Real Time Obstacle Avoidance

for

racecar_eklavya

=> Our car is equipped with all the required Hardwares, now the need of an algorithm is needed to avoid the obstacles.

Path Planning
- Global-Path planning
  - Needs Information of GIS (geographic info system)
- Local-Path Planning
  - Needs Info of relative position and obstalle avoidance
    - Main-Subject of racecar SRA

=> Now, In order to avoid collision the robot not only needs to detect an obstacle but also to recalculate the detouring path and to steer itself towards a safe and efficient path in real time.

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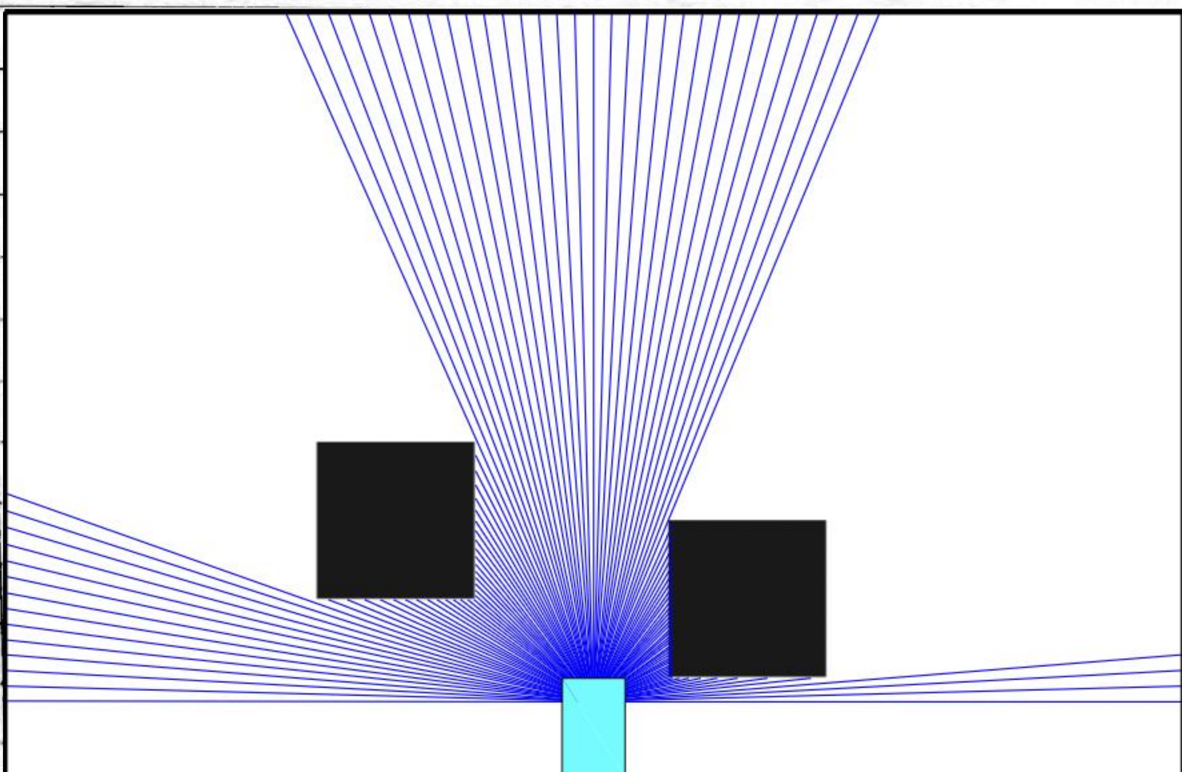
★ Concept of Artificial Potential Method

=> In this method two different potential feilds attractive and repulsive are summed up and combined to give a vector. In which following the vector the obstacle is avoided by repulsive feild and the goal is acheived by attractive feild vector.

★ Related Work

=> For Path-following we need a range/lidar sensor.
→ In the figure the infrared laser beams used to measure the distance.



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→ the data from laser range finder are distances corresponding to predefined angles in the sensor.

★ Conventional Potential Field method.

=> The Attractive field attract robot towards goal
=> whereas, the repulsive field repels the obstacles from the racecar.

$$f_{Total} = f_{att} + f_{rep},$$

$$f_{att} = K_{att} \frac{r_{goal} - r}{|r_{goal} - r|}$$

$$f_{rep} = \begin{cases} -K_{rep} \sum_{i=1}^{n} \left(\frac{1}{d_i} - \frac{1}{d_{max}}\right) s_i \\ 0 \quad , \text{ if } d_i > d_{max} \end{cases}$$

whereas $s_i = \frac{r - O_i}{|r - O_i|}$

where, r_{goal} → Position vector of goal
r → Position vector of robot
O_i → Position vector of obstacle

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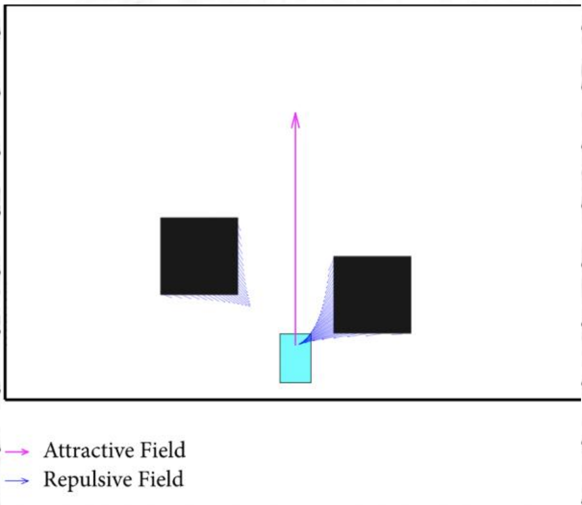
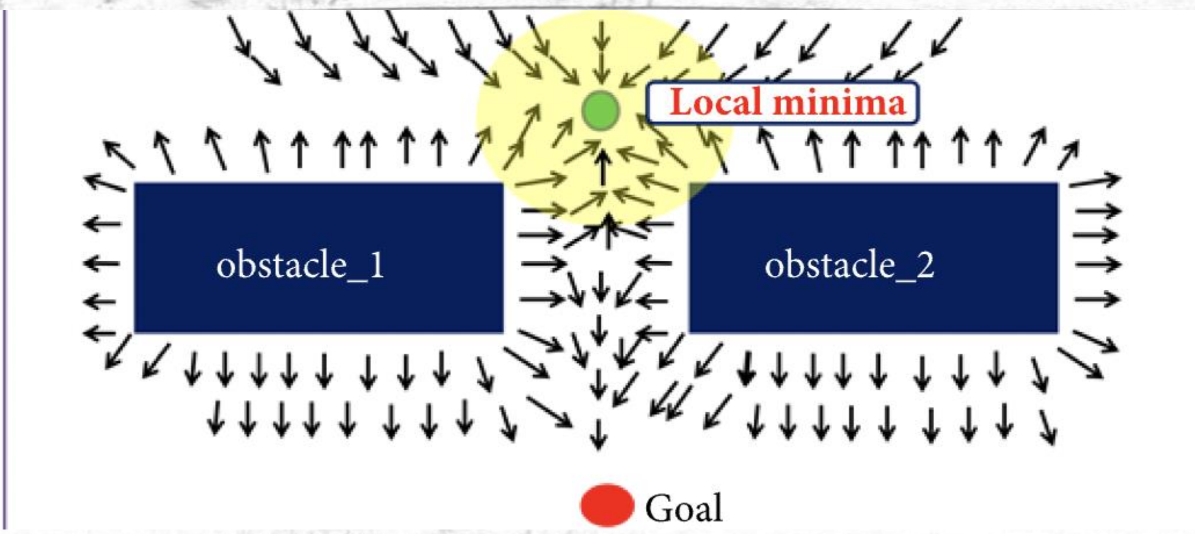
=> This figure shows attractive and repulsive feild in PFM.



=> DrawBack of PFM :-
Local Minima of conventional PFM.



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* The main focussing Algorithm: -

The Obstacle Dependent Gaussian Potential Field.

→ The main idea behind this method is that, after receiving distance data from the range sensor's

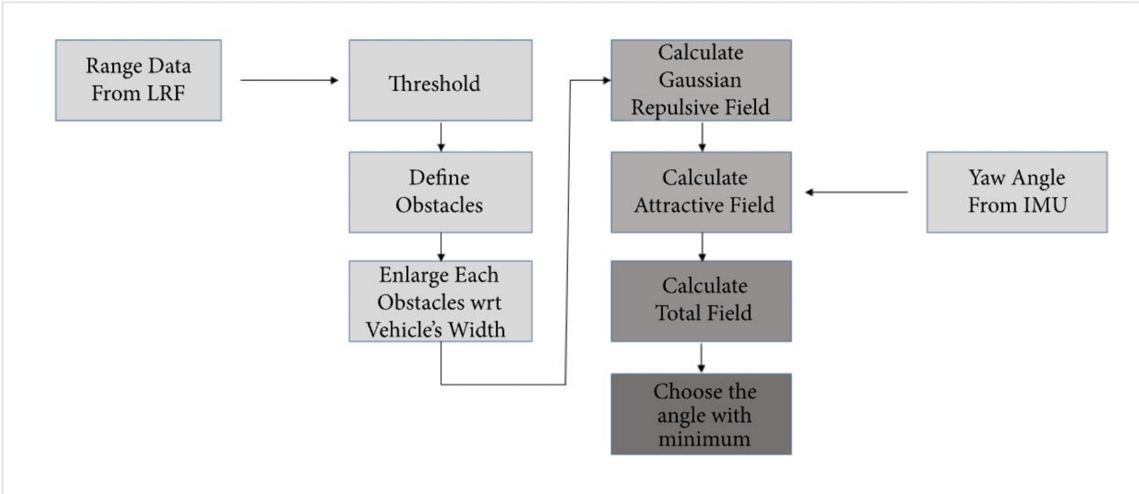
→ We consider the object within the threshold range (2m, for example), enlarge

→ Enlarge the obstacles with regard to vehicle's width, and construct a gaussian potential feild from them.

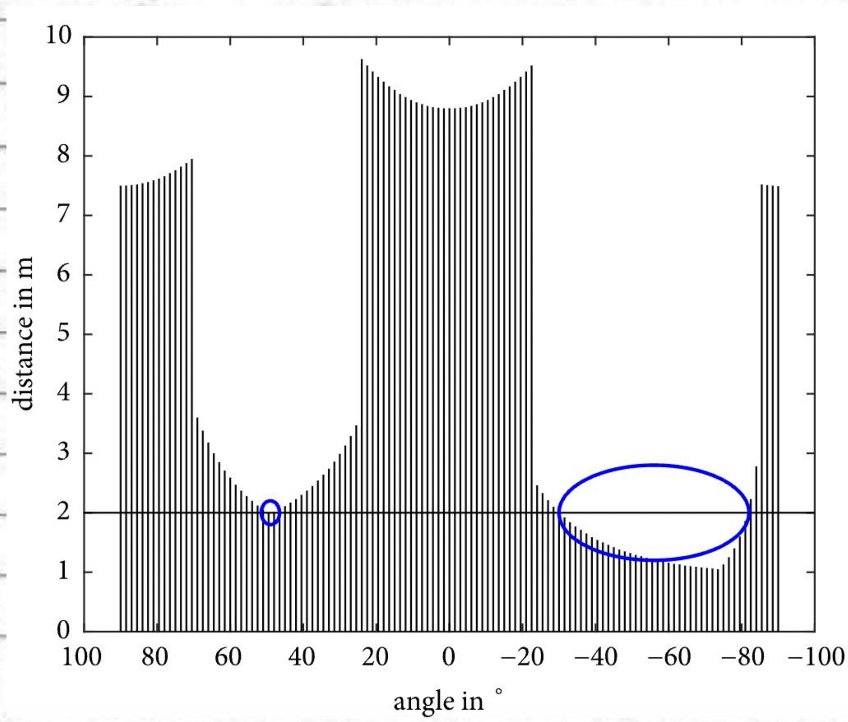
→ Next we calculate Yaw angle for calculating attractive feild using IMU (inertial Measurment Unit).

→ The total feild value is calculated using this two feilds. and from it, we choose the angle with the minimum total feild value.

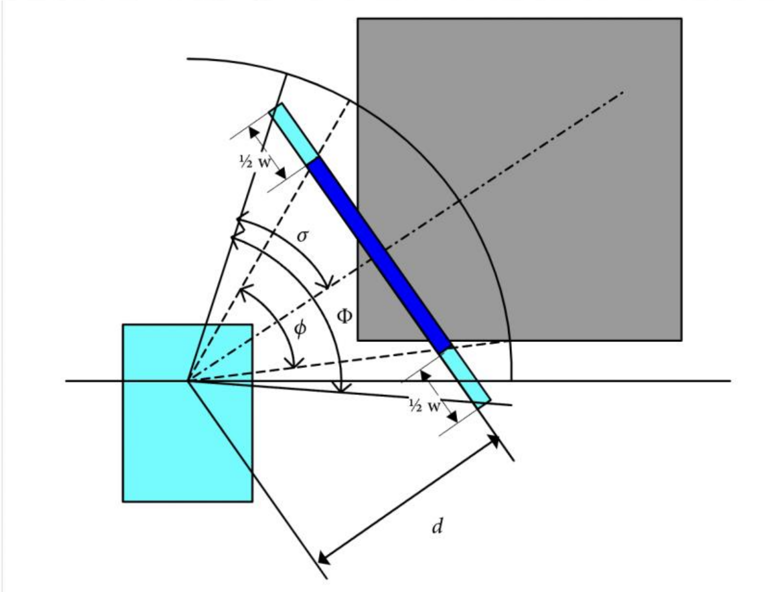
* Flowchart of ODG-PF.



⇒ We calculate average distance of obstacle 1 & 2 i.e 1.99 m and 1.36 m if threshold is 2m, occupied by the obstacles are 1.5° & 51.5°.



=> In Real systems we should consider the vehicle's width and, in many algorithms the vehicle's width or size is added to the obstacle's size. is shrunk to zero



if we consider the vehicle's width, we need to recalculate angle ϕ_k as

$$\Phi_k = 2\sigma_k = 2\cdot \operatorname{atan2}\left(d_k \tan\frac{\phi_k}{2} + \frac{W_{robot}}{2}, d_k\right).$$

where d_k is the average distance to the kth obstacle.

Gaussian likelihood functions (repulsive fields) of the obstacles are calculated as.

$$f_k(\theta_i) = A_k \exp\left(-\frac{(\theta_k-\theta_i)^2}{2\sigma_k^2}\right)$$