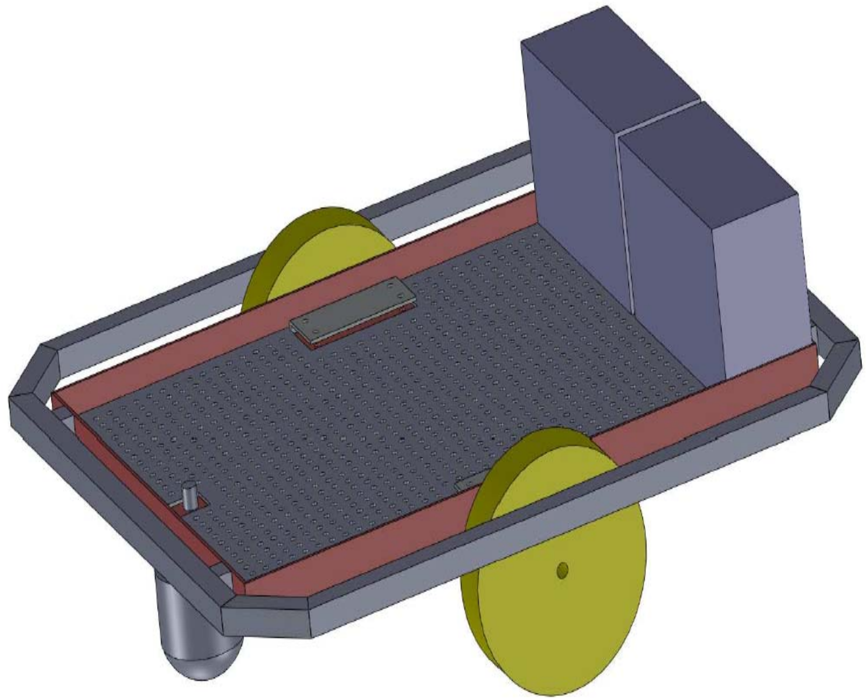
- First Semester
  - define the system and the disposable devices
  - mathematical models for general ultrasonic sensor
  - mathematical model for the given ultrasonic sensor
  - propose dislocation of the sensors around the Mobile Robot

- Second Semester
  - developing an algorithm for determining the position of the obstacle around the MR
  - elaborate a scanning algorithm, for the given PIC μP, which will sequentially scanning the US sensors and collecting the dates from them.

Devices

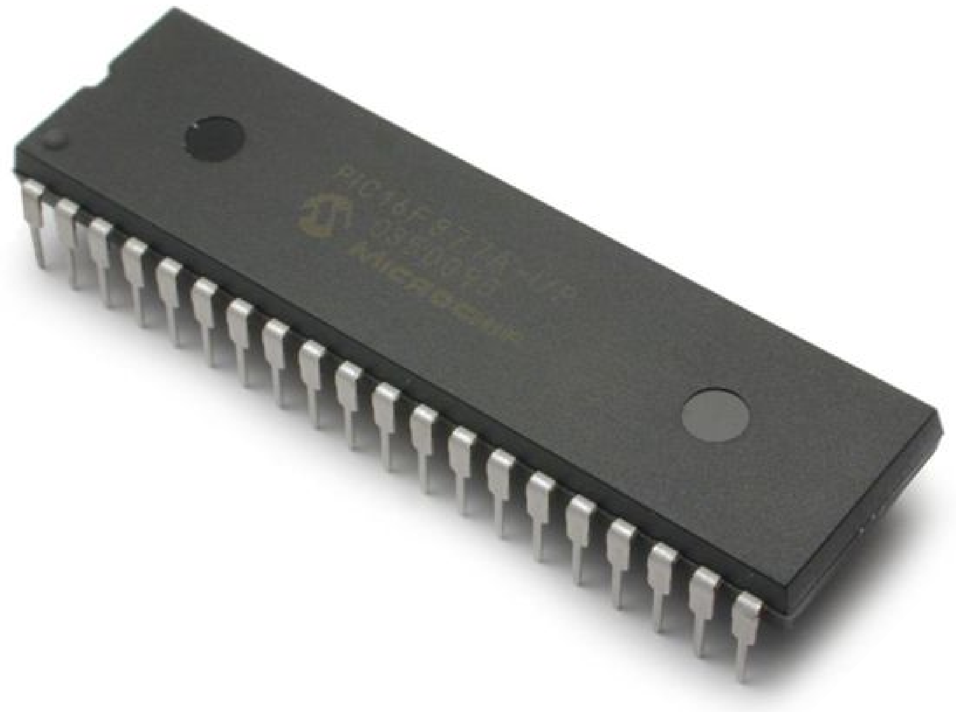
- Mobile Robot (MobiRobi)





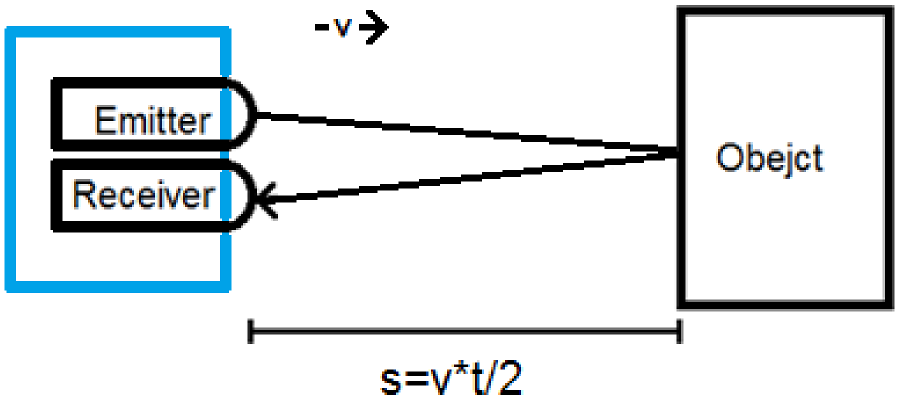
Devices

- PIC - Peripheral Interface Controller



Ultrasonic Sensor Modelling

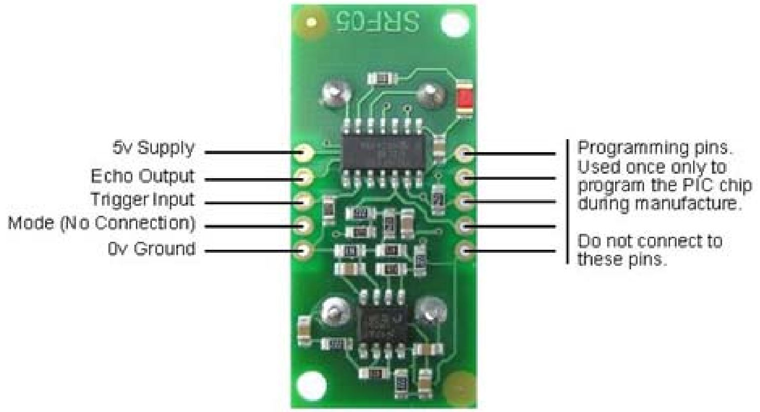
- Speed of sound
  - In general: $c = \sqrt{\frac{K}{\rho}}$.
  - In dry air: $c = 331.3\sqrt{1 + \frac{\vartheta}{273.15}}$
- Object Distance



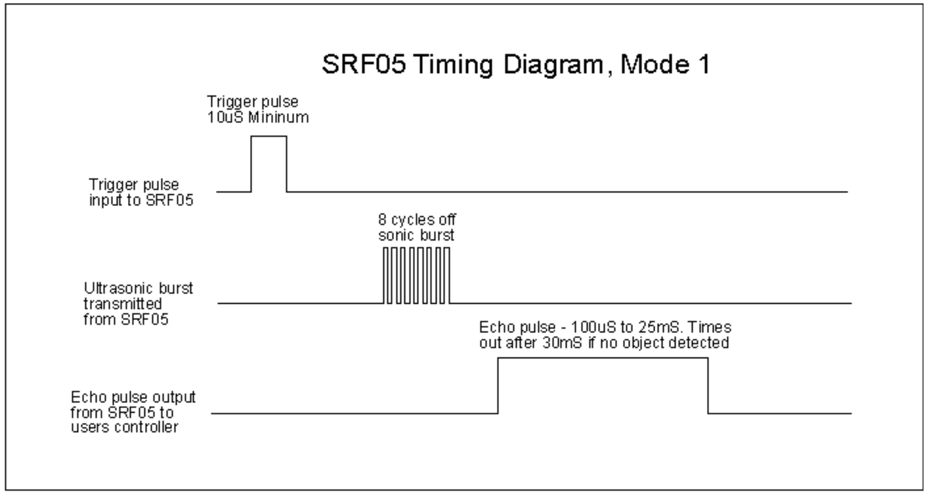
SFR05

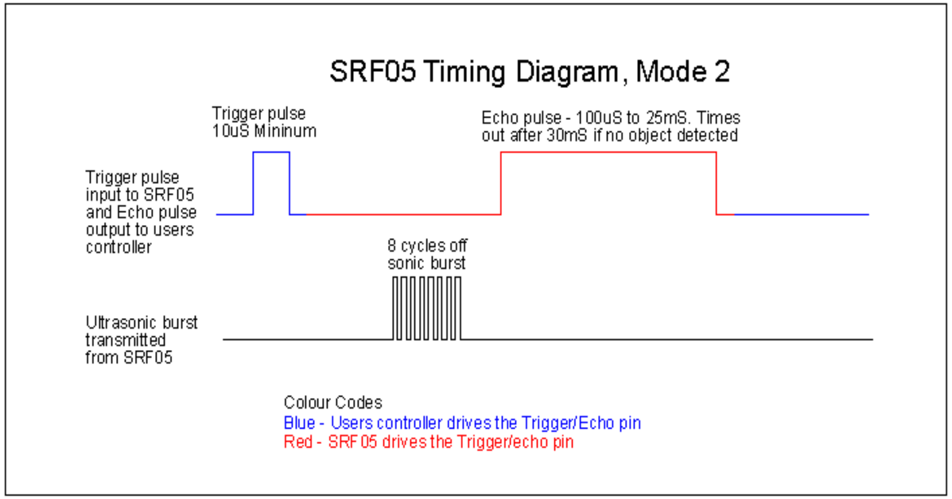
- Technical data:

Parameter	Value	Unit
Dimensions	43 x 20 x 17	mm
Operating voltage	5	Vcc
Current consumption	4	mA
Working frequency	40	KHz
Maximum range	4000	mm
Minimum range	10	mm
Minimum trigger pulse's time	10	µs
Minimum waiting time between to samples	20	ms



- Operation modes





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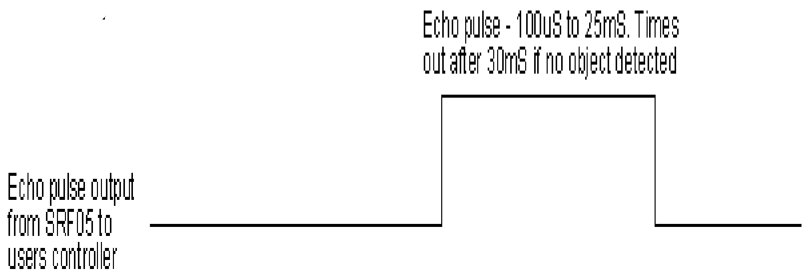
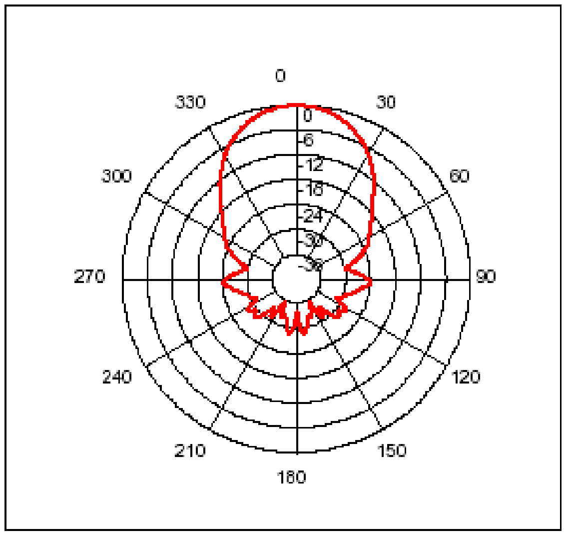
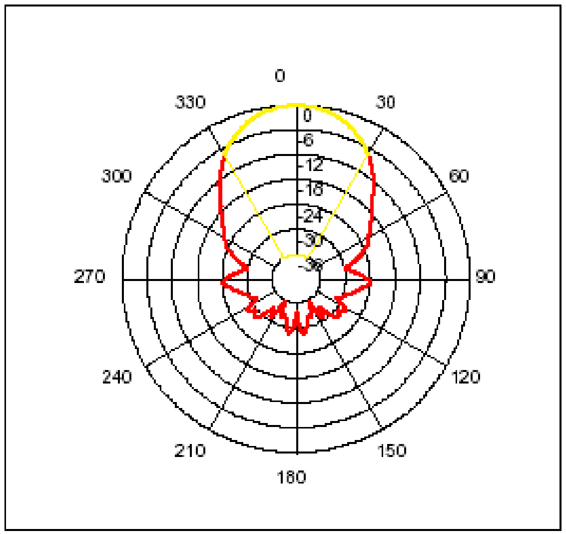
- Calculating Distance



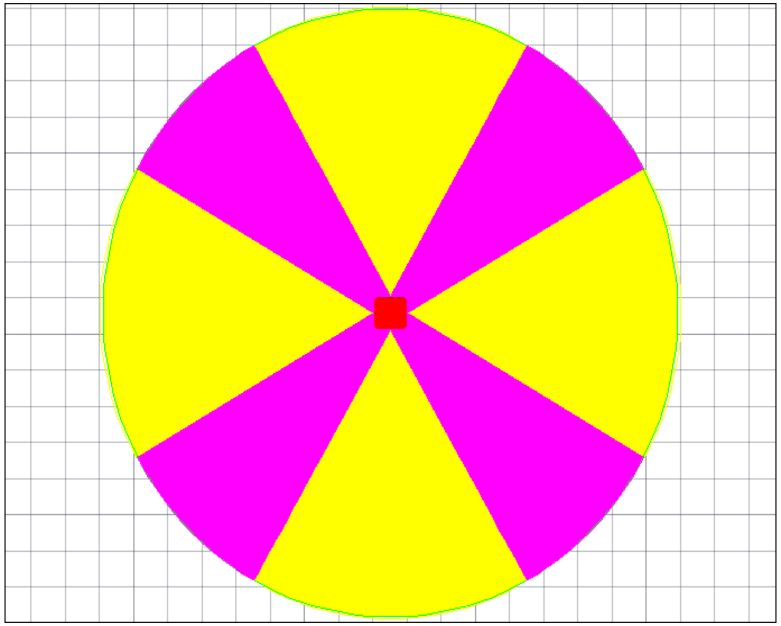
- $s\ (cm) = echo\ pulse\ (\mu S)\ /58$
- Can be triggered in 50 mS intervals

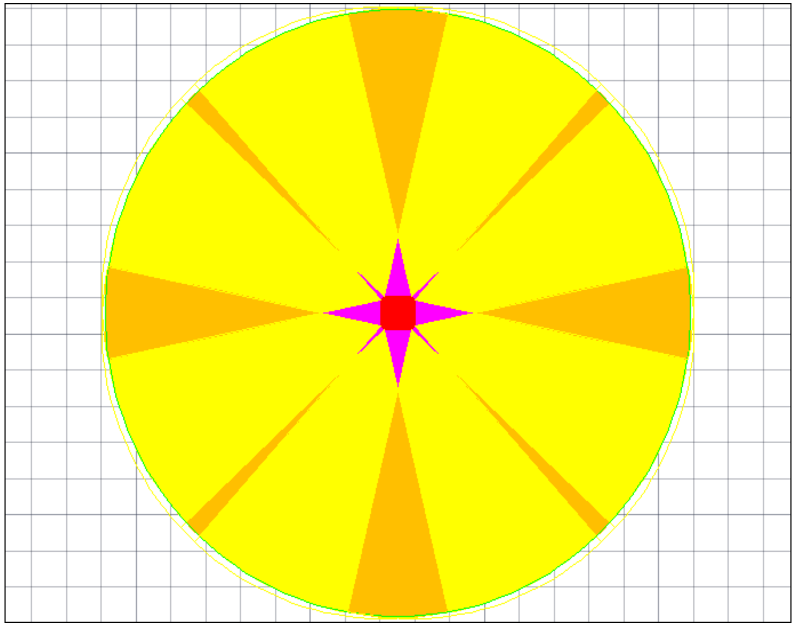
- Beam pattern





Sensor Displacement





$A_{circle} = \pi * r^2 = 5.5418*10^5 cm^2$

$A_{blind} = 221719.1619 cm^2$

$\%_{blind} = (A_{blind} / A_{circle})*100 = 40\%$

$D_{higher} = 400$ cm

$A_{circle} = \pi * r^2 = 5.5418*10^5 cm^2$

$A_{blind} = 7631.8816 cm^2$

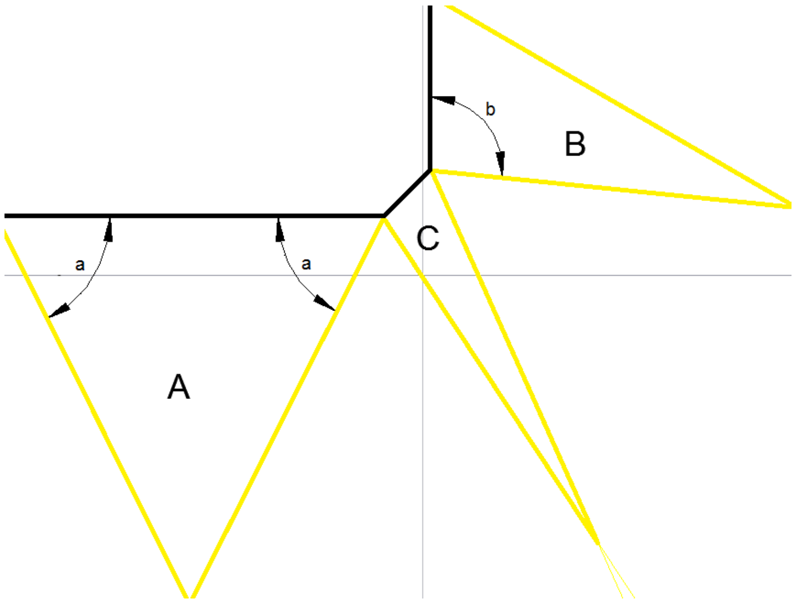
$\%_{blind} = (A_{blind} / A_{circle})*100 = 1.38\%$

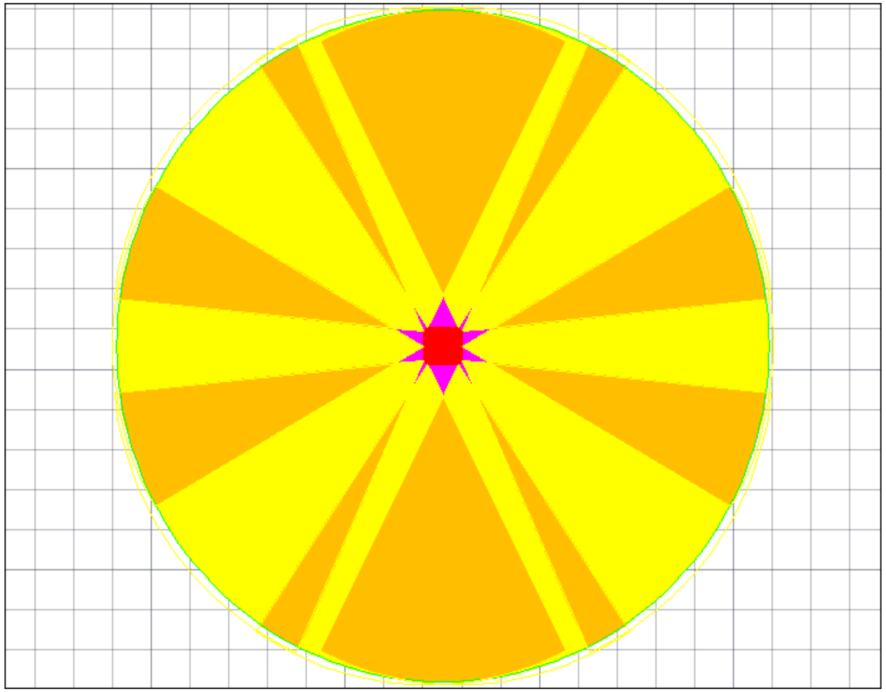
$A_{superposition} = 101099.5284 cm^2$

$\%_{superposition} = (A_{superposition} / A_{circle})*100 = 18.24\%$

$D_{higher} = 85.79$ cm

Sensor Displacement





$$A = 648 * \tan(\alpha) + \frac{800\sqrt{3}}{\left(1+\frac{\sqrt{3}}{\tan(\beta)}\right)} + \frac{98}{\frac{1}{\tan(165-\alpha)}+\frac{1}{\tan(165-\beta)}}$$

A_{blind} = 3522.0606 cm^2

$\%_{blind}$ = (A_{blind} / A_{circle})*100 = 0.64%

$A_{superposition}$ = 262956.0573 cm^2

$\%_{superposition}$ = ($A_{superposition}$ / A_{circle})*100 = 47.45%

D_{higher} = 41.33 cm

References

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