Autonomous Ground Vehicle (AGV) Project

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Project Goals

- Construct autonomous mobile vehicle
  - Use DARPA Guidelines
  - Operates using software controller
  - Equipped with sensors (SICK LMS, GPS)
- Simulate using “C” programming language
  - Vehicle Dynamics
  - GPS signal
  - Heading
  - Environmental response data

Ford F-150 4X4 truck basis of the autonomous ground vehicle

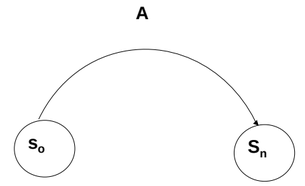
Introduction

- Ford F-150 4X4 truck
- Drive-by-wire system
  - Uses voltages to actuate throttle, steering and brake
- Obstacle sensing, Navigation hardware
  - SICK LMS (Laser Measurement System)
  - Global Positioning Sensor (GPS)

Drive-by-wire system actuates steering, throttle, and brakes

Background

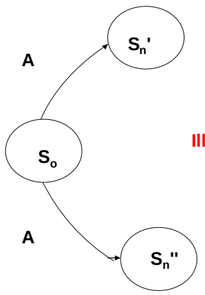
- Simulation models are used to conduct experiments
  - To understand the behavior of a system
  - To evaluate various strategies for the operation of a system
- Various ways to classify a system
  - Natural Systems versus Man-Made
  - Continuous versus Discrete
    - Change in state occurs continuously over time (Continuous)
    - Change in state occurs in finite intervals (Discrete)
  - Deterministic versus Stochastic



Illustrates a deterministic system

Deterministic versus Stochastic

- Stochastic Systems
  - Randomness in transaction from one state to another
  - Not always possible to assign probability to next state the system will assume after a given state and activity
- Deterministic Systems
  - New state of system completely determined by previous state and activity
  - System evolves in deterministic manner form one state to another in response to a given activity



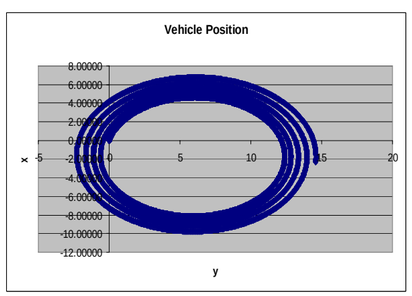
Illustrates a stochastic system

Methodology

- Read text file containing waypoints
- Used first latitude and longitude as start position of truck
- Gave an arbitrary value for throttle and steering angle
- Inputted throttle, steering angle, old x and y positions, heading, speed, yaw, velocity and a specified amount of time into the diffeq function
- Function uses differential equations to calculate vehicle dynamics
- New X and Y positions are used to calculate latitude and longitude
- Latitude and longitude are converted to degrees minutes and fractions of minutes
- Latitude and longitude as new location to a serial port
- Software controller later reads that port

Results

- Simulated vehicle dynamics including: position, heading, speed, velocity and yaw
- Simulated GPS data twenty time per second
- Produced graph to illustrate vehicle position



The x and y positions are plotted and the graph confirms that with a set steering angle and throttle the vehicle travels in a circular path

Conclusion

- Simulated the navigational sensors used on the truck
- Data will be used when simulating obstacle sensing and when determining the desired path to each waypoint
- Simulation can be used instead of continuous testing of the AGV
- Simulator can be used to improve the software controller
  - Exposes controller to different situations and see its response

References

1] J. Massey. Waypoint Navigational Controller for the Texas A&M DARPA Vehicle. Texas A&M University., 4-27-05
[2] C. Odom. Documentation for SICK LMS: AGV Project. Texas A&M University.,
[3] Graybeal and Pooch. Simulation: Principles and Methods. Winthrop Publishers, INC. 1980