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Monitoring and Control of Seniors' Home Environment

Siman Daniel, Bujňák Juraj, Šimšík Dušan

Department of Biomedical Engineering, Automation and Measurement, Faculty of Mechanical Engineering, Technical University of Kosice, Letna 9, 042 00, Kosice, Slovak Republic, phone and fax: +421/556022654, email: dusan.simsik@tuke.sk

Abstract-Paper is focused on the monitoring and communication systems in the households for comfort of seniors and people with disabilities. It is focused on the selected wireless monitoring systems which are located in our Laboratory of Ambient Intelligence at the Technical University of Kosice (TUKE). Purpose of installed systems is to adapt the home environment to main human needs, like correct values of humidity and temperature, avoid dangerous situations like leakage of gas or water, smoke, and monitor users' health status in their households. Permanent monitoring via web console is available, and it offers another possibility to control home environment. This remote control can obviate risky situations in daily activities of seniors and helps their families to check the health status in their absence. Energy counter is used to review of energy spending of each device turned off and still plugged in. Counter can easily measure how much energy device spend, while idling in standby and then decide what to unplug for savings, what to sell and buy a newer, more energy efficient model, and what to leave. Result of monitoring and wireless communication systems is to improve the quality of life and autonomy of elderly and people with disability living at home alone.

I. Ambient Intelligence

Ambient Intelligence refers to electronic devices embedded in the environment that are sensitive and responsive to the presence of people. Ambient intelligence is a vision on the future that is related to consumer electronics, telecommunication, information technology and communication systems that were originally developed in the late 1990s for the time frame 2010–2020. When ambient intelligence is applied into the real life conditions, devices work in concert to support people to carry out their daily activities in easy, comfortable and natural way. The main feature of devices within ambient intelligence is that information and intelligence is hidden in the network that interconnects these devices. As the devices has tendency to grow smaller, use enhanced connection and become integrated into the environment, the technology disappears into surroundings whereas only user interface remains perceivable for users. The ambient intelligence paradigm builds upon pervasive computing, ubiquitous computing, profiling practices, and human-centric computer interaction design and is characterized by systems and technologies that are [1, 2, 3]:

- embedded (networked devices are integrated into the environment),
- context aware (devices can recognize you and your situational context),
- personalized (they can be tailored to the user's needs),
- adaptive (they can change in response to user),
- anticipatory (they can anticipate the desires without a conscious mediation).

Already 10 years ago M. Weiser talked about making machines fit the human environment instead of forcing humans to enter the machine's environment. He noted that the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it [4]. Weiser's vision, outlined two decades ago, led to ubiquitous computing. Now, there is a must to rethink the relationship and interactions between humans and machines again. Including a variety of technologies, including computing technologies; communication, social-interaction, and Web technologies; and embedded, fixed, or mobile sensors and devices creates computing for human experience. The vision is built on a suite of technologies that serves, assists, and cooperates with humans to non-destructively and unobtrusively complement and enrich normal activities, with minimal explicit concern or effort on the humans' part.

Computing for human experience will anticipate when to gather and apply relevant knowledge and intelligence [5].
In the near future ensure the individual's support through ICTs, which will be optimal and intelligent for users. Practically it means replacement of computer monitors by technical devices installed into the everyday life objects. By using this technologies and services the users will spend less time using, setting and maintaining the technology and will have more time for themselves, their life and their relatives. Nowadays there are applied services provided by digital television, mobile operators and internet providers, whose products support performance of everyday life activities and increase the quality of life of the widest group of people, including seniors and people with disability. The aim is to improve the life, make it easier by improving on the places where people spend the most of their time – households and workplaces. In dependence on the changed needs the technologies, products and services are interconnected by the purpose of creating the intelligent environment and so creating more comfortable, safer and maintainable environment.

II. Laboratory of Ambient Intelligence at TUKE

The main task of Laboratory of Ambient Intelligence at the Technical University of Kosice is a fully compatible, intuitive-to-use environment so for the user side as for the healthcare provider through the web interface. The advantage of the system is to support user's autonomy, safety and more comfort for the members of the family. The built environment is using sensor and electronics technology available on the market [6]. Whole system is divided into group due to their purpose to use. The devices installed in the Laboratory of Ambient Intelligence:

- Motion sensor and camera (needed for cooperation with motion sensor)
- Energy saver – Plogg
- Gas detector
- Humidity sensor
- Temperature sensor

A. Plogg - energy saver

The instrument is actually an adapter that fits between a device's plug and the electrical socket. Plogg measures how much energy the device needs during standby and sends that information to a computer of user´s or to caregiver's interface, called residential gateway. All information can be seen by user also on smart phone (iPhone in our study). All devices are attached to Plogg and can be monitored by camera integrated in the cell phone. Plogg generates detailed information about electricity expenditure of the appliance at the moment of monitoring. Software platform of Plogg also performs data analysis. Measured data are collected in central PC unit and the report about the electricity expenditure of different devices is produced. If an appliance was left running for hours, Plogg can be used to alert user or can be set to turn off the device automatically [7].

Figure 1. Plogg device

B. Gas detector

The gas detector is equipped with the 1-wire output developed at our lab and can be used as a part of house alarm system. If gas is detected, the detectors make a warning sound and its 1-wire output will be triggered.

There is an optional alarm memory function. The detectors make regular auto testing and report their condition with its LED indicator.
Gas leak detector JA-80G responds to the presence of flammable gases (natural gas, propane, butane, coal gas, etc.). The activation of fire alarm and declare the same time signalized danger acoustical built-in siren. It has alarm output relays to control such electric valve for gas supply. Detectors regularly check their functionality. [6]

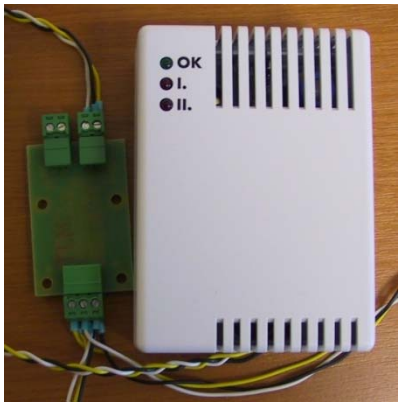

Figure 2. Gas alarm connected to 1-wire technology

C. Humidity sensor

Technological device for monitoring environmental conditions is used especially for detection air humidity. The device may be installed in multiple indoor locations, to monitor conditions throughout the home (e.g. bathroom, kitchen, living areas). As a part of a total home automation system, humidity can be a trigger for events such as turning on fans, or controlling zone heating and cooling. It can works with several scenes, e.g. to set humidity level which is comfortable for him and cooperating devices like air-condition or fan can decrease level of humidity.
In general, it requires no operation. It automatically transmits all data required to the control unit. If the room air humidity does not correspond to the desired values, sensor can be activated by touching the button on the bottom. The operation is supported by red LEDs. Measured humidity values can be displayed on the residential gateway.

D. Temperature sensor

Sensor measures the air temperature inside rooms. In addition, the user can enter the desired temperature values. Sensor then sends the actual and nominal values via the radio network to the control unit, which uses them for an optimum control of the indoor climate.
In general, it requires no user operation. It automatically transmits all data required to the control unit. If the room temperature does not correspond to the desired values, sensor can be activated by touching the button to the right. The operation is supported by green LEDs. To increase the service life of the batteries, the LEDs fade after a while and sensor changes to the standby mode. The course of the measured temperature values can be displayed on the control unit.

III. Monitoring and control

The monitoring aims to get information about the actual status of the monitored environment of a residence based on sensor's data and definition of the services. The general architecture is centralized with the residential gateway (RG) as the main module. Majority of sensors are using ZigBee protocol, so they are connected by wireless connection system. Sensors measure parameters inside the room. Depending on the sensor types, different information about the current sensors status and collected data can be reached on the RG by the web interface. Some actuators use an advantage of the 1-wire technology to be powered directly.
The MonAMI system architecture is displayed on the Figure 3. Sensors and actuators based on ZigBee and 1-wire technology are connected to the central unit (residential gateway). We use touch screen display as a front end to the system when monitoring and controlling from a household and phone with internet browser when monitoring and controlling remotely.

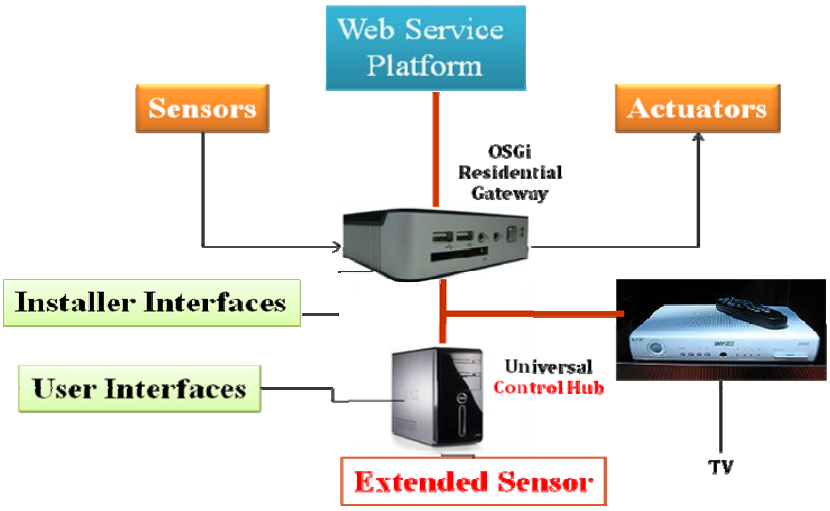

Figure 3 Architecture of MonAMI system

A. Measurement

We have built a special laboratory - the Laboratory of Ambient Intelligence at the Technical University to be able to provide tests with potential users. The main objective was to create complex networking system consisting of many sensors and actuators that enableenvironmental monitoring and control. All measured values in this environment and even some features of the personal status are accessible through mobile phone, internet browser and some operational unit in household.
The concept of the MonAMI services is based on the basis of measured values, which are aimed to continuous measuring of the environmental factors relating to well being or regular activity of a vulnerable person by the carer or remote service centre. A common scenario for this service counts with a carer as the main user to be able to monitor home and vulnerable person's status or activities remotely, and to act in case of emergency when the vulnerable person in his/her care needs it. Emergency situations concern safety of vulnerable persons or their well-being relating to environmental conditions and security. Remote checking of home status can be used to get extra information to better assess the situation (like pictures of the room, presence information, etc.). Also relatives of user often want to be warned when safety of vulnerable person may be at risk. They can check the situation contacting the vulnerable person through the communication unit (speakerphone) before an emergency situation will be confirmed [8].

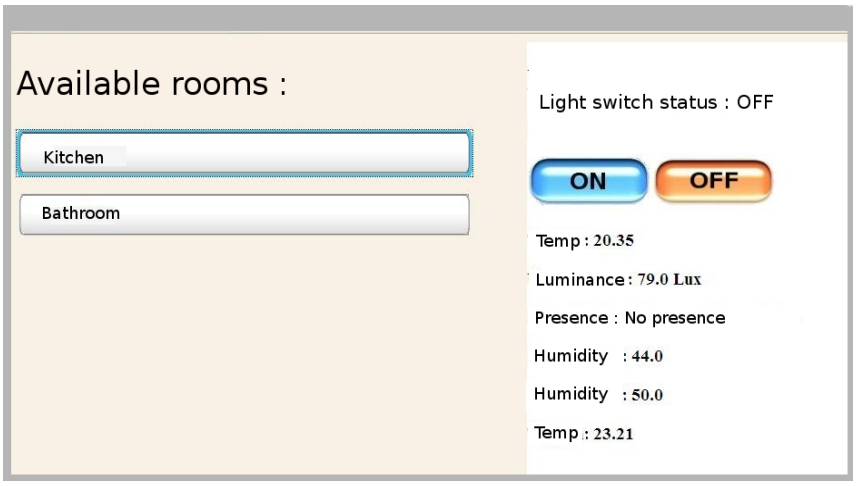

Figure 4. Measured values on web interface

B. Testing of usability and reliability

It is necessary to have parameters from sensors with tolerances lower than 1 % of measured values for our services. We test these values in the Laboratory of Ambient Intelligence at the Technical University of Kosice and subsequently they will be tested in real seniors' homes environment.
For testing purposes there were created testing scenarios covering the whole functionality of the system. Each testing scenario consists of several steps with the following pattern:

- action – action that will initiate system response
- pre-requisite – relations that have to be fulfilled
- expected reaction - expected behaviour of the system

Results of our testing in the laboratory environment succeed in good order – only 4 of 38 steps protocol were not functional as expected.

V. Conclusion

The development of the technologies of the intelligent environment is increasing due to situation of ageing population. The persons who often need the help of nurse, healthcare centres or relatives, could live more independently with increasing their personal autonomy. This is also psychological point. By the technologies of intelligent environment the problem of social inclusion and handicaps can be less or more eliminated. The helpful technologies, e.g. home automation can provide better quality of life, make the home control and performing of the everyday tasks easier and more comfortable as well as making the life easier by the health monitoring systems installed at households. New technologies allow transforming the elements of communication and the home control into new dimensions, home control can be wireless and easy and the health status of citizens at risk level can be monitored directly from household without need of assistance and automatically sent to the hospital centre or straight to the medical doctor.
Small, compact devices, matching the design of the sensor control unit, can be positioned anywhere thanks to the wireless technology. Interacting with the other system components, it allows for a presence-related regulation of the inside climate, with the highest level of energy efficiency. The auto-adaptive program of the control unit registers the temperature and humidity values entered by the user and automatically adapts the control rules for the indoor climate regulation.
A comparison of used components' parameters with the Slovak Legal metrology shows differences between used devices. Testing is now in state of collecting results. When we focused on transmission of signals, interference and loss of signals were negligibly. Gas sensor have no tolerances, there is applied the doubled measurement, because failure can lead to loss in lives. Plogg gives utility to households capability to switch off discretionary loads, such as immersion heaters, fridges or TV sets – none of which, if turned off at agreed times, would affect the consumers' lifestyle or comfort level.

Acknowledgement

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