A Study on Senior Behavioral Analysis and Care System Using Big Data

Jae-Youl Jang · Jin-Il Choi · Je-Sun Uh · Chul-Jae Choi

ABSTRACT

Various applied solutions utilizing the technology of the 4th Industrial Revolution are being applied to the health and welfare sector. In the proposed paper, the senior care system solution based on big data is designed. The principles of operation of the proposed system are collecting senior behavioral analyses through API information of smart devices, and sending a primary notification to the relevant senior in cases where a senior reacts differently from the existing standards. A system is proposed to prevent dangerous situations by providing information to peer seniors, family members, and the emergency center in cases where there is no response.

키워드
Senior Care, Big Data, Cloud, Artificial Intelligence, Block Chain
시니어 돌봄, 빅 데이터, 클라우드, 인공 지능, 블록 체인

Ⅰ. Introduction

The steady increase in the senior population indicates that our society aged society and is becoming a super-aged society [1]. The technologies of the fourth industrial revolution are discovering diverse solutions necessary to be prepared for an aging society, and the government has been concentrating on the commercialization of solutions developed ranging from IoT (Internet of Things)-based systems installed in the houses of seniors to solutions that apply sensors to dolls, and applied solutions usable through smartphone apps in tandem with the relevant companies.
In particular, among senior citizens, those who live alone act in their houses for more than 60% of their time, and their fatal dangerous situations due to fracture cannot be smoothly dealt with in their houses[2].

The purpose of the proposed paper is to develop a system that will continuously collect daily activity information from the elderly living alone among those senior members who use smart devices, notify the relevant elderly living alone in cases where any abnormal symptom different from conditions at normal times was detected, notify peer senior members in the surroundings in cases where the symptom is not resolved, and finally notify the risk element to family members and emergency relief facilities.

In Chapter 2, information on senior citizens living alone and similar solutions are defined based on related studies, and in Chapter 3, the design of solutions for care services for senior citizens living alone is defined. Finally, in Chapter 4, measures to implement and commercialize the design are defined through conclusions.

II. Related Works

2.1 Analysis of the environment of the elderly living alone

The number of the elderly living alone is continuously increasing due to the deepening of aging and changes in the attitudes toward parent caregiving[3]. In particular, given the trend of increasing single-person households due to changes in living culture such as late marriage and non-marriage, the number of the elderly living alone is expected to continue to increase in the future[4]. In addition, the increase in alcoholic patients and suicide problems in the elderly due to drinking are also magnified [5,6].

As of 2018, the number of the elderly living alone reached 1,405 thousand out of the entire elderly population of 7,384 thousand, and is expected to increase to 1,990 thousand out of 10,508 thousand by 2025. This prediction means that as of 2025, 20% of the total population will be the elderly population and that 18.9% of them are the elderly living alone, who need help from surrounding people.

However, while the number of accidents occurring in the houses of the elderly living alone is constantly increasing, the recognition and measures to respond to accidents are significantly inferior to those of the general elderly population. The proposed paper aims to investigate the continuously increasing activity areas of seniors in advance with a view to preventing dangerous situations with solutions as countermeasures, and provide information on the activities of seniors to the academia and technology developing companies.

Table 1. Estimation of the elderly living alone (Unit : Thousand people)

<table>
<thead>
<tr>
<th>Classification</th>
<th>2010</th>
<th>2018</th>
<th>2022</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of elderly people (Ratio of the total population)</td>
<td>5,452 (11.0)</td>
<td>7,384 (14.3)</td>
<td>8,978 (17.2)</td>
<td>10,508 (20.0)</td>
</tr>
<tr>
<td>Number of senior citizens aged 65 or older living alone (Ratio of the elderly population)</td>
<td>1,056 (19.4)</td>
<td>1,405 (19.0)</td>
<td>1,714 (19.1)</td>
<td>1,990 (18.9)</td>
</tr>
</tbody>
</table>

Fig. 1 Trend of elderly damage caused by fire accidents
In Figure 1, the top two lines of the chart represent the numbers of injured persons by age, and the bottom two lines of the charts represent the numbers of deaths by age. In the analysis of accident cases, the accidents can be classified into safety accidents such as smoke or toxic gas inhalation and burns, toppled or slipped, building collapse, and lacerations. Among the places of occurrence of safety accidents, houses were shown to be the most frequent at 60.5% and among the causes of accidents, falling was shown to be the most frequent at 47.4%. Among the places of accidents in the house, bedrooms and rooms were the most frequent at 15.0%, followed by toilets and bathrooms at 11.0%, and living rooms at 8.4% [7].

2.2 Present situation of domestic development

<table>
<thead>
<tr>
<th>Service Provided</th>
<th>Service Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emergency Safety Care System</strong></td>
<td>- Eliminate safety blind spots for the elderly living alone and provide specialized welfare services&lt;br&gt;- Establishment of a community-based regular protection system through the provision of emergency safety services for severely&lt;br&gt;</td>
</tr>
<tr>
<td><strong>Telecare Service</strong></td>
<td>- Emergency safety monitoring in homes for the elderly living alone and severely disabled</td>
</tr>
<tr>
<td><strong>Social Abbreviation Smart Location Management System</strong></td>
<td>- Identifying location information and providing reassurance notification and emergency call services for the elderly with dementia, the physically handicapped, and the socially disadvantaged</td>
</tr>
<tr>
<td><strong>Healthcare Service</strong></td>
<td>- Use infrared sensor and IMU sensor technology to send various measurement data to the server and use it to treat the elderly with intellectual disabilities and dementia</td>
</tr>
</tbody>
</table>

In line with the continuous increase in the elderly population, domestic core related technologies are developed in various fields. To date, research and development has been activated centering on exercise and rehabilitation for the elderly [8], the severely handicapped, and the elderly with dementia, who are specific subjects, but no technology has been developed for the entire elderly population.

2.3 Present situation of overseas development

Solutions for dying alone and disabled and aged populations, which are problems in a super-aged society, are being developed and released centering on Japan. Products developed thus far are hardware-based solutions, and have problems such as difficulties in operation and maintenance.

<table>
<thead>
<tr>
<th>Service Provided</th>
<th>Service Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Silver watch</strong></td>
<td>- It is a product exclusively for the deaf. Connect the intercom or phone at the front door to the transmitter, and if there is a customer or call, the information is transmitted to the device around the arm to inform you by vibration, light, text, etc.</td>
</tr>
<tr>
<td><strong>Wandering senile surveillance system</strong></td>
<td>- A system that detects elderly dementia patients who want to go out with sensors and notifies their guardians, such as their families, amid the growing number of accidents caused by elderly people with dementia, such as traffic accidents caused by elderly people with dementia.</td>
</tr>
<tr>
<td><strong>Net service for protection of living rhythm</strong></td>
<td>- A system to check the use of electricity, temperature changes, and the opening and closing of windows, and to check their safety through the Internet.</td>
</tr>
<tr>
<td><strong>Nintendo DSi LL</strong></td>
<td>- It is a product that was first listed in the Guinness Book of World Records as a healing robot. A robot capable of interacting with humans physically, mentally and socially (sensitive to light, temperature, hearing, touch, facial expression).</td>
</tr>
<tr>
<td><strong>PARO</strong></td>
<td>- It was first listed in the Guinness Book of World Records as a healing robot. A robot capable of interacting with humans physically, mentally and socially (sensitive to light, temperature, hearing, touch, facial expression).</td>
</tr>
</tbody>
</table>

III. Studies of senior behavioral analysis and care systems using big data

3.1 Design of scenarios for caring for the elderly living alone

The behavioral analysis and care system for the elderly living alone that will be designed in the proposed paper, is a solution that enables coping with dangerous situations in advance by enabling family members, colleagues, and the members of the life managers to share the activity information of the relevant elderly living alone through a smartphone application within the privacy environment.
Figure 2 shows the design of a service in which life managers, family members, and emergency relief facilities, who are application users, analyze sleep and non-sleep information, corresponding to daily life, and location information, focusing on the elderly living alone [9] and provide danger notice information to the elderly living alone and the members in sequence in cases where the solution recognizes quantitative information different from that at certain time, and the emergency relief facilities collect the danger notice information and visit the relevant elderly living alone.

3.2 Service flow diagram design

The design of senior behavioral analysis and care systems using big data [10] consists of a service architecture, big data collection for voice and face photo analysis, artificial intelligence analysis, and a blockchain service for sharing information among emergency relief facilities.

3.2.1 Service architecture

After signing up for membership, the relevant elderly living alone registers daily information as meta-information and based on pattern analysis through continuous self-learning, the relevant elderly living alone is notified first when any abnormal symptom has occurred. In cases where there is no response to the abnormal symptom, the information is notified to colleagues and life managers, and emergency relief facilities are connected depending on the presence or absence of an abnormality at the time of the visit.

Table 4 shows the system construction environment based on the e-government framework considering scalability.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Framework</td>
<td>E-government framework 3.8</td>
</tr>
<tr>
<td>UI</td>
<td>bootstrap</td>
</tr>
<tr>
<td>Application</td>
<td>JAVA (jdk-8u73)</td>
</tr>
<tr>
<td>Data Base</td>
<td>Maria DB 10.4</td>
</tr>
<tr>
<td>WAS / OS</td>
<td>Tomcat 8 / Ubuntu 16.04</td>
</tr>
</tbody>
</table>

The proposed solution in Figure 3 provides Real Talk and photo-taking menus. The elderly living alone can focus on conversation and photo-taking through the menus, and since the information is shared with the life manager, base data are provided so that the situation of the elderly living alone can be recognized at normal times.

3.2.2 Big data scenario

To analyze big data of the elderly living alone, the activity information is analyzed using the acceleration sensor (Type_Accelerometer), the user location change detection sensor (Type_Significant_Motion), the user step recognition sensor (Type_Step), and the user face recognition sensor (Type_Face).
sensor (Type_Step_Detector), and the step count (Type_Step_Counter) after booting the terminal provided by the smartphone, the voice information and photo information are organized into event information corresponding to individual personal information, visualized, and systematized into the form of a dashboard. Thereafter, the relevant information is provided to the top manager and life manager, who require it.

3.2.3 Artificial intelligence scenario

Based on the collected information on the elderly living alone, the highest and lowest values and average information are correlated to make meaningful data on accidents and diseases into rules and models and create an algorithm. Abnormal situations and dangerous situation are judged through the relevant algorithm. Figure 5 shows the process of artificial intelligence scenarios to analyze abnormal situations by individual and define them as daily and dangerous environments.

3.2.4 Blockchain element technology

The data on the elderly living alone should be connected as blocks to design the technology so that the data in the entire blocks cannot be falsified or stolen. Individual participating nodes should be decentralized so that the data cannot be hacked and since the data ledger is distributed for storage, safety should be ensured so that data can be easily recovered even when problems have occurred in the data of some server nodes in the event of a disaster.

Figure 7 shows the hyperledger composer technology for storing and managing the activity information of the elderly living alone in the server. To make the health_idx (sequence ID, which stores the activity information of the relevant elderly living alone in regular time units), senior ID (elderly living alone identifying information), stepCount (Check the number of steps of the elderly living alone), latitude/longitude (collect location information through latitudes and longitudes), and individual servers in the emergency relief facilities independent from each other, the hyperledger rest server for blockchain application has the functions of a full node server (synchronization among servers using block chains), and synchronization of all servers and ID based synchronization.
3.2.5 Cloud design

In cases where the number of the elderly living alone to be managed increases or the area where services are introduced expands, a technology is needed to ensure the scalability of the server at a minimum cost.

![Cloud design](image)

Through Figure 8, the introduction of cloud which enables easy and efficient expansion of servers when a new service has been added and system resources are insufficient is designed.

3.2.6 ERD design

In this section, the DB structure for user information (elderly living alone, life manager, family member) and issue information (activity information and location information of the elderly living alone) applied to the senior behavioral analysis and care system, and notices and operator information of the app solution were designed with ERD.

![ERD design](image)

3.2.7 Design of emergency service flow chart

The process through which the activity information of an elderly living alone is identified from the elderly living alone in cases where the situation is judged to be urgent because there is no activity information of the elderly living alone and the urgent situation which communicated to the liked members is designed through this menu.

![Emergency service flow chart](image)

Fig. 11 shows the design of emergency situation prediction and location information tracking in cases...
where the elderly living alone deviated from the daily path based on the relevant location information after periodically collecting activity information and location information of the elderly living alone.

It is a scenario through which operators with authority, such as life managers, can collect motion information of the elderly living alone through the DB in normalized time units, collect the location information as latitude and longitude information in the app menu, and thereafter monitor real-time motion information.

Fig. 11 Emergency situation prediction and location tracking design

IV. Conclusion

Diverse applied solutions incorporating the core technologies of the fourth industrial revolution are being developed, and the proposed paper aims to design a care solution for the elderly living alone that can monitor dangerous situations in advance after analyzing activity information.

This solution has a scenario through which information at normal times is collected as big data through the sensor of a smart device, a notice is given to the elderly living alone to identify whether there is any abnormality in cases where an abnormal symptom has been identified based on activity/inactivity information and location information, the information on the dangerous situation is shared with peer senior members, family members, and life managers through messages in cases where there is no response, and the information is finally delivered to emergency relief facilities.

The proposed paper is a step before implementing care system after designing senior behavioral analysis and aims to expand the service to single-person households and children who are in the socially vulnerable class after developing the technology later.

References


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