Chapter 23
Knowledge Transfer to Boost Human Activity Recognition Performance

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ABSTRACT

Activity recognition systems automatically recognize the daily activities of residents in smart home environments. Their development has been the subject of numerous studies, indicating a well-established area of research. Developing HAR systems for practical use encounters numerous challenges. Deep learning approaches require labeled datasets from the target environment that are large enough. Acquiring sufficient activity labels is an expensive and time-consuming task. The problem could be addressed by transferring knowledge from other environments. This process is known as transfer learning. In the chapter, some scenarios from the activity recognition environments, which illustrate these conditions, are described. Before knowledge transfer can be utilized, some issues need to be addressed. Source and target environments can differ to a great extent and need to be unified. This chapter discusses methods for handling differences. The chapter reviews some influential works in the field of transfer learning for activity recognition with a greater focus on recently published literature.

1. INTRODUCTION

In recent years, the challenges of an aging population have become more pronounced, with the rate of aging accelerating beyond historical trends. According to the World Health Organization (WHO), the percentage of the global population aged 60 and above is projected to almost double from 12% in 2015 to 22% by 2050 (https://www.who.int/news-room/fact-sheets/detail/ageing-and-health). Advances in medical care have led to higher survival rates among the elderly, which in turn has increased cognitive

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impairments and other age-related health issues. More elderly individuals are now living at home, often alone. The concept of "aging in place" refers to older adults remaining in their own homes as they age. While many elderly people maintain independence in their daily activities, sudden health problems can arise, gradually progressing to a point where living independently is no longer feasible. This raises concerns for older adults and their families about safety, mobility, and other daily needs. In response, home-based care is provided by both formal and informal healthcare organizations, offering health, personal, and support services to help individuals remain at home and live as independently as possible. The growing aging population is placing significant strain on healthcare systems, intensifying the need to find more efficient ways to deliver care and support to older adults in their homes.

Basic daily tasks, known as Activities of Daily Living (ADLs), are essential functions most healthy people can perform independently. These tasks serve as key indicators of an elderly person's overall health. Difficulty in completing ADLs can lead to unsafe living situations and a reduced quality of life. Healthcare professionals assess individuals' ability to carry out ADLs to determine who may require assistance. By monitoring the daily routines of healthy individuals, we can understand their typical patterns of behavior. A shift in how these tasks are performed may signal the onset of health problems.

ADL recognition systems designed for smart environments can automatically detect the activities carried out by residents. The development of such systems has been the focus of many research efforts, highlighting it as a mature field of study. Recent advancements in sensor technology, the Internet of Things, machine learning, and artificial intelligence have contributed to significant progress in this area. Deep learning methods, in particular, show the most potential for training ADL recognition systems, but their effectiveness depends heavily on the availability of labeled data.

Sufficiently large amounts of labeled data are required to train the ADL recognition system. Acquiring labeled data is expensive and time-consuming. In real-world settings, there is often not enough time to manually collect a large volume of labeled data, train an ADL recognition system on that data, and then deploy the system in the environment. Since the environments where ADL systems are used share certain similarities, researchers are exploring methods to transfer knowledge between different environments, aiming to minimize the time and effort needed to set up ADL recognition systems in new settings.

Domains similar to the target domain often exist. Utilizing labeled data from related domains can be advantageous. Methods for transferring knowledge between domains are known as transfer learning and have been researched and utilized to accelerate development and enhance the performance of various machine learning applications. In this chapter, we review transfer learning in ADL recognition.

2. BACKGROUND

2.1 Activities of Daily Living

Activities of daily living are fundamental, routine tasks that the majority of healthy individuals are able to carry out independently without needing help. An ADL assessment helps evaluate whether an individual might need assistance with daily tasks. In the 1950s, geriatrician Sidney Katz defined ADLs as comprising six basic activities: personal hygiene, dressing, toileting, transferring (such as moving in and out of a chair or bed unaided), continence, and feeding (Katz, 1983). ADLs serve as an indicator of