

Mathematics and Programming Exercises for Educational Robot Navigation

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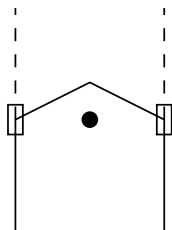
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- Audience
 - For students: Ideas that may be useful for developing a convenient library for robot navigation
 - For educators: Mathematics and programming exercises you can suggest to students, especially at the advanced high school level.
- Mathematical tools:
 - algebra
 - trigonometry
 - linear regression
 - *no* calculus
- Programming examples in this paper:
 - Based on Botball Create primitives
 - Use timing delays
 - See paper from Robotics in Education (RiE) paper (co-located with ECER) for LEGO-based examples using `get_motor_position_counter` and experimental results.

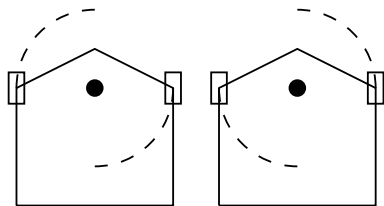
Assumptions

Differential-drive robot

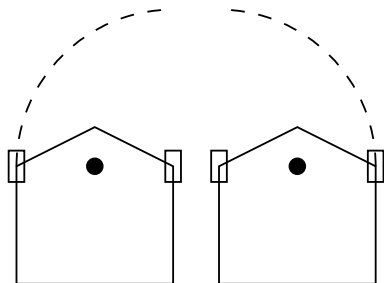
Bounded wheel velocities.
3 main motion types.
Plus could make ref pt
traverse a circular arc.



straight



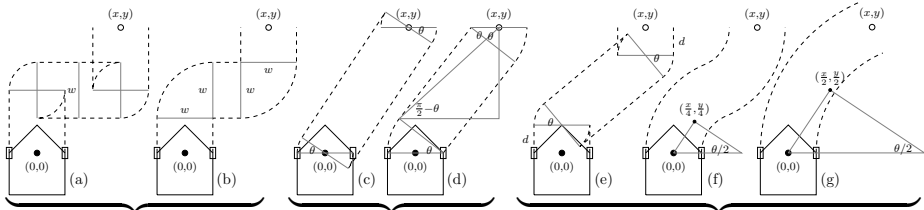
rotations



swings

Mathematical exercises: Analyze various trajectories

Analyze time under assumption of instantaneous acceleration and deceleration, but can also compare regarding the number of speed discontinuities and other considerations.



rectilinear:
rotations vs swings

general:
rotations
vs swings

additional variations

See auxiliary materials on Loyola eCommons for 2019 Frontiers in Education conference paper “Exercises Integrating High School Mathematics with Robot Motion Planning” for a standalone student worksheet and source files for L^AT_EX document formatting system.

See the paper for sample code for:

- Movement primitives `gostraight`, `rotate`, `swing`. Also `arc`.
- Paths: `gotorectswing`, `gotogenswing`
- Root finding for `gotogenswing`. Can show students how to pass a function to a function!

Conclusion

- We have shown a number of ways for students to apply intermediate-level mathematics to robot motion planning.
- Please use the worksheet I referenced or a variation, and give me feedback (rig@cs.luc.edu).
- We have sketched programming that could be used towards building a general navigation library.