

Chapter 7

A Robotic Arm for Electric Scooters

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ABSTRACT

This chapter describes the mechanical design, manufacture and performance of a three-degree-of-freedom manipulator arm and gripper that can be attached to a mobile vehicle or electric scooter. Known by the acronym “ESRA”, or “Electric Scooter Robot Arm”, this device can be remotely or automatically controlled to pick up and retrieve heavy objects, such as books or grocery products, from high shelves or difficult-to-reach locations. Such tasks are often considered to be arduous or even impossible for the frail elderly and people with disabilities. This chapter describes one example of how the combination of mechanical and electronic engineering technology can be used to perform physically strenuous tasks and enable the frail elderly and people with disabilities to enjoy a greater degree of self-sufficiency, independence and physical productivity. It includes the design process for robotic arm manipulators and actuators. It also provides a brief overview of existing “state of the art” robotic and machine vision technologies, and how these can be used to perform many everyday domestic or household chores.

INTRODUCTION

The population of elderly people is rapidly expanding worldwide. In developed countries, the large “Baby Boomer” generation (40-65 year old people) is approaching the age of retirement. Improvements in healthcare and food supplies over the last century have led to longer life ex-

pectancies. Currently, the population growth rate of people above 65 years of age is higher than the growth rate in any other age category in Australia (ABS, 2008).

The fastest growing population group is the cohort aged 80 years and older (ABS, 2008). In 2008, the life expectancy of Australian males was approximately 79.0 years, and for females, it was 83.7 years. There has been a rapid increase: In 1994-96, or a little over 10 years ago, the life

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expectancy for Australian males was 75.2 years, and for females, it was 81.1 years. Over the last 20 years, life expectancy at birth has improved by 6.0 years for males and 4.1 years for females. Hence, at present, life expectancy is increasing at approximately 3.6 months per year for males, and 2.46 months per year for females (ABS, 2008).

Chronic illness and disability tend to increase with age. Twenty-three per cent of people over 65 years of age in Australia have a profound or severe core activity limitation, and chronic illnesses are common conditions (AIHW, 2006). As the percentage of elderly continues to expand in the population, there is a growing need for tools and technologies to assist the frail elderly in completing day-to-day activities, such as shopping for groceries, completing housework tasks and performing heavy or strenuous lifting or other physical work.

The field of gerontology is the branch of medical science that deals with diseases and problems specific to the aged. Research in these fields continues to distinguish effects of disease from the effects of aging on the physical health and functioning of the elderly (Rowe & Kahn, 1987). The process of aging and its related physical and mental effects on the elderly are described by Moody (1998) and Ricklefs (1995). Aging studies, such as the one conducted by Rakowski and Hickey (1992), show that most of the elderly who were interviewed did not notice significant deterioration in physical health and ADL (Activities of Daily Living) over a period of one year. ADLs include daily activities such as dressing, bathing, using the toilet, eating, walking, getting outside and transferring (moving). However, other studies, such as those conducted by Parker et al. (2005) and Freedman et al. (2002) indicate that deterioration in quality of health and in ADLs are very noticeable over a much longer time period. Two large sample groups of elderly Swedish people, aged 77 years of age and over, were interviewed by Parker et al. (2005). Some of the health problems

that were reported as becoming more severe over the survey period 1992-2002 included:

- Musculoskeletal pain: Shoulder pain, back pain, joint pain (in arms or legs).
- Functional limitations: Hearing, mobility, IADLs. (Instrumental ADLs include tasks such as house cleaning, shopping, and preparing food without help.)
- Nervous system / psychosomatic conditions: Dizziness, mental illness, depression, anxiety, sleeplessness, general fatigue.

Other health related problems reported were chest pain, heart problems, stroke and breathlessness.

Robotic or mechatronic devices can play a significant role in improving the lives of the frail elderly and people with disabilities by performing common daily physical manipulation tasks. Robotic and mechatronic engineering technologies can help the frail elderly and people with disabilities to regain some of their former physical functionality. The anticipated benefits and advantages of implementing such technologies are many and provide strong justification for further research into assistive robotic technologies:

1. **Psychological:** Frail elderly and people with disabilities people can regain a sense of freedom and independence by doing a number of physical tasks, such as heavy or strenuous work. Achieving a high degree of freedom, mobility, autonomy and self-sufficiency are all important for people to maintain personal pride, dignity and self-confidence. Robots can help the frail elderly and people with disabilities to feel more productive and physically capable. Gaining a high degree of independence will reduce the feeling of being an encumbrance on others. Being physically active and productive can also help people to feel more self-confident, positive and optimistic.

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