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Smart wheelchairs: A literature review

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Abstract—Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility. While the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. To accommodate this population, researchers have used technologies originally developed for mobile robots to create "smart wheelchairs." Smart wheelchairs have been the subject of research since the early 1980s and have been developed on four continents. This article presents a summary of the current state of the art and directions for future research.

Key words: artificial intelligence, independent mobility, infrared range finder, laser range finder, machine vision, power wheelchairs, robotics, sonar, subsumption, voice control.

INTRODUCTION

Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility, including power wheelchairs, manual wheelchairs, scooters, and walkers [1–2]. Independent mobility increases vocational and educational opportunities, reduces dependence on caregivers and family members, and promotes feelings of self-reliance. For young children, independent mobility serves as the foundation for much early learning [1]. Nonambulatory children lack access to the wealth of stimuli afforded self-ambulating children. This lack of exploration and control often produces a cycle of deprivation and reduced motivation that leads to learned helplessness [3].

For adults, independent mobility is an important aspect of self-esteem and plays a pivotal role in "aging in place." For example, if older people find it increasingly difficult to walk or wheel themselves to the commode, they may do so less often or they may drink less fluid to reduce the frequency of urination. If they become unable to walk or wheel themselves to the commode and help is not routinely available in the home when needed, a move to a more enabling environment (e.g., assisted living) may be necessary. Mobility limitations are the leading cause of functional limitations among adults, with an estimated prevalence of 40 per 1,000 persons age 18 to 44 and 188 per 1,000 at age 85 and older [4]. Mobility difficulties are also strong predictors of activities of daily living (ADL) and instrumental ADL disabilities because of the need to

Abbreviations: ADL = activities of daily living, CALL = Communication Aids for Language and Learning, EOG = electro-oculographic, IR = infrared, LRF = laser range finder, MAid = Mobility Aid for elderly and disabled people, NLPR = National Laboratory of Pattern Recognition, OMNI = Office wheelchair with high Maneuverability and Navigational Intelligence, SPAM = Smart Power Assistance Module, SWCS = Smart Wheelchair Component System, VAHM = Véhicule Autonome pour Handicapé Moteur.

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