

# Support Technologies for the Elderly

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The main purpose of support technologies for elderly is to maintain physical and mental ability so as to achieve higher quality of life. Unfortunately, aging of cellular level is still unavoidable even by the most advanced sciences. Due to aging, each organ function diminishes, and recovery from illness becomes difficult. In some exceptional people, a good balance in physiological function is maintained naturally even above hundred years old, but majority of elderly need medical and welfare services. Therefore, it will be reasonable to apply technology first to maintain physiological balances, and then to substitute the defect of function. However, in each individual, urgent need is always to improve the condition when physical problems occur. Most efforts have been done in this line. Only recently, technologies for maintaining health are appearing. In this talk, I will try a brief review of present research works in this field in Japan especially in the national project of longevity science, and then introduce our attempts of home health monitoring.

The national project of longevity science was started in 1990 funded from the Ministry of Health and Welfare. In 1997, about 130 research groups are involved in it, and spends about 1.3 billion JPY.

While the amount of total fund is not so big, this project covers major fundamental researches just going on in Japan. It covers research fields from fundamental medicine to engineering and social sciences relating problems of aging. Among them, 10 research groups relating support technology are involved. Research topics of support technology are:

- Outdoor monitoring
- Home health monitoring
- Support technology for health management
- Early diagnosis system
- Support technology for locomotion
- Support technology for independent living
- Communication support
- Automation in elderly care
- Support technology for rehabilitation
- Application of high technologies

About 90 million JPY were spent in these studies. Annual report (in Japanese) of these studies has been published by the Society of Promoting Aging and Health Research (1-3-6 Toranomon, Minato-ku, Tokyo 105).

In the research of support technology, most groups

consist of medical and engineering peoples. Good cooperations have been progressing. For example, an anatomist has been contributed greatly in the development of a functional electrical stimulation system which requires accurate positioning of intramuscular stimulating electrodes. Many entirely new concepts were proposed both from medical and engineering sides. For example, a cylindrical bath tub was proposed by a medical doctor which realizes bathing at standing posture due to buoyancy and applicable even for bed-ridden peoples. It was shown that it is realizable and fairly comfortable.

Home health monitoring is a concept emerged from the discussion of medical and engineering research members. In the national project of longevity science, there have been many attempts of patient care at home. Being cared at home will be more comfortable than in hospital. It is also expected to reduce medical cost by reducing hospitalization. It is obvious that to reduce the need of medical service is much better than any medical treatment. However, actual situation is the opposite. Great many efforts have been done to treat illness, but curiously, efforts to reduce illness were quite limited. Elderly peoples are always vulnerable for illness because of aging progressing at cellular level. So careful monitoring of health will help to find early signs of illness, and it is more desirable to apply monitoring for maintaining health at a higher level of healthiness. From such consideration, our group has been attempted to develop home health monitoring systems, and it has been involved in the national longevity science project.

We thought that monitoring system can be accepted by ordinary elderly people only if monitoring is achieved fully automatically so that it

does not disturb ordinary daily life. By this requirement, most of existing medical devices and instruments can not be employed for this purpose. Even a simple procedure such as to measure blood pressure by an electronic manometer requires an effort which inevitably disturb daily activity. Ideal way is to obtain physiological information without attaching any device to the body, and monitoring is performed automatically so that the subject is not aware of being monitored. There is no existing technique to satisfy such requirement. So we consider completely different methods from existing techniques [1-4]. At present, we are attempting three possibilities, which are 1) Monitoring during sleep in a bed, 2) Monitoring at a toilet and 3) Monitoring at bathing.

Because these measurement sites are involved in ordinary daily life, it is expected to obtain health information every day without requiring cooperation of subject if the systems are fully automated. Each method of obtaining health information is a challenge of technology. While our attempts are still limited and fairly primitive, we found that this concept is promising.

At a bed, we put thermistors beneath the sheet either along a line perpendicular to the body axis or in matrix arrangement. It was found that body movements can be detected as the changes of temperature profile, and it can be used as a sleep monitor [5,6]. Another study showed that ECG and respiration can be monitored by attaching conductive clothes on the sheet at the head, chest and lower limb levels. While large artifacts appear at body movements, it was shown that fairly stable ECG and chest impedance change which reflects respiration could be obtained when the body is quiet [7].

At a toilet, one of my colleague attempted body weight measurement using a precision load cell installed at the floor beside the toilet, and the toilet seat is supported by a frame so that the weight loaded to the seat is also loaded to the same load cell at the floor. It was shown that body weight can be measured automatically in high accuracy, and beside that, the weight of urine and feces can also be measured by the decrease in body weight [8].

At bathing, ECG monitoring in a bath tub was attempted. Very many people in Japan take bath almost every day using a deep tub where the water almost covers the shoulder. Electrodes were attached on the inside wall of the tub near the extremities. It was shown that quite stable ECG can be obtained through the tap water [9]. While the wave forms obtained are not identical with those of standard limb lead, quite similar wave forms are always observed. Personal identification from a slight differences in wave forms between subjects was attempted, and a preliminary study showed that ECG wave forms in a family could be identified even it has up to 5 members [10].

There are some other attempts in this concept. For example, Celler et al. At tempted monitoring daily activities in a house where many sensors such as infrared interrupters and magnetic switches are installed at doors and appliances [11]. Ohta et al. also reported similar study using piroelectric infrared sensors [12]. An attempt is now on going in which many sensors are installed in an experimental house build in Toyama, Japan [13]. From these experiences, we convinced a possibility of fully automated home monitoring which will provide long term health data without awareness of each subject. There are many

other possibilities of applying existing technologies for home health monitoring, and also more possibilities will be conceived if future technologies are considered.

Accumulated data will be utilized primary for each subject. From the long term data, normal range of each health parameter will be determined for each individual which will be quit narrow comparing with that in a population, and thus, small change in such parameter can be a significant information. When the subject becomes ill, accumulated data can be analyzed retrospectively so as to utilized for diagnosis. Such data will also be an important database for epidemiological studies.

As mentioned above, many projects of support technology for elderly are now progressing in different facilities in Japan. The home health monitoring is becoming an important topic because it will contribute to maintain good health condition in elderly living at home, and in future when such technologies are accepted widely, it is expected to be a possible solution for serious increase of medical economy.

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