Intelligent Driving Agents

The agent approach to tactical driving in autonomous vehicles and traffic simulation

Presentation Master’s thesis
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Imagine....
Overview of presentation

- Project and theory
- Design
- Simulation
- Conclusions and recommendations
- Short demonstration
Project

- Study the use of intelligent agents controlling a vehicle in an urban environment

- **Two cases:**
  1. Real life vehicles
  2. Simulated vehicles

- Focus on **tactical-level** driving
Theory: tactical driving

Driving task separated in three levels:

- **strategic**
  long-term decisions, determine goals

- **tactical**
  short-term decisions, current situation

- **operational**
  actual performed actions
Theory: what are agents?

**Definition**: autonomous computerized entity capable of sensing its environment and acting intelligently based on its perception.

“smart creature inside computer”

- Ability to perform a given task
- Autonomous
- Adaptive / capable of learning
Design: driving agent

- Perform tactical driving
- Real time control
- Safety
- Expandibility
Design: driving agent (continued)

Behavioral rules

- Overtaking
- Car following
- Traffic lights
- Road following
- Collision avoidance

Sensors → Communication → Controller & Memory → Arbiter → Vehicle

Environment

Parameters

Supervisor / other agents
Implementation: simulator

- Decided to create new prototype traffic simulation program
- Used Borland Delphi 5 language
  - Suitable for fast prototyping
  - Experience
Implementation: simulator

1: update
Simulation controller
- Timer

Environment
- Vehicles
- Traffic lights
- Roads
- Traffic light controllers
- Intersections

Simulated objects

2: visual feedback
User interface
- Picture of environment
Implementation: agent

Environment

- Traffic lights
- Traffic light controllers
- Roads
- Intersections

Simulated objects

Agents

- Reasoning
- Sensors

Communication:

- b: send orders
- c: sleep
- a: get information
Implementation: rules

- Implemented and tested one-by-one
- Behaviour rules are directly coded into the program

example: \textbf{If} (agent speed < preferred speed) \textbf{then} Accelerate (normal)
Implementation: example
Conclusions

- Designed driving agent can control vehicles

- Advantages agent-based simulation
  - increased realism
  - flexible
  - distributed processing possible

- Disadvantages
  - increase computational load
  - many parameters
Recommendations / Future work

- Improve simulator and agent
- Use distributed approach
- Use agent to control real vehicles?
Demonstration
Theory: sense-plan-act

Traditional model, popular in 70’s and 80’s

Sensors → Perception → World modeling → Planning → Task execution → Actuators
Rodney Brooks, MIT 1986

Sensors → Build maps
            Explore
            Wander
            Avoid objects → Actuators
Design: behaviour rules

- Specialised and fast procedures that propose an action
- Any method may be used within constraints
- Use behavioural parameters
  - preferred speed
  - acceleration & deceleration rate
  - gap acceptance
  - reaction time
  - sensor range (visibility)
Agent execution loop

1. Get input from sensors
2. Send input to memory
3. Determine action proposals
4. Arbiter selects best proposal
5. Send proposal to vehicle
6. Sleep until next loop
Example Road Following

- Drive at preferred speed
- Stay in lane
- Adjust speed for curve
- Brake for end of road
DESCRIPTION="Demo scenario - Intersection"
SCALE=40
MAPWIDTH=300
MAPHEIGHT=300
ROAD (road1, [000,100], [100,100], 350, 350,1,1)
ROAD (road2, [100,100], [300,100], 350, 350,1,1)
ROAD (road3, [100,100], [100,000], 350, 350,1,1)
ROAD (road4, [100,100], [100,300], 350, 350,1,1)
TRAFFICLIGHT (light1, [087,113], road1, 1, right)
TRAFFICLIGHT (light3, [113,087], road2, 1, left)
TRAFFICLIGHT (light4, [087,087], road3, 1, left)
TRAFFICLIGHT (light2, [113,113], road4, 1, left)
LIGHTCONTROLLER (lc1, 5000, light1, light2, light3, light4)
Experiments

- Low preferred speed
- Large gap acceptance
- Low deceleration rate
- High preferred speed
- Small gap acceptance
- High deceleration rate
Experiments (continued)