
Learning Structure of Human Behavior Patterns in a Smart Home System

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Abstract. A growing proportion of the aged in population provokes shortage of caregivers and restructuring of living spaces. One of the most promising solutions is to provide with a smart home environment that ensures independence of users. In this paper, we first call attention to the fact that a learning capability of human behavior patterns can play a central role in adequate functioning of such systems. Specifically, we give an overview of important related studies to illustrate how a variety of learning functions can be successfully incorporated into the smart home environment. We then present our approaches towards the issues of life-long learning and non-supervised learning, which are considered essential aspects of a smart home system. The two learning schemes are shown to be satisfactory in facilitating independent living over different time scales and with less human intervention. Finally, we mention about a prospective model of a future smart home.

Keywords: learning, life-long learning, non-supervised learning, human behavior patterns, smart home.

1 Introduction

According to the statistical bureau reports of Asian, European, and US [1-4], the rate of the aged population has dramatically increased. For example, the expected rate amounts to more than 25 percent in Korea, Japan, and Germany, and 20 percent in US, England, and France. The proportion of the aged is growing worldwide, and it is expected that this will be tripled by 2050 [5]. We are concerned about this situation because this may unfold shortage of caregivers and living spaces. Note that the elderly suffers from the problem of degenerated motor functions which lead social isolation with affective disorders. To be more specific, the

proportion of the aged in Korea is expected to be tripled by 2030, whereas the social capability to support them will be doubled [2]. The world population bulletin has reported that "Old-age dependency ratio" (number of people 65 or older over number of people ages 20 to 64) is expected to be doubled by 2045 [5]. As a result, the percentage of the worldwide population over the age 65 will be doubled within three decades; 7.4% in the year 2005 will become 15.2% in the year 2045.

It appears from the population reports that our society will suffer from the lack of young people who are capable of supporting older people. This problem has long been tackled by many social groups as well as researchers in the field of robotics. As a feasible solution of particular interest, the robotic approaches have been coupled with the smart home technologies so as to successfully substitute human caregivers with some automated service agents.

Table 1. List of Well-known Smart Homes

| | Name | Nation | Level of Intelligence | Web/ related works |
|----|-------------------------------------|-------------|-----------------------|--------------------|
| 1 | Adaptive House | USA | 3 | (1)[7] |
| 2 | Aware Home | USA | 1 | (2) |
| 3 | Ceit Living Lab | Austria | 1 | (3) |
| 4 | Cogknow | Europe-wide | 1 | (4) |
| 5 | community computing | Korea | 1 | (5)[8] |
| 6 | Context visualization | Korea | 1 | -/[9] |
| 7 | Context-aware unified remocon | Korea | 1 | (6)[10] |
| 8 | DLF SmartHome | UK | 1 | (7) |
| 9 | Domotics | EU | 2 | (8)[11] |
| 10 | DOMUS | Canada | 1 | (9)[12] |
| 11 | Easyliving Room | USA | 1 | -/[13] |
| 12 | Futurelife Haus | Swiss | 1 | (10) |
| 13 | Gator Tech Smart House | USA | 1 | (11)[14] |
| 14 | Global Village initiative | Worldwide | 1 | (12) |
| 15 | Home Control Center | Finland | 1 | (13) |
| 16 | Home Depot Smart Home | USA | 3 | (14) |
| 17 | Home Network | Korea | 1 | (15)[15] |
| 18 | Human Space | Korea | 1 | (16) |
| 19 | ICT-ADI | Worldwide | 3 | (17) |
| 20 | In-HAM Home Lab | Belgium | 1 | (18) |
| 21 | Inhaus-Zentrum in Duisburg | Germany | 1 | (19) |
| 22 | Intelligent Sweet Home | Korea | 3 | (20)[16] |
| 23 | Intelligent Workplace | USA | 1 | (21) |
| 24 | IR remocon module-based Smart Home | Korea | 1 | -/[17] |
| 25 | IR-based User Detection System | Korea | 1 | -/[18] |
| 26 | Kompetenzzentrum Smart Environments | Germany | 1 | (22) |
| 27 | Living Tomorrow in Amsterdam | Belgium | 1 | (23) |
| 28 | MARC smart home | USA | 1 | (24)[19] |
| 29 | Microsoft Home | USA | 1 | (25) |
| 30 | Millennium Homes | UK | 1 | (26)[20] |
| 31 | MIT house_n | USA | 1 | (27) |
| 32 | MIT smart city | USA | 1 | (28) |
| 33 | NUADU | Europewide | 1 | (29) |