Utilization and Impacts of GPS Tracking in Healthcare: A Research Study for Elderly Care

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ABSTRACT
This study provided awareness about the importance of Information and Communications Technologies (ICTs) in healthcare. This research evaluated existing tracking devices for elderly people and identified the difficulties and possible solutions in the performance analysis. There were two GPS (global positioning system) tracking devices examined and tested by eight elderly subjects and a questionnaire survey filled at the end. The first device was simple and easier in handling while the second device has more features and slightly difficult in handling. These devices can potentially increase the privacy and raises self-motivation in elderly. Nevertheless, these devices were not suitable for (i) memory loss patients because they cannot handle these kinds of devices. (ii) A significant issue was also the maintenance of the device itself: who reminds the elderly patients about to use and who recharges the battery. This may create a similar situation as with the other use of telemedicine technologies and raised ethical concerns. However, these kinds of devices can be very important to reduce the major risk of elderly people getting lost, and provide the peace of mind to caregivers. In addition, homecare-tracking devices can be helpful in reducing the rush at healthcare centers and provide cheap solutions in remote monitoring of elderly.

Keywords
Elderly Care, information and communication technology (ICT), telemedicine, GPS tracking devices.

1. INTRODUCTION
The population of elderly people is increasing worldwide dramatically. This problem can increase the rush and financial budget of healthcare centers. According to an estimate by the Center for American Progress, there were 34 million elderly Americans in 2007 and this number was predicted to increase to 80 million by 2050 [1]. Similarly in Europe, it was predicted that people over sixty-five will make up one-third of the EU population by 2050 [2]. In Finland, 130,000 people are suffering from dementia and Alzheimer's disease [3]. There are many patients less than 60 years of age suffering from dementia and Alzheimer's disease and need to be the same treatment as elderly. This rather immense issue now needs urgent attention, otherwise normal healthcare and hospitals will be under tremendous pressure if forced to handle such a large number of elderly patients.

The traditional healthcare system needs to adopt the latest Information and Communications Technologies (ICTs) that monitor a number of patients simultaneously and alert the caregiver or nurse in case of an emergency.

The merger of ICTs in healthcare introduced a new field known as Biomedical Engineering (BME) [4]. A sub-branch of BME that merged with telecommunication is called telemedicine [5] provides homecare solutions that can make the life of the elderly independent and easier to perform daily life routine.

There are different kinds of home-based healthcare research going on worldwide. This research mainly focused on the tracking devices for an elderly monitoring system. ICTs play an important role in the development of homecare tracking devices. The following are the technologies that are using in the manufacturing of tracking devices: Radio Frequency Identification (RFID), Global Positioning System (GPS), Global System for Mobile communications (GSM), and General Packet Radio Service (GPRS) [6].

This work has been initiated and carried out by the help of the Telemedicine Laboratory of Tampere University of Technology and South Ostrobothnia Health Care District (EPTEK) located in the MediWest Technology Center in Seinäjoki, Finland.

2. METHODS
This research work was carried out in two parts. Firstly, there was a literature study about the available tracking devices. Secondly, eight elderly patients tested two different tracking devices and then a questionnaire was filled in person interview about the performance of devices. The municipalities' homecare unit chose these elderly participants, who live in rural areas of Southern Ostrobothnia, Finland.

2.1 Literature Review
GPS and GSM are generally used in the manufacturing of tracking devices to enhance the privacy of a patient [7]. Previously, researchers focused on RFID technology only but now GPS are widely used in tracking because of real time navigation. The free accessibility of GPS technology has boosted the mass research and production of GPS tracking devices [8].

In recent years, research has been started on the adaptability of tracking devices for elderly care and analyzed the thoughts of family and caregivers towards the use of GPS and RFID for tracking devices. The main motivation behind the use of GPS and RFID technology in elderly care is to enhance the independence and privacy of the elderly, and reduce the problems of caregivers. According to an estimate that family caregivers showed more interest in the use of GPS tracking devices instead of hiring professional caregivers for the safety of the elderly. Both family and professional caregivers agreed on the point that caring for elderly patients via GPS tracking devices is an internal family matter. Family caregivers

emphasized that tracking devices must be simple and user-friendly. Furthermore, the future of GPS and RFID based devices are bright, and improving gradually to enhance the quality of these devices and make them as simple as possible [7]. In this research, EPTEK ry provided two tracking device for testing purposes and finding the opinion of elderly.

2.2 Tracking Device 1

The device 1 was about 7.7 cm in height, 4.45 cm in width, and 2.7 cm in thickness. This device was composed of a GPS receiver, GSM modem, GPRS service, and the location of a device was monitored online provided by the device manufacturer. For analysis purposes, a specific path was chosen about 1.25 km that consists of a narrow walking track that continued to the main road, crossing a market, then a school, which usually take fifteen to twenty minutes. Observations that noted during the test performance were the efficiency of sent alarm messages when the emergency button pressed. Then the positions of devices were monitored every five minutes on the web, and if the battery power was low or turned off then checked the efficiency of sent alert messages.

2.3 Tracking Device 2

The device 2 was about 9.1 cm in height, 4.4 cm in width and 1.9 cm in thickness. This device was also used for tracking purposes, which includes an additional feature of calling in case of an emergency. This device was also tested in the same way as device 1.

2.4 Questionnaire Survey

A questionnaire was filled by eight people, who used these devices. This was in person interview with elderly people between ages 72 to 89 years old. This questionnaire was made to assess how much these people were satisfied after using these devices. The questionnaire was organized into multiple-choice questions, allowing the user to select the best option. It took roughly five to six minutes to fill in the questionnaire form.

3. RESULTS

3.1 Literature Review

Most of the scientific researches related to tracking devices were started with the aging population problem [9]-[11]. According to WHO (World Health Organization), approximately 1.2 billion people will be above 50 years of age by 2025 [9].

The usage of GPS satellite technology in homecare provides the peace of mind for family members as well as professional caregivers [10]. These devices were non-invasive and designed in such a way that an elderly can be used them easily.

GPS found to be the most useful technology in the manufacture of tracking devices. An ideal model was discussed for homecare technology where devices can be performed multitask functions such as monitoring the heart rate, control ceiling fans, adjust a thermostat, adjust an entertainment system setting, display GPS connectivity, and raise and lower blinds within a single device [9].

3.2 Performance Analysis

In the performance analysis of devices, the focus was on efficiency of sending or receiving an alert messaging to the caregiver. Once the emergency button of the device was pressed on a predefined path, within a few seconds an SMS message was received on the caregiver's mobile about "Button Alarm". The accurate position was marked on the web where the emergency button was pressed.

Next, when the battery power was low, an alert message was sent by the device about "Low Battery" and this message was continuously sent in every half an hour. After two hours when the device totally lost power, another SMS was received about "Device Off" and the time of the message indicated when the device was turned off.

The device lost GPS connectivity when it entered a covered shelter or inside a building and connect again after coming out from the building but the device took a long time about three to five minutes before receiving the GPS signals again. This lost of the signal cannot be reported as an alarm signal and the exact location point is missing on a web.

3.3 Questionnaire Survey

Table 1 shows the resultant elderly opinion about these devices. Multiple-choice questions were asked which gives a rating from one to five. Rating one means poor performance, two fair, three average, four good, and five for excellent performance.

Table 1. Observation and Result of Devices

(n=8)	Device 1		Device 2	
	Rating (Mean)	SD	Rating (Mean)	SD
Handling	4.0	0.58	3.33	0.58
Comfortable feelings	3.43	1.13	4.33	1.15
Battery Life	3.71	0.76	4.33	0.58
Personal grading	3.29	1.11	3.67	0.58
Recommend to others	4.14	1.07	4.33	1.15
Interest in new version	3.57	1.90	4.33	1.15
Call feature	N/A	N/A	4.80	0.45
Overall Performance	2.71	0.95	3.33	0.58
SD= Standard deviation				

4. DISCUSSION

The objective of this research was to provide information about tracking devices and create awareness among the caregivers, elderly or professional caregivers [11]. The performance analysis of two devices shows that they were simple and user-friendly devices. Some users feel difficulty in using it, as they have never interacted with devices of such kind before. Most of the elderly were satisfied with device performance and battery life. The size of devices was reasonable, but the handling was not easy for elderly people because it was difficult to remember or remind them to keep the device when they were going out and it must be switched on. Device 1 was easier to handle because only a single button has to be pressed in case of an emergency while Device 2 has five different functionality buttons that confused some of the elderly. The GPS connectivity was weak and took about three to five minutes in established satellite signal connection that may annoy the elderly. Web tracking was straightforward, but

the map information was not much descriptive means the device did not locate well how far from any main street or road if the elderly was in a small town. The efficiency of the device to send alert messages was excellent. Delay can be experienced depending on the GSM service provider but the device sends alert messages immediately.

These tracking devices were easier in handlings that have experienced using electronic gadgets like smart mobile phones. An elderly person must be remembered to press the emergency button on the device in cases of an emergency because there was no sensor technology used that detected the elderly movement.

However, a caregiver can defined a specific alarming area perimeter from which elderly cannot move out. Fig.1 shows a specific area, alarm set for a 400-meter radius and check positioning after every ten minutes. The red dots represent the position of a device; this positioning was pointed after every ten minutes or whenever caregiver wants to see the current position. The green line shows the direction between the two consecutive points where the device was moved and the bus icon shows the current position. If the user moved out of specific range, then the device would send an alert message to the caregiver.

The questionnaire surveys about these devices were highly valuable in terms of knowing the opinions of elderly. Elderly people felt somewhat comfortable with these devices when they went for a walk alone without any helper. Some of the elderly suggested that the sizes of these devices should be smaller and shape like a wristwatch.

One of the biggest fears about these devices is the reduction of human interaction between the environment and elderly people. This may create a situation as with the other use of telemedicine technologies that are under debate regarding ethical concerns [12].

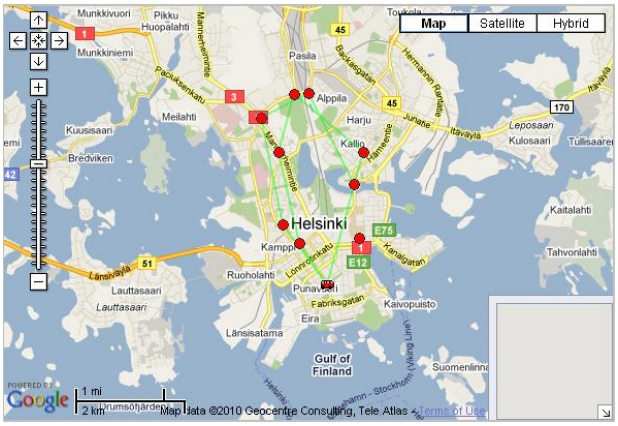

Fig. 1. Tracker Security Locator webpage.

5. CONCLUSION

Elderly people feel independent and easier to perform daily routine life with the help of tracking devices. These devices can raise independence and enhance self-motivation in elderly life. However, these devices took a long time in establishing a GPS connection. More perfection is required in web tracking because the webpage does not update quickly and shows delay in locating the device position accurately. More accuracy is required and maps that are more detailed should be designed for web tracking. There were some important suggestions given by the elderly users; the device size needs to be smaller that help them in handling. It must be foolproof and needs to be good enough for long-distance travelers. The device must work inside buildings and that can be possible by embedding A-GPS (Assisted-GPS) hardware. Moreover, all the history of each elderly must be maintained in an electronic patient record system.

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