

# A Robust Layered Control System for a Mobile Robot

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# Requirements

- Multiple Goals
- Multiple Sensors
- Robustness
- Extensibility

# Levels of Competence

- Proposed approach creates levels based on expected external functionality
  1. Avoid contact with objects
  2. Wander around aimlessly (without hitting things)
  3. “Explore” the world
  4. Build a map of the world to plan routes
  5. Notice changes in the “static” environment
  6. Reason about the world and perform tasks
  7. Formulate and execute plans to change the world
  8. Reason about the behavior of objects and modify plans accordingly

# Layers of Control

- Layers of control directly map to layers of confidence
- Subsumption architecture
  - Build and debug a control layer with level 0 confidence
    - Level 0 layer should never be altered
  - Add one layer of control at a time to previous layers
    - A layer may examine the data of the layer below it
    - A layer may interfere with the layer below it

# Layers of Control

- This approach naturally lends itself to meeting the stated requirements
  - Multiple Goals: Individual layers may work on individual goals concurrently
  - Multiple Sensors: Sensors need not feed data into some central representation
  - Robustness: Lower layers continue to function when higher layers fail
  - Extensibility: Each layer can run on its own processor

# Implementation

- 0-Level Layer: “Avoid”
  - Ensures that the robot does not come in contact with other objects
  - Will avoid stationary objects
  - Will flee from moving obstacles
  - Consists of a number of mini-modules, including “sonar”, “collide”, “feelforce”, “runaway”, “turn”, and “forward”
    - The latter two interact directly with the robot

# Implementation

- Level 1 Layer – “Wander”
  - Creates a new destination for the robot every few seconds
  - Relies on 0-level functionality to avoid obstacles
  - Adds two mini-modules to the system: “Wander”, and “Avoid”

# Implementation

- Level 3 Layer: “Explore”
  - Allows the robot to seek out interesting places to visit
  - Adds the mini-modules “Stereo”, “Look”, “Pathplan”, “Integrate”, and “Whenlook”
  - Impedes output of level 1 layer to reach its goal