House of the future relies on multimedia and wireless sensors

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The Aspire Home for Quality Life mixes creative designs and leading interactive computer technologies to create a space that responds to users’ needs and desires.

In this quickly growing digital world, responsive media, controlled environments, and fully computerized homes have the potential to improve human lives in an era of limited resources. Our creative digital life research team has developed a model home that integrates information communication technology into many daily activities.

The National Cheng Kung University (NCKU) Aspire Home for Quality Life includes responsive designs and leading technologies, such as wireless sensor networking, human-centric intelligence, interactive multimedia adaptations of devices, and intelligent product designs. The Aspire Home consists of six major sectors: an interactive 3D multimedia room, an interactive garden with a responsive wall, a smart study room, a digital kitchen, a smart bedroom, and a smart living room. Figure 1 shows the layout of the Aspire Home with photos of the various rooms.

In the Aspire Home, the integrated media center with its associated wireless sensor network not only provides control interfaces for all electronic appliances but also offers entertainment and information services. For example, entertainment includes video, pictures, music, weather forecasts, television, games, and event controls. These services migrate seamlessly and without interruption as the user moves from one room to another. In addition, lighting control is quite important in the Aspire Home. The red-green-blue lights are configured with ZigBee wireless sensors that can change brightness and color to save energy or set a mood. Group management has been used in these sensor networks to support services such as fault tolerance, security, time synchronization, object tracking, and power management.

The responsive wall system in the Aspire Home supports the dynamic configuration of smart spaces. As shown in Figure 2, all the walls hang from a ceiling grid structure that allows users to reconfigure the space for specific physical and social contexts by moving the walls. The physical properties of the walls in the system can also change (e.g., from opaque to transparent) according to users’ activities and locations.1

The interactive garden is a sensing-based ubiquitous art installation designed for natural interaction in a smart home. As shown in Figure 2, we borrowed from the Japanese karesansui rock gardens used in meditation and filled the space with sand, gravel, rocks, and membranes. The interactive garden is

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intended to connect people, emotions, and media.\textsuperscript{2} It is aware of people’s presence.

The interactive 3D multimedia room features a widescreen, 3D, interactive virtual reality system\textsuperscript{3} that is based on four LCD projectors and controlled by an interactive glove, as shown in Figure 3. The multimedia room also includes a virtual window that can display nature scenes and interactive educational games as well as conduct disorder assessments.\textsuperscript{3}

The study room in the Aspire Home is based on the concept of ubiquitous computing and aims to build microprocessors into ordinary furniture, in this case a desk and a bookshelf, as shown in Figure 4. The table incorporates multitouch technology that makes control of the process more intuitive and easier to use. The bookshelf is used for storing and retrieving information. Book cards enable this interaction.

In the digital kitchen, voice commands can be used to control every appliance. Our system uses speaker-independent and mixed Mandarin and English speech-recognition techniques.\textsuperscript{4,5} Thus, anyone can use this system without speech training. Moreover, we designed microphone array technology with a ubiquitous voice input interface for noise cancellation.\textsuperscript{6} This allows users to input voice commands anywhere in the kitchen. In addition, using radio frequency identification (RFID) technology, the monitor can display the current inventory of items in the refrigerator as well as the contents of cookbooks.

The smart bedroom in the Aspire Home contains sensing-based intelligence to create a cozy, relaxing, and secure sleeping space. All personal activities are detected. For example, the system provides automatic light guidance when the user gets up to go to the bathroom during the night. Relaxing music, movies, and scenery based on personalized suitability and preferences are delivered when the user lies on the bed. The system also issues automatic reminders regarding the user’s health and can contact relatives and/or medical personnel should an emergency occur. The bedroom is seamlessly connected with all other spaces in the Aspire Home.

In the smart bedroom, the Magic Mirror system\textsuperscript{7} combines standard glass with multimedia technology to implement an interactive system. Magic Mirror can be used as an ordinary mirror

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or an intelligent genie that can provide any information needed through a 3D virtual character that can talk and interact with the user. The system employs speech recognition technology to accept commands from the user and speech synthesis to respond to queries while performing requested actions. The 3D character provides a human-like interface. In addition, the Magic Mirror can also perform face recognition and tracking, retrieve news and weather reports, play music and video on demand, and gather other information from the Internet.

This article briefly overviews the NCKU Aspire Home for Quality Life, which integrates creative design with interactive technology. This multimedia-aware and wirelessly connected home was completed in just six months. We have also designed a creative art exhibition corridor that presents paintings and photos in interactive ways to allow users more involvement while viewing artworks.

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