Title:
The Monitoring Technology for the Latent Risk Population

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Introduction:
Falls occur frequently in the elderly population and significantly impair their quality of life. It is estimated that more than one in three elderly individuals living at home fall at least once a year with the risk of falling increasing with age. Falls also lead to decreased mobility, fear of falling again, and death [1][3]. After a fall, many seniors become so afraid of falling again that they limit their activities which in turn decreases their fitness, mobility and balance, and leads to decreased social interactions, reduced satisfaction with life, and a higher likelihood of depression. This fear then increases the risk of another fall [5].

Due to 3D capabilities becoming ubiquitous and computers with basic graphics hardware running 3D applications, we designed a computer-aided real-time automated monitoring system. Our monitoring system is intended to overcome these limitations. It has the potential to capture rare, irregular, or transient events; symptoms that are difficult for a patient to report; and changes in condition that evolve slowly over time. These improvements, in turn, could yield more accurate and earlier detection of changes that may interfere with healthy and independent living. The development of our technologies will significantly enable functional independence and improve the quality of life for people with disabilities, people aging with mild impairments, as well as individuals with chronic conditions.

Main Idea:
By wearing Watching-Over-Me (WOM), a person will be monitored not only in his or her home but also in places where the person spends plenty of time (stores, parks, etc.). The system will contain the devices for fall detection, surrounding environmental monitoring, as well as measuring a person's blood pressure, pulse, and oxygen saturation in real-time. Furthermore, the systems will integrate information from multiple sensors, appropriate clinical information, and ambient data such as temperature and/or global position. Fig. 1 is the framework of the processing system. First, the system acquires real-time data from the surrounding environment and the health data from the person wearing WOM. This information is stored as standard scenes and each time the person appears in the same scene the system compares the surrounding environmental information with the information in stored standard scenes. The system continually learns from environmental data and then constructs the 3D scene. The 3D scene is accumulated as the person passes through more and more places.

The devices periodically compare the real time data with the learned data. When an abnormal event occurs, it will make a decision and inform the pre-determined parties (ambulance, caregiver, family members, etc.). The system will base determining abnormal scenes on its experience to detect progressive declines in physical and cognitive abilities.

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A tri-axial accelerometer is integrated into the fall sensor, and the fall sensor sends early warning information if the trigger conditions are met with handling the three axes' sample values. Many smartphones have a tri-axial accelerometer. We can use these smartphones, such as the HTC G3 Hero smartphone, which has a tri-axial accelerometer, as fall sensors.

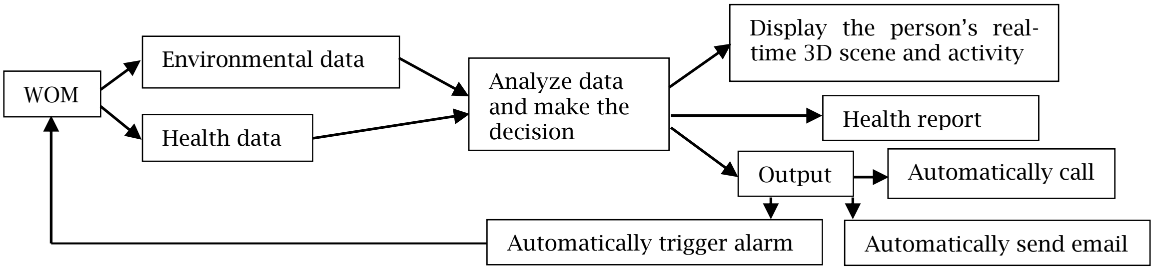

Fig. 1: The framework of the system.

WOM (see Fig. 1) portable signaling devices with two sets of complementary sensors are on the elder person's side at all times. One set of biochemical sensors detect biochemical markers in the elder person, such as blood glucose, blood pressure, pulse, oxygen saturation, sweat pH and salt balance. Biochemical abnormalities occur when the individual's biochemical and physiological parameters exceed the threshold and reach a dangerous level. Another set of sensors are image sensors – tiny cameras that are becoming increasingly smaller. Due to modern day standards, they can be mounted on the person's clothes or in a hat and capture real-time images of the surroundings.

The system collects video streams and automatic, real-time 3D reconstruction from videos of scenes. The core algorithms operate on the frames of a single video-camera as it moves in space. The reconstructions are based on frames captured at different time instances by the same camera under the assumption that the scenes remain static [4]. The depth estimates are used around object boundaries by operating on individual light rays [2]. The system processes the data from surrounding environments, and the health data from the person wearing WOM. Fig. 2 is a neural network which analyzes data to make the decision for the output.

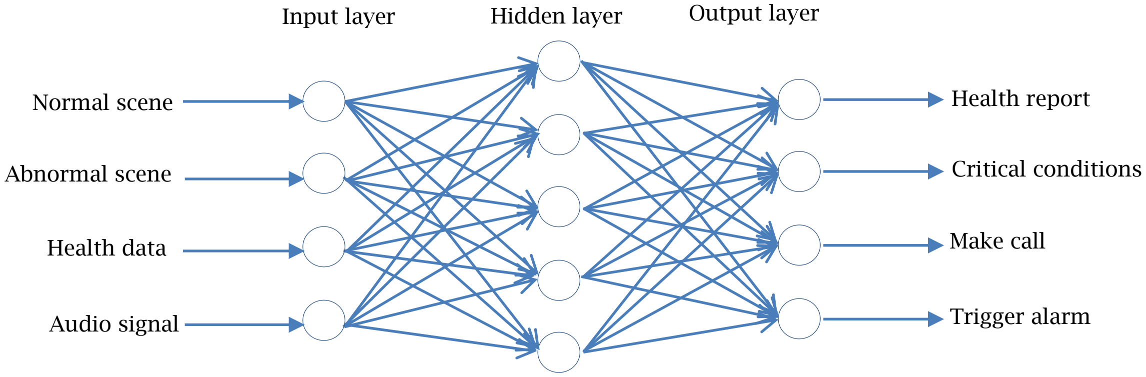

Fig. 2: A neural network for making decision.

The system transforms the data into a real-time 3D scene and 3D character. The data is continuously fed and the character and surrounding environment are updated all the time. The system automatically searches for a good point of view, allowing a good understanding of a scene for a human user. The position will be the optimal light source position. Heuristic search is used to choose viewpoints only in potentially interesting regions, obtained by subdivision of spherical triangles.

To generate a 3D character model and render action of model in the scene is based on the idea of declarative modeling [6]. Opposite the imperative geometric modeling, it requires neither a complete knowledge of the final result at start time nor specified numeric details. Furthermore, consistency of the description can be automatically and continuously maintained by the system. The character structure of our system is shown in Fig. 3.

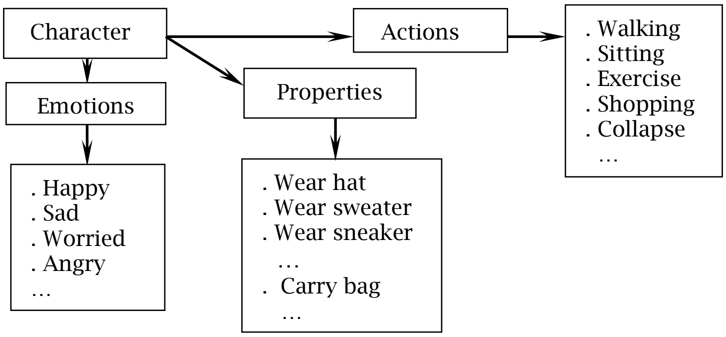

Fig. 3: The character structure.

Conclusions:

We have presented a novel design for healthy independent living. It is reliable, safe, and simple. It is easy to use and has intuitive user interfaces with consideration for a user's disability or impairment. The design provides feedback in meaningful forms, whether auditory, visual, or tactile. Most importantly, our system for healthy independent living engages, empowers, and motivates the individuals with respect to his or her own abilities.

The advantage of our system is that we are able to detect the person's dynamic state. Our method is based on surrounding environmental information, fall detection, and health data as auxiliary information. As long as the person is wearing WOM, it is all automated. Even if the person suddenly falls unconscious, the device will still take the appropriate actions. Thus, this technology has multiple benefits and can be targeted for both disabled and healthy individuals alike.

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References:

[1] Doughty, K.; Lewis, R.; McIntosh, A.: The design of a practical and reliable fall detector for community and institutional telecare, J.Telemed. Telecare, 6(1), 2000, 150-154.

[2] Kim, C.; Zimmer, H.; Pritch, Y.; Sorkine-Hornung, A.; Gross, M.: Scene Reconstruction from High Spatio-Angular Resolution Light Fields, Proceedings of ACM SIGGRAPH (Anaheim, USA, July 21-25, 2013), ACM Transactions on Graphics, 32(4), 2013, 73:71-73:12.

[3] Ozcan, A.; Donat, H.; Gelecek, N.; Ozdirenc, M.; Karadibak, D.: The relationship between risk factors for falling and quality of life in older adults. BMC Public Health, 5,2005, 90.

[4] Pollefeys, M.; Nistér, D.; Frahm, J.-M.; Akbarzadeh, A.; Mordohai, P.; Clipp, B.; Engels, C.; Gallup, D.; Kim, S.-J.; Merrell, P.; Salmi, C.; Sinha, S.; Talton, B.; Wang, L.; Yang, Q.; Stewénius, H.; Yang, R.; Welch, G.; Towles, H.: Detailed Real-Time Urban 3D Reconstruction from Video, International Journal of Computer Vision, 78(2-3), 2008, 143-167.

[5] Provincial Health Officer, B.C.M.o.H.P.O.o.t.: Prevention of Falls and Injuries Among the Elderly: A Special Report From the Office of the Provincial Health Officer.2004.

[6] Roux, O.L.; Gaildrat, V.; Caubet, R.: Constraint satisfaction techniques for the generation phase in declarative modeling, Geometric modeling, 2004 194 – 215.