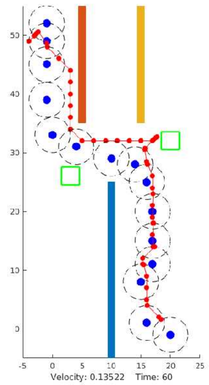
INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

R&D SHOWCASE 2021
Technology, Social Impact

PERSON FOLLOWING ROBOT: MOTION PLANNING & CONTROL

ABSTRACTS

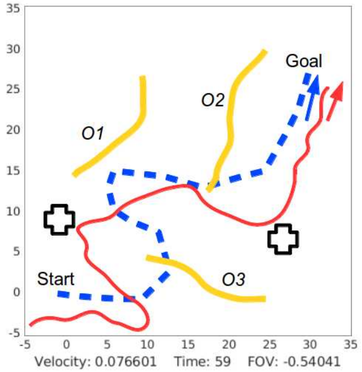
A Person Following Robot or PFR constitutes a range of wheeled mobile robots for assistive and human-robot collaborative applications in hospitals, airports, malls, metro stations, warehouses, and military. This involves real-time path and motion planning with dynamic environment with humans and other robots. Because, these require advanced control, MPC comes to rescue, while ROS is used for commerical programming platform.

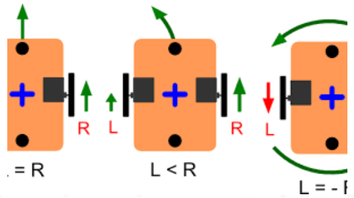


OBJECTIVE

To optimize a single MPC with a cost function to follow the person, and constraints for smoothness, obstacle avoidance, and safety in a social surrounding.

- Track the person and retain FOV at all times.
- Avoid static and dynamic obstacles.
- Safe operation with human factor
- Predict out-of-sight scenarios, and avoid it
- Early relocation to avoid loss of target person





Human Movement Pattern (10 Hops)	Avg. Min Runtime (s) (10 Rounds) 360° FOV	Avg. Max Runtime (s) (10 Rounds) 360° FOV	Avg. Median Runtime (s) 10 Rounds ±15° FOV	Avg. Median Runtime (s) 10 Rounds ±45°FOV
	0.010	0.013	0.017	0.015
	0.014	0.018	0.037	0.027
	0.019	0.021	0.030	0.024
	0.011	0.015	0.018	0.013
	0.017	0.120	0.032	0.019
	0.021	0.048	0.037	0.027

METHOD

Receeding Horizon Control

- Kinematics
- Penalize Vx, Vy
- Proxemics
- Local Map
- Interior-Point Solver
- Unicycle Model
- Path Generate, & Optimize

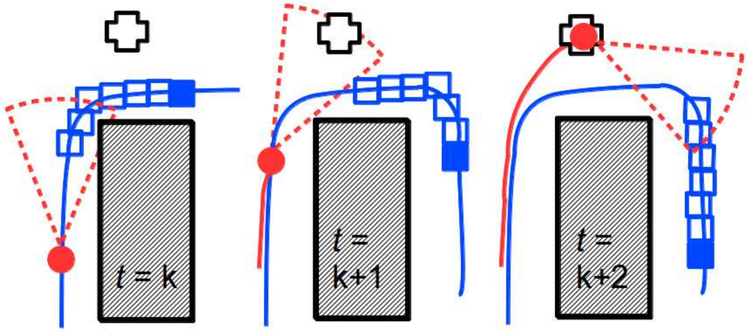
$$\underset{v_x, v_y}{\text{minimize}} \sum_{j=1}^{N} (v_x(i) - v_x^{pref}(i))^2 + (v_y(i) - v_y^{pref}(i))^2 \quad (4)$$

subject to

$$\left.\begin{aligned} x_{t+dt} &= x_t + v_x cos(\theta_t) dt \\ y_{t+dt} &= y_t + v_y sin(\theta_t) dt \\ \theta_{t+dt} &= \theta_t + \frac{d\theta}{dt} dt \end{aligned}\right\} \quad (5)$$

$$x_{t+dt} - \begin{pmatrix} x_t^{obs1} \\ x_t^{obs2} \\ \vdots \\ x_t^{obs N} \end{pmatrix} + y_{t+dt} - \begin{pmatrix} y_t^{obs1} \\ y_t^{obs2} \\ \vdots \\ y_t^{obs N} \end{pmatrix} \geq (r_{bot} + r_{clear})^2 \quad (6)$$

$$(\theta_{bot} + \beta)^2 \leq \tan^{-1}\left(\frac{y_t^{person} - y_t^{bot}}{x_t^{person} - x_t^{bot}}\right) \leq (\theta_{bot} - \beta)^2$$



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Research Center Name:--Robotics Research Center