Complex Behavior from a Simple Rule: Demonstration with Lego Mindstorms NXT Kit

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Objective
- To demonstrate that sophisticated animal behavior can result from very simple rules encoded in neurons.

Background
- Perception and action are linked by decision making. How?
- Mechanical systems have been used by Professor Barbara Webb in perception and behavior studies, and specifically for her work on female mating cricket. Barbara Webb in perception and behavior studies, and specifically for her work on female mating cricket.
- The Lego Mindstorms NXT robot kit has been used to investigate the female mating cricket and Echoic Flow.

Demonstrations
- Mimic the female cricket’s behavior of locating her mate with only sound signals using two sound sensors and two motors.
- Be able to freely navigate in an open space with obstacles using the echoic flow in a manner similar to a bat.

Sound Seeking Strategy
- Two interconnecting neurons provide the basis for the strategy.
- Logic of movements to move to sound source:
  - Update Left & Right Range Data from Ultrasonic Sensors
  - Record Clock Time at Each Update
  - Calculate Left Tau & Right Tau
  - Update Left & Right Range Data from Ultrasonic Sensors
  - Record Clock Time at Each Update

Sound Sensor Evaluation
- Directivity: Omni-Directional
- Sampling Frequency: 300 Hz

Sound Seeking Result
- Speaker Location: 2.30m, 50° left from normal to Lego’s Starting Point
- Movement 1: No Obstacle
- Movement 2: One Obstacle
- Flow field. Echoic Flow: \( \tau = r \Delta t / \Delta r \), a direct measure of the current time to collision.
- Logic of movements based on a 2-neuron system:
  - Flow field. Echoic Flow: \( \tau = r \Delta t / \Delta r \), a direct measure of the current time to collision.
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Collision Avoidance
- Flow field. Echoic Flow: \( \tau = r \Delta t / \Delta r \), a direct measure of the current time to collision.
- Logic of movements based on a 2-neuron system:

Conclusions
- Two-neuron systems can exhibit complicated behavior such that:
  1. The sound source seeking robot: Successfully moved to the sound source (in working range).
  2. The robot can navigate around obstacles without colliding using echoic flow.
- The simple Lego sensors and motors limit the robots’ performance, but are still able to demonstrate complex behavior.

References