Pervasive Visual Sensor Networks for Elderly Care

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I. ABSTRACT

The proportion of aging population in human society is demonstrating a remarkable increase every year. Our society faces the following challenges to deal with this increase in the *aging population*: more investment is needed for elderly care and the decrease in the working population will cause a shortage of skilled caregivers [1]. Therefore extensive research efforts take place on developing smart care systems.

The state of the art solutions for smart elderly care systems include video monitoring and wearable devices. In video monitoring, or camera-based surveillance, the cameras independently and continuously transmit video streams to a central processing server. Captured video is analyzed by a human operator, or it is stored in a database for later processing. This solution requires a considerable amount of man-power to monitor all the activities and may violate the privacy of the elderly when their activities are continuously monitored. Wearable devices with the capability of raising alarms when the user is in trouble may include a wearable with a button that needs the elderly to raise an alarm [1], or a wearable that is equipped with motion detectors (accelerometers, etc.) and raises an alarm when a dangerous situation is detected, such as a fall [2]. However, the efficiency of the wearable systems is limited by the willingness of the elderly to wear them and to raise an alarm.

An alternative elderly care solution that recently gained attention is to use *pervasive smart camera systems* or in other words *Visual Sensor Networks (VSNs)* [3]. VSNs are considered as a subclass of *Wireless Sensor Networks* and are composed of embedded camera devices. In an elderly-care context, such a pervasive camera system can be deployed by placing camera sensors in the living space of the elderly to monitor their safety and raise alarms when a danger is detected. Compared to the solutions on wearable devices, VSNs are *unobtrusive* and *non-intrusive* to elderly life and compared to continuous monitoring, VSNs respect the *privacy* of elderly since they start recording if a danger is detected.

Although some examples of VSN systems for elderly support exist in the literature [4-6], they mostly focus on specific problems, such as fall detection, where the objective is to demonstrate that even a system composed of low-power, low resolution cameras can assist the elderly in a cost-effective manner. Moreover, these systems are usually deployed with a limited number of cameras in an indoor setting. In this research, our **objective** is to take a more *comprehensive* and *multi-disciplinary* approach and to find the best tradeoffs between processing and communication components of a VSN system not only deployed in a limited home environment but also large outdoor environments, such as a garden of a nursing house, where we can demonstrate scalable solutions and where we can benefit from the self organization characteristics of VSNs. Our research aims to contribute to the following objectives and our poster will present the preliminary ideas on the following:

- *Scalable and Efficient Network Architectures:* We will investigate the use of a multi-tier architecture by using different tiers that include different set of nodes with different capabilities, such as movement sensors at the lowest level to detect a person and wake up the upper tier which includes the camera nodes.
- *Developing Lightweight Vision Processing Algorithms:* Many vision processing algorithms are designed for single camera systems and are not optimized for resource constrained cameras. In this context, we will research the algorithms that can be used in VSNs and adaptation issues.
- *QoS-aware Communication Protocol:* Our initial focus will be on designing a MAC protocol which brings the ability of assigning different priorities to varied users, frames, packets and considering their deadlines by controlling the sharing of the wireless medium. Then we will extend our focus to the routing/transport layers by following a cross layer approach to meet the QoS requirements imposed by the application.
- *Cross Layer Resource Optimization in VSNs:* We aim for designing adaptive processing and communication algorithms that interact with each other. For instance by reducing the amount of data to be transmitted, energy consumption at the communication side is reduced but on the other hand this may lead to a poor image quality and false identification of events. The number of sensors to report an event, amount of data to be reported, and access to variable bandwidth medium are all just some example parts of a resource management problem in VSNs.

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