

Chapter 52

A Survey and Surveillance Issues in Smart Homes Environment for Assistive Living

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ABSTRACT

A surveillance system for assisting the elderly in remaining independent in their familiar environment is one of the subjects interest in recent healthcare studies. When mature, it is expected that this system will have the ability to track objects that a resident may lose periodically, detect falls within the home, alert family members or healthcare professionals to abnormal behaviors. This paper addresses the early stages and issues of the development of such a system, the physical characteristics of the system that is being designed, early results, and guidance on the future work that will have to be completed in the future.

1. INTRODUCTION

In the last 10 years, research in the field of automated multiple camera surveillance has grown dramatically. Advances in the technologies of image sensors, embedded processors and image processing techniques enable the inclusion of vision-based nodes in various smart environment applications. Video content captured by camera sensors provides rich information both for human observation and for computer interpretation. Thus, information acquired by surveillance system can significantly aid monitoring of certain areas and lead to automatic analysis and understanding of events, recognition of the status of the observed humans and even prognosis of abnormal, harmful or malicious situations.

Many works specifically address methods for the surveillance of traffic in outdoor environments, like the work of [Pasula et al. 1999], but interest in the automation of surveillance in indoor environments has also grown from the prevalence of existing surveillance systems in public and private buildings. Indoor surveillance posed new challenges and provided new benefits that were not present in outdoor surveil-

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lance. Indoor environments are generally protected from environmental factors that outdoor surveillance equipment would need to be robust to. However, the sudden illumination changes that frequently occur in indoor environments must be adequately dealt with.

A specialization of the indoor surveillance problem is the problem of surveillance in smart homes and smart rooms. While general surveillance systems attempt to use each camera to monitor a broad area, thus limiting the number of required cameras, the goal of surveillance in smart homes and rooms is to efficiently capture details that may be important to the user. For instance, subtle details in the user's motion itself, as observed in a monitored environment may define particular activities or the emotional state the user is in. More generally, details in the scene might refer to certain important objects, which are to be automatically recognized and tracked by the surveillance system, for example pill boxes in a smart home for assisting the elderly.

In this work, we discuss the initial steps in designing and implementing the hardware and software components for a surveillance system in a smart home environment. More specifically, we mainly discuss the problems that occurred during the implementation of our own surveillance system in an emulation of a smart room environment and during the use of state of the art algorithms for foreground segmentation and tracking. During experimentation we also use two modern datasets designed in a similar setting, so as to examine several other challenges that spring from the data. The greatest emphasis is given in tracking algorithms and setups, which is a complex and crucial step in many methodologies. Our hope is that our discoveries will aid future researchers understand better the challenges of the field and possibly avoid dead-ends.

Section 2 provides a brief comparison on surveillance systems in order to show the progress made in this area and offers a synopsis of several video surveillance systems designed for smart homes. Section 3 describes our dataset along with the other two datasets used for experiments. Section 4 presents the chosen method of background subtraction. Section 5 describes several implementations of object tracking algorithms. Finally, Section 6 concludes the paper with a discussion of the most prominent challenges these systems face.

2. A LIGHT COMPARISON ON SURVEILLANCE SYSTEMS

Here we offer a light comparison among several systems to show their progress towards completion and the features used for this comparison. In particular, we have used a number of elements (cost=E1, friendliness=E2, range=E3, calibration=E4, system-complexity=E5, software-complexity=E6, robustness=E7, scalability=E8, lifetime=E9, real-time=E10, reliability=E11, self-starting=E12, synthesis=E13, alternative-power=E14)) that users, engineers, and software developers would be concerned with in the production, deployment, and use of a surveillance system for a smart home.

Table 1 defines each of the elements that were used in the evaluation and an example of how a system would be ideal with respect to each element. In particular, each element's importance to a specific group that would interact with the system was assigned a number between 1 and 10. An assignment of 1 would indicate that the particular group did not see the element as important in any way and an assignment of 10 would indicate that a particular group saw the element as being of the utmost importance to them. Because a surveillance system in a smart home could potentially be used to monitor the well-being of an occupant and report changes in their condition to a health care provider, each element was also assigned

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