CogniWin: An Integrated Framework to Support Older Adults at Work

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Figure 1. CogniWin work environment.

Figure 2. Mockup design of the intelligent mouse.

ABSTRACT
Assisting older adults at work is of critical importance in nowadays fast-emerging computerized environments. Therefore, it is paramount to provide support to mitigate age-related cognitive degradation and to relieve their fear towards technological changes. In this demo paper, we present CogniWin, an integrated framework for providing personalized support to older adults at work, which aims to achieve the above goals and to make them feel more positive in prolonging their stay at work. We present an overall description of the system components and the integration architecture, and highlight the benefits of using the system.

CCS Concepts
• Human-centered Computing → Human Computer Interaction (HCI) → Interactive Systems and Tools.

Keywords
Assisted Living; Adaptive Interactive System; Eye-tracker; Computer Mouse; Older Adults.

1. INTRODUCTION
Many older adults have bright expectations for an active future and would like to continue managing their work in an office as a paid activity. However, seniors working in highly computerized environments are often required to learn new capabilities and acquire new knowledge, and to adapt their working way to fast emerging, new or upgraded software systems and methods. This requirement, combined with eventual age-related cognitive degradations (e.g., limited working memory capacity) makes them feel mentally stressed or tired to stay longer active at their work, limits their self-confidence and decreases their productivity.

In this realm, both the research community and the industry have come to understand the critical importance of assisting older adults in nowadays fast-emerging technological working environments. A number of research works exist that aim to support older adults and motivate them to stay for longer active and productive [1, 2].

In this demo paper, we present an integrated framework, named CogniWin, which provides personalized support to overcome eventual age-related memory degradation and gradual decrease of other cognitive capabilities, and at the same time assists users to increase their learning abilities. Thus, it enables them to cope better with software application changes in their organizations. The system implements an innovative cognitive-based user model, embracing various cognitive characteristics of the older adults. Moreover, it provides to older adults personalized tips in order to avoid unwanted age-related health situations at their work via a well-being advisor that assesses measurements provided by an intelligent computer mouse and an eye tracking device, and considers adult's personal health-related characteristics stored in the system to infer potential negative trends in well-being at work.

2. COGNIWIN – COGNITIVE SUPPORT FOR OLDER ADULTS AT WORK
CogniWin is an integrated framework that blends different technologies to assist the seamless workflow and learning process of older adults in computerized working environments, and at the same time provide well-being guidance (*cf.* Figure 1). In a nutshell, CogniWin continuously monitors various user interaction and physiological parameters through an in-house developed computer mouse, an off-the-shelf eye tracking device and a task analysis recorder for contextualizing the users' interactions. Accordingly, the data from various sources is fused and analyzed in real-time, assisting older adults during unpleasant situations (e.g., when feeling stressed, frustrated, etc.) and when facing task completion difficulty [3]. CogniWin entails four primary services:

- **Advanced Monitoring:** based on an intelligent mouse (*cf.* Figure 2) and an eye tracking device, CogniWin measures physiological and visual parameters using sensors that enable the extraction of user states and behaviors;
- **Learning Assistant:** provides personalized tips (audio-visual) based on the users' cognitive characteristics aiding them to achieve goals and improve performance;
- **Well-being Advisor:** provides personalized well-being advice to prevent unwanted age-related health situations effectively, preserving and improving their well-being status in the work environment;
- **Working Memory Support:** anticipates the next task or subtask (e.g., moving the mouse pointer to the concerned graphical area) in order to reduce cognitive overload during computerized activities where working memory is highly solicited.

3. DESCRIPTION OF THE SYSTEM

The system architecture is composed at the lower level by: *i)* an Intelligent Computer Mouse (CogniMouse [4]); *ii)* an Eye Tracking system; and *iii)* a Knowledge Repository. At this level, the system collects anonymously user data from the human-interface devices while working with the system, and retrieves relevant data stored in the Knowledge Repository such as a priori health profiles and specific user capabilities. The intelligent computer mouse embeds sensors to measure skin conductivity, grip force, heart rate, temperature, and inertial measurements which are further analyzed aiming to detect user hesitation, frustration and stressful events. The Eye Tracker provides eye gaze point, blinking rate, fixation and saccades rate, and velocity as first level parameters which are further processed to get information about vigilance, hesitation, drowsiness and other health and cognitive-related parameters.

The above information is then fed to the components in the middle-layer level, namely: *i)* a Contextual Recorder; *ii)* a Data Fusion component; and *iii)* a Behavior Analysis component. The Contextual Recorder is responsible to log the user's keyboard and mouse events, and identify which task, process or services the user is running so as to determine the context according to the actions performed. The Data Fusion component combines, filters and synchronizes the outcomes of the lower level modules (CogniMouse and Eye Tracker), and delivers it to the Behavior Analysis module. Also leveraging prior health, personal and cognitive characteristics of the specific user and contextual data, different user behaviors are recognized in real-time in the Behavior Analysis component by means of advanced probabilistic reasoning algorithms.

Finally, at a higher level stand the user interface components, which include: *i)* a Personal Learning Assistant; and *ii)* a Well-being Advisor. In one hand, the role of the Personal Learning Assistant is mainly to assist the user in computerized tasks when facing difficulties, or at user request. It also provides useful suggestions and helpful tips to provide adaptive support according to the user preferences in order to reduce anxiety or stress. On the other hand, the Well-being Advisor is triggered when unexpected behavior is detected and provides intervention to prevent unwanted age-related health situations resulting from user's uncomfortable symptoms. Examples of interventions include promoting work breaks or stress reducing exercises at specific times to recreate the user's productivity.

An integrated data model considers relevant historical, contextual, sensorial and fused data and incorporates the knowledge repository, and the user's preferences. Furthermore, in terms of system integration, it follows a decoupled architecture. This allows for components to be implemented using different programming languages, being gracefully integrated via a distributed messaging broker, which enables asynchronous communication between the different components.

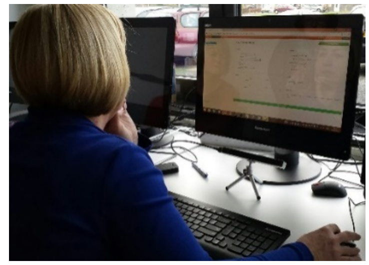

Figure 3. A user testing the CogniWin system.

At its current stage, CogniWin runs on any personal computer (*cf.* Figure 3) endowed with Microsoft Windows 7, 8 or 10, and the system is capable of identifying and reacting to the following user behaviors when performing a task: normal state, hesitation, drowsiness, vigilance, fatigue, cognitive overload, stress or anxiety, and frustration.

4. CONCLUSION AND FUTURE WORK

The behaviors recognized by the system are continuously under validation, e.g. as seen in [4], where results revealed links between mouse triggering states of user hesitation and user task completion difficulty. Moreover, two pilot trials at two different end-user institutions have been performed during the project's lifecycle. In general, feedback from employees via user questionnaires and think-aloud protocols has been very positive regarding the system functionality. They appreciate CogniWin, found it useful (System Usability Scale of 68.3) and felt confident working with the devices, as they did not feel any embarrassment due to sensors' usage. Nevertheless, the framework is still not finalized and we foresee additional upcoming work. In particular, we intend to improve the timing of advices, enhance the interfaces according to user's feedback, display the user's well-being status so they can monitor their own health parameters, and integrate more precise assistance and training to the user by displaying suitable videos, pictures and text.

5. ACKNOWLEDGMENTS

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