The EvBot Robot Platforms

(Autonomous Robot Platforms for Robot Colony Research and Machine Learned Control)

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Presentation Outline

• Background
• Design Specifications and Implementation
• Experiments
• Conclusion and Suggestions for Future Work
**Evolutionary Robotics**

- **Project Goal:**

  “To produce distributed robotic platforms that display group cooperating characteristics, such as searching, terrain mapping, and reconnaissance, through evolutionary self-learning and shared data and knowledge transference”

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**Early Work - JBots**


[Images of JBot hardware and software components]
JBot Edge Detection & Rule-Based Control

EvBot Specification

**E**VOLUTIONARY **R**OBOTS

- Small and mobile
- Economic cost
- Provide a wealth of data
- Learn using evolutionary computing methods
- Cooperate as a team
- Potential for SSR application
EvBot Hardware

Treaded Base

- Locomotion
  - DC motors
  - H-bridges
- BasicX MCU
  - Multitasking
  - Speed control
  - Sensors and actuators
  - Serial PC/104 interface
PC/104 Stack

- Stacking architecture
- Pentium class single-board computer
- 64 MB of RAM
- Wireless Ethernet
- 104 MB of flash-disk storage
- All standard computer interfaces

Communications

- Radio frequency wireless communications
  - Shared bandwidth a potential problem
  - Short-range local communication
- Information sharing protocol
- Remote monitoring and control software
- Wireless Ethernet
Experiment 1

- Trained the networks in MATLAB simulations on a computer
- Can log into robot over wireless network and manually control robot operation

Experiment 2

- Visually segregating robots
- Two red EvBots, two green EvBots
- “Find your friend, avoid your enemy”
Experiment 3

- EvBots that communicate
- “Find your friend; if you see him, let him know.”

Comparison to Other Platforms

- More autonomous than the Rascal
  - More powerful CPU
  - Don’t use a lot of space for Linux
- Smaller than the Tank
  - Several EvBots can operate in the same room at once
  - More powerful CPU
  - Less advanced simulation environment
EvBot Limitations

- Robot base was not very stable
- Low power motors
- There is no feedback from motors
- Limited capability for more sensors
- Can only drive two motors

Improvements to the EvBot

- Use a larger and more stable base
- Use more powerful motors
- Incorporate shaft encoders
- Add the capability to drive 3 motors
- Modify hardware to facilitate addition of extra sensors
The EvBot II Base

- Retrofitted radio-controlled car (Bedlam)
- New motors and encoders installed

Motor Control and Feedback Processing

- Incorporated on the utility PCB
- Two BasicX microcontrollers
- Communications chain from CPU to microcontrollers
- Full bridge driver ICs (L298)
- Decoders (HCTL-2016)
Other Improvements

• Added USB hub
• Increased memory size
• Redesigned utility board to incorporate the new circuits

Experimentation with the EvBot II

Open-loop calibration:
• Adjusted commanded values to obtain desired speed or rotation angle
Experimentation with the EvBot II

Closed-loop calibration:
• PID parameters adjustment
• Scaling factors adjusted

EvBot II in Action

EvBot II running a same neural network controller evolved in simulation
Acoustic Array System

- Research in this area started with the development of a large-scale acoustic array
- Can perform directional listening through beamforming
- Can pinpoint the coordinates of a sound source through triangulation
- Tracking and navigation applications
- GOAL: Add an acoustic array onto the EvBotII

Software for Beamforming Simulation

- 3-D plot of beam patterns
- Sonar simulation illustrates use of the system for tracking
Software for Testing the Acoustic Array

• 3-D plot of beam patterns from real data
• Tracking Sonar demonstrates use of the system

Evaluation of the EvBot II Acoustic Array

• Comparison of beam patterns from simulation and from real data
USB-DAQ8
Data Acquisition System

• Link the acoustic array to the EvBot II CPU
• Simultaneous Sampling of 8 audio channels @ 78KHz
• Transmit data through USB
• Provide signal amplification

Acquiring Data with the USB-DAQ8

• USBscope
• Sampling a 202Hz signal
EvBot II Navigation by Sound

- Robot turns and moves towards the sound source

Conclusions

The EvBot II is:

- Small, cheap, robust, and provides a wealth of data
- Can integrate new sensors as required
- Well suited to evolutionary robotics experimentation
- Well suited to autonomous robot colony research
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