UD principles for home appliances and some talking devices to support independent life for dementia or MCI

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Abstract. The authors found problems that the elderly people are facing in their daily life using everyday technologies including home electric appliances. They developed principles to design home appliances for elderly persons and a couple of talking apparatuses to draw attention or to lead correct behavior for persons who are dementia or MCI. They are the smell warning for refrigerator, the adviser to stay at home, and the room climate telling.

Keywords. Dementia, MCI, Micro controller, Home appliances, Voice synthesizer, UI

Introduction

Japan is well known as hyper aged society in the world. The population ratio of elderlies is over 23%. In 2013, the ministry of health, labor and welfare of Japan announced that there are 4.62 million dementia and about 4 million MCI in Japan. That means about quarter of elderly people have some cognitive problems in their daily life. Adding this, the family size of Japan become so smaller that 9.4% of houses were solitary household by over 65 in 2010, and is growing up.

The authors surveyed 91 elderlies including dementias who live alone in house or live alone in daytime, using the ETUQ-Kobe method which is based on Everyday Technology Usage Questionnaire developed by Louise Nygård in Karolinska Institute Sweden. Then the authors found two points of view to support them: one is necessity of friendly user interface in home appliances as Universal Design, and the other is necessity of advising devices as an Assistive Technology.

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1. Background and Aim

In rapidly aging society, it is easily imagine that to live alone with cognitive problems or to live with dementia spouse brings a lot of problems. In early stage of Alzheimer disease, small accidents may occur by memory loss; for example, `cooking disturbed by delivery, the pot on the stove burned`, or `go out without locked the door`. After these small accidents, he/she might be inhibit do such activity by their family or care giver, then his/her cognitive ability may drop by disuse syndrome.

The modern life in urbanized countries is supported by a lot of electric home appliances and ICTs, such as microwave oven, refrigerator, washing machine, air conditioner, telephone, mobile phone, T.V. set, ATM, elevator, public transportation system, and etc. Louise defined these useful household and public appliances as Everyday Technology (shortly ET). When people cannot use any ET, he/she faced serious difficulty in life. The refrigerator enable long term food storage and precooked food delivery, combined with the microwave oven, the elderly people easily obtain independent in eating. The air conditioner ease controlling room temperature and it is also important as life saver in hot and humid Japanese summer. The TV set or radio will work as important information sauce in case of disaster.

Most of household appliances are highly developed to reduce physical burden, however as purchasing high performance or high functions, the makers left behind to design easy to use or easy to understand for elderly users.

Therefore elderly people living alone are growing rapidly in Japan or developed countries, the diffusion of usable ET for persons with cognitive problems is important challenge to keep independent life as long as possible.

2. Method

This research is divided into two phases: one is survey and the other is design. The survey is mainly carried by Kobe University and the design is carried by Kobe Design University.

2.1. Survey

The authors interviewed elderly people who live alone or stay alone in almost daytime, who have cognitive problems with or without diagnoses, or have no cognitive problems. The ETUQ (Everyday Technology Usage Questionnaire) was adopted for the survey, which was developed by Louise Nygård et. al. in Karolinska Institute in SWD [1]. In the ETUQ, the objects are asked still keeping, using or quit using a lot of useable technologies not only indoor but also outdoor. In original ETUQ 93 items are listed, but in Kobe version 101 items arranged to suit Japanese culture are listed [2].

Before asking ETUQ-Kobe, the subjects are asked basic items such as born year, sex, educational history and occupational history, and tested MMSE, GDS and FAI. After that, they are asked several questions about using appliances then take pictures of those appliances.

2.2. Design

Based on the results and pictures or movies taken in each interviews, the points of each problems and several episodes are listed and discussed. Adding this, the focused problems in daily life are discussed, then some propositions for MCI friendly interface for home appliances are figured out.

To configure the effect of advising function, the authors developed some prototypes.

3. Results

3.1. Survey

The interview were taken to 92 subjects from 2010 to 2012, however one of them lacked basic information, so that 91 were effective answers. The male were 21 and the female were70, the average of all were 79.8 years old. 30 subjects were dementia and 4 subjects had diagnosis of MCI. More details are described in table 1.

Table 1. Features of subjects

Group	Sex	N	Age	MMSE	GDS	FAI
Total		91	79.8±6.6	24.6	4.0	25.5
	M	21	78.7±6.2	26.4	2.1	29.0
	F	70	80.0±6.7	24.4	4.6	24.4
Sound		57	80.0±6.3	26.8	3.7	26.8
	M	18	77.8±6.1	27.3	1.7	31.9
	F	39	81.1±6.2	26.5	4.6	27.0
Dementia		30	79.8±5.6	20.4	4.3	19.1
	M	3	84.0±4.0	21.3	5.0	11.7
	F	27	79.4±5.7	20.3	4.3	20.0
MCI	F	4	81.5±4.4	25.3	6.5	27.0

Most commonly used top 20s ET are listed in left side of figure 1. The TV set and the toilette flush are continuously used without any difficulties, however not a little have problems in the remote controller for TV set. The right side of figure 1 shows similar result in case of dementia group. They felt difficulty in using the iron, the vacuum cleaner, the rice cooker, the boiler for the bath, the washing machine, the room heater or the microwave oven [3, 4].

In the top 50% used ET, not a little elderlies quit using the sewing machine, the radio, the video recorder/player, recording to the answering machine, the hair drier and the electric calculator. On the other hand, the TV set, the toilette flush, the electric fan, the automatic faucet in the public toilette and the cylindrical door lock are still used without difficulties.

The dementias and MCIs felt difficulty or needed some assistances in using the remote controller for the TV set (15), the microwave oven (8), the washing machine (7), the tabletop water heater (6), the stove (6) and the mobile phone (6).

3.2. Design proposal

TV system reformed to digital terrestrial television broadcasting in 2011 in Japan. This new system allows bidirectional data transmission or captioning, then adding these commands results complication of the remote controller. One of the co-author Toru Nagao designed a plastic cover to hide unnecessary buttons for simplified remote controller which is on the market. It shows only 5 buttons; the power on/off, the channel up/down and the volume up/down. After the user evaluation, although sound elderlies felt complicated to select channel by stepping up/down, some dementia felt it essential item for independent use. One of the family made similar cover for the air conditioner by this experience.
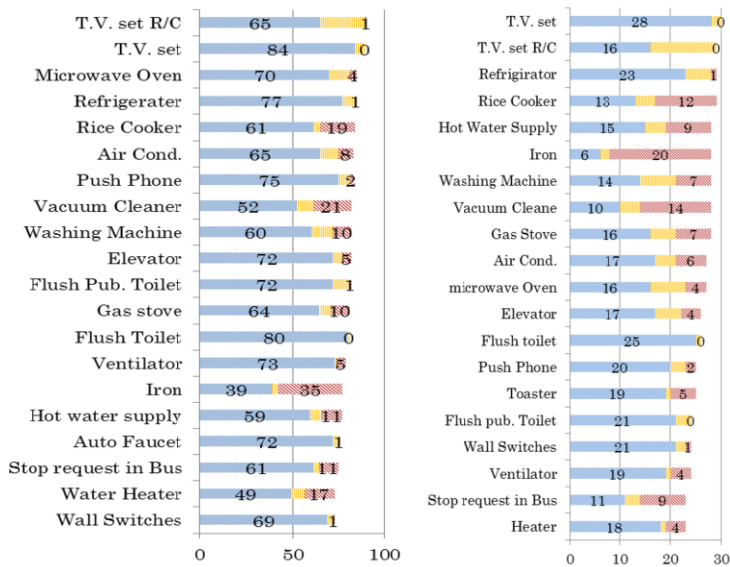
Figure 1. Top 20 Everyday Technology usage by all subjects (left) and Top 20 Everyday Technology usage by dementia subjects (Right).
The graph shows; still using, Using with some difficulty, Quit using

In dementia cases, they may be more confused by losing way to recover from unfamiliar state when pressed wrong button, than complexity of information. To hide out infrequently used switches affect a guard to change to unfamiliar mode [5].

In case of mobile phone and codeless phone, the line will be connected by pressing additional button after the sequence of phone number which is displayed on the LCD. Some of dementias confused in this status seeing her daughter's name and face on the LCD. One's family added a colored seal to aware the button. Similar problem was observed in timer or temperature set in the microwave oven or the boiler. Elderlies can choose desired value but forget pressing button to set or start it. The new UI which set or activate after waiting cancelling action should be considered.

The rotary type controller is more usable than the pushbutton type controller for the elderly. Especially the rotary timer with spring motor is preferred. It may considered that the rotating body action directly link to the desired time. When using rotary encoder type controller, the user must press start button, and it may be forgotten according the layout of these controls [6, 7].

3.3. Prototyping

Through the interviews the following episodes are observed frequently by subjects.

- Warmed up food left behind in the microwave oven
- Same many foods are stored in the refrigerator then some of them goes bad
- Take note such as "meet Ms. AAA at the station on 10AM tomorrow", however on tomorrow she realize the meeting on tomorrow. Tomorrow never come.
- Too much remote-controllers on the table.
- The failed battery of the remote-controller make nothing.
- In the evening, visit neighborhood and talk too long. It becomes bothering one.
- Even if it is too hot in the house, don't use air conditioner or don't take a water
- Unplug all cables of electric appliances when he/she saw them are plugged in

The authors choose four of these and developed four prototypes.

3.3.1. Microwave oven monitor

A few minutes past after using the microwave oven when the door stay closed, it talk "Warmed up". And if the door left open, it say "the door is open". The working of the microwave oven is detected by current sensor adopted to the AC line, and the door open/close is detected by infrared phototransistor opt-couplers. Although, in this prototype, devices are installed into plastic box and put on the top of the microwave oven as shown in figure 2, all devices are set into the microwave oven when develop it as commercial product. Figure 3 shows block diagram of the monitor.

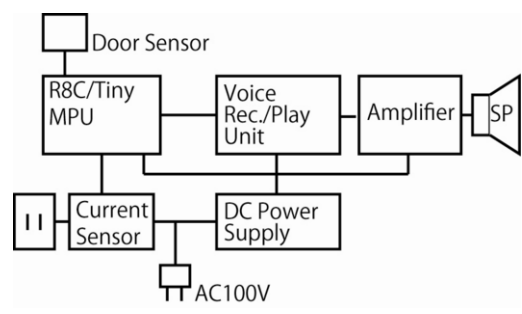Figure 2. The prototype placed on the top of the microwave oven

Figure 3. The block diagram of the prototype

3.3.2. Smell warning

The Gas sensor which can detect hydrogen sulfide (H_2S), methanethiol (CH_3SH), ammonia (NH_3) and alcohol (C_2H_5OH) is adopted to check some foods going bad. When the door of the refrigerator is closed, the sensor detect the air in it and store the data. When the door is opened next time, it will talk according to the stored data. The figure 4 shows the block diagram of the smell warning device.
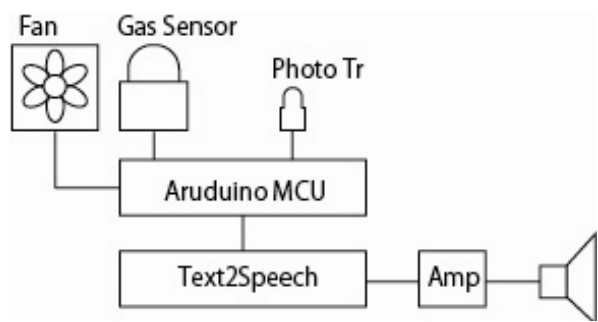
Figure 4. The block diagram of the smell warning

3.3.3. Front door monitor

This was designed for old dementia lady who lived with her son, according to her son's complaint that "My mother go out frequently in the evening to visit and talk together with her neighborhood when I am working. I want to detain her with my voice." When the infrared motion sensor detect the human body approaching to the front door, green LED light up to indicate it. Others such as her son or care giver can stop talking but she cannot do it, then the recorded son's voice talk to her after few second. Unfortunately, she moved into institution before the device was prepared. But it worked well in other case. The old lady who lived with her spouse frequently left home. Dr. Rumi recorded a message to quit leaving home by her voice, "Well, Ms. xxx where are you going at

such a late time? Please back to your room". According to her spouse's report, at the first night, she walk to the front door, but she returned to her room when the voice came out. Some days ago, she walk back to her room murmuring the message.

This report suggested some important points to this device. The first is the message should suit to time zone. The second is the sensing angle should be narrowed not to detect unnecessary movement. And the third is it might be placed more freely at the front door. According to these suggestions, the authors are going to design new type. Figure 5 shows the situation of trial, and figure 6 and 7 shows block diagrams of the first model and the second model.
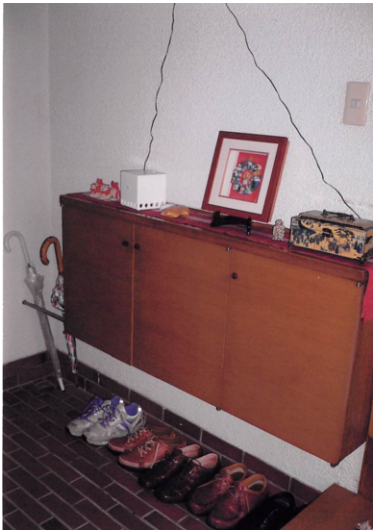

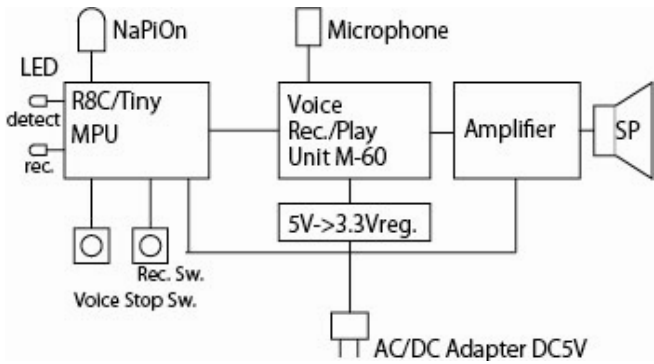Figure 5. Front door monitor put on the cabinet: The white cubic one.

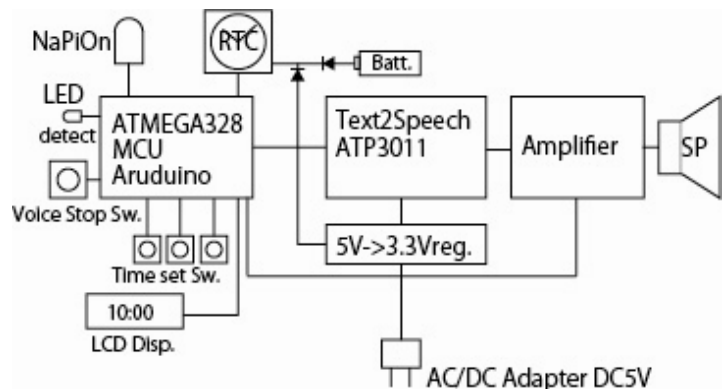Figure 6. Block diagram of the front door monitor first model

Figure 7. Block diagram of front door monitor second model

3.3.4. Indoor climate monitor

It is quite hot and humid in summer in Japan. In the urbanized area, usually the windows are shut and people depend on air conditioner to keep cool. Several elderlies who live alone died by heatstroke in last summer. So substantial elderlies are apt to be patient not to power on the air conditioner and are inclined to be insensitive to temperature, that a device which monitor temperature, humidity and air pressure then advice to take appropriate behavior. Figure 8 shows the block diagram of the device.
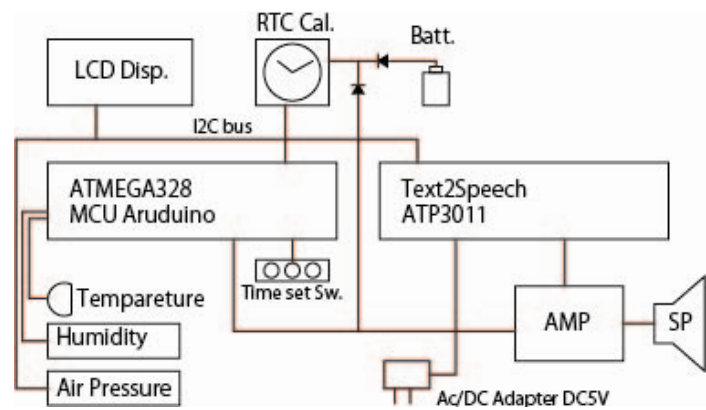

Figure 8. Block diagram of the indoor climate monitor

4. Discussion

The authors found following seven principles through the survey and these proto typing.

4.1. Some basic home appliances are quit using by change of family members or change of life stage

The iron becomes unnecessary by choosing wears, and the vacuum cleaner is replaced to chemical mop to save trouble. Cooking rice and various foods are replaced to bread and pre-cooked foods after losing spouse.

4.2. To hide unnecessary controls or to mark up major controls are effective measures

Too much functions or various settings are prepared on home appliances especially in Japanese ones. It is effective to hide controls except automatic or essential some controls. In case of mobile phone or codeless phone, as the button to connect line is forgotten often, adding colored seal to mark up it works well.

4.3. Rotary type controls are preferable than push button type controls

In case of setting time or temperature, it is easier to understand how to control by rotating nob than by pushing up or down buttons. In cade of the volume controls, triangle shape or up/down arrows may be overcame with Chinese character '大 = Large' and '小 = Small' or symbols of plus '+' and minus '-', because of its symbolic shape. These Chinese characters are effective to avoid confusion with choosing channels.

4.4. Operation steps should be shorten as possible

Unlock switch or on-line switch are difficult to remember to touch. The appliances should be designed to guide accurate operation by voice or flashing illumination, or be designed to allow canceling and start automatically after definite seconds.

4.5. Guidance by voice is effective for all

The warning or queue by melody or buzzer require understanding of each meanings, so the voice message is quite effective to recognize it. The messages must be considered well: it must not order any behavior but just tell the conditions. It is highly important to guide voluntary action and decision making. Because the heading of the voice is tend to miss, some jingle should be added to catch attention.

 The source of the voice must be considered well. There is no answer yet, which is better for dementia the recorded voice or the synthesized voice. In emotional aspect, the recoded voice is better than the synthesized, however it has too much sentiment to tell the conditions. In case of brain damaged young lady, she dislike to hear her mother's voice which tell the toilette not flushed. She felt be commanded from the voice.

4.6. Small retail shops of electric appliances for technical assistant

The mass retailers become major in Japan, and the small retail shops are withdrawing rapidly. This situation becomes big problem for elderlies who live alone or without young family. The elderlies feel hard to exchange bulbs or batteries, or to go shopping.

The small retail shop as neighborhood will assist them as one of the resource of social care.

4.7. Continuity of accustomed appliances or interfaces

Not only the dementia or MCI but also sound elderlies feel difficulty to learn operation of new appliances. When the accustomed appliances breakdown, replacement to new model is become popular than repair, then the new model has new user interface or added functions. The regeneration of repair system or replacement of infill will become necessary in coming super aging society.

5. Acknowledgments

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