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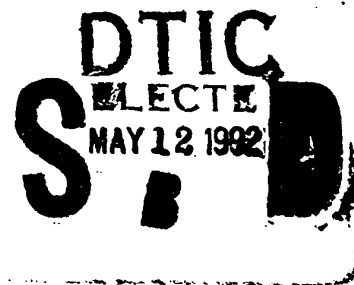
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Neural Network Perception for Mobile Robot Guidance

Dean A. Pomerleau

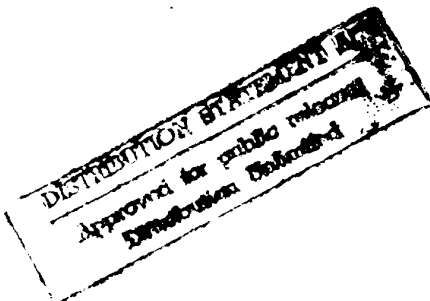
February 16, 1992

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School of Computer Science
Carnegie Mellon University
Pittsburgh, PA 15213

*Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy.*



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School of Computer Science

DOCTORAL THESIS
in the field of
Computer Science

Neural Network Perception for Mobile Robot Guidance

DEAN POMERLEAU

Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

ACCEPTED:

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2/10/92
DATE

Dedicated to Terry, Glen and Phyllis

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Abstract

Vision based mobile robot guidance has proven difficult for classical machine vision methods because of the diversity and real time constraints inherent in the task. This thesis describes a connectionist system called ALVINN (Autonomous Land Vehicle In a Neural Network) that overcomes these difficulties. ALVINN learns to guide mobile robots using the back-propagation training algorithm. Because of its ability to learn from example, ALVINN can adapt to new situations and therefore cope with the diversity of the autonomous navigation task.

But real world problems like vision based mobile robot guidance presents a different set of challenges for the connectionist paradigm. Among them are:

- How to develop a general representation from a limited amount of real training data,
- How to understand the internal representations developed by artificial neural networks,
- How to estimate the reliability of individual networks,
- How to combine multiple networks trained for different situations into a single system,
- How to combine connectionist perception with symbolic reasoning.

This thesis presents novel solutions to each of these problems. Using these techniques, the ALVINN system can learn to control an autonomous van in under 5 minutes by watching a person drive. Once trained, individual ALVINN networks can drive in a variety of circumstances, including single-lane paved and unpaved roads, and multi-lane lined and unlined roads, at speeds of up to 55 miles per hour. The techniques also are shown to generalize to the task of controlling the precise foot placement of a walking robot.

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