An Integrated Navigation and Motion Control System for Autonomous Multisensory Mobile Robots

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An essential task for a mobile robot system is navigation and motion control. The characteristics of perception required by environment modeling or motion control are very different. This may be basically obtained using several sensors. The described NMC system integrates the elementary data acquisition, modeling, planning, and motion control subsystems. A set of rules determines the dynamic structure and the behavior of the system and provides a man/machine and system to system interface.

1 Introduction

Research on mobile robots began in the late sixties with the Stanford Research Institute’s pioneering work. Two versions of SHAKEY, an autonomous mobile robot, were built in 1968 and 1971. The main purpose of this project was “to study processes for the real-time control of a robot system that interacts with a complex environment” (NIL 69). Indeed, mobile robots were and still are a very convenient and powerful support for research on artificial intelligence oriented robotics. They possess the capacity to provide a variety of problems at different levels of generality and difficulty in a large domain including perception, decision making, communication, etc., which all have to be considered within the scope of the specific constraints of robotics: on-line computing, cost considerations, operating ability, and reliability.

A second and quite different trend of research began around the same period. It was aimed at solving the problem of robot vehicle locomotion over rough terrain. The work focus was the design and the study of the kinematics and dynamics of multilegged robots (McG 79).

During the seventies various reasons, such as too remote real-world applications and lack of efficient on-board instrumentation (computers, sensors, etc.), slowed the research thrust in the field and even lead to important funding cuts. Meanwhile the so-called industrial robots, i.e., manipulator robots, became the main body of a fast expanding field of robotics.

The present renewal of interest in mobile robots started in the late seventies fostered by powerful on-board signal and data processing capacities offered by microprocessor technology.

Today, in 1983, the scientific reasons for using mobile robots as a support for concep-
tual and experimental work in advanced robotics hold more than ever. Furthermore a
number of real-world applications can now be realistically envisioned, some for the
near future. These applications range from intervention robots operating in hostile or
extremely dangerous environments to day-to-day machines in highly automated fac­tories using flexible manufacturing systems (FMS) technology.

In this paper we focus on aspects of the HILARE project's current research that we
believe are the key to autonomous mobile robots development: system integration,
multisensory driven navigation, and motion control.

2 Overview of HILARE, A Mobile Robot

The HILARE project started by the end of 1977 at LAAS (GIR 79). The project's goal
is to perform general research in robotics and robot perception and planning. A mobile
robot was constructed to serve as an experimental means.

The environment domain considered is a world of a flat or near flat smooth floor with
walls which include rooms, hallways, corridors, various portable objects, and mobile or
fixed obstacles.

2.1 The Physical Infrastructure
The vehicle has three wheels as shown in figure 1. The two rear wheels are powered by
stepping motors and the front wheel is free. This structure is simple but allows the robot
to perform such trajectories as straight lines, circles and clothoids.