

System Thinking Project Proposal

ELAR (Elderly Life Assisting Robot)

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1. Problem Situation

a. Executive summary

b. States the problem

The U.S. older population, persons 65 years or older, was numbered 37.3 million in 2006. They represent 12.4% of the U.S. population, which means that there is about one elder person in every eight Americans. By 2030, there will be about 71.5 million older persons, more than twice the number in 2000. People 65+ represented 12.4% of the population in the year 2000 but are expected to grow to be 20% of the population by 2030. This population structure will produce a lot of problems to society, especially with eldercare issue. As the elder population increases, the Aged dependency Ratio, the ratio of the economically dependent aged part of the population to the productive part, would increase as well (see equation below). Hence, it would be increasingly difficult to find an adequate source of labor to take care of this population.

$$\text{Aged dependency ratio} = \frac{\text{number of people aged 65 and over}}{\text{number of people aged 15 - 64}} \times 100$$

In order to help the elderly enjoy the rest of their life, it is necessary to establish an efficient eldercare system that requires minimum human labor in assisting them with basic living tasks and focuses on improving the social life for them. The major technology for this system is the use of elderly care robots in various tasks.

c. Describes the customer

The customers of the system include the elderly at home or care center, and the disable people at home.

d.

2. Customer Requirements

a. Detailed problem statements

As mentioned above, with the population of elderly increasing every year, many countries, including the U.S., will soon face more difficulties with elderly care issue. There will be a shortage of labor to take care and maintain a safe living environment for them. According to the statistics, over 90% of the elderly live at home and the number who stays at nursing home actually has reduced over the last few years. Therefore, one of the major goals in elderly healthcare industry is to provide adequate aids for the majority of old people who stay at home and only require a minimum amount of human labor. In attempt to help solving this issue of managing elderly care more efficiently and effectively, our team suggests a creation of a homecare robot, named ELAR (Elderly Life Assisting Robot). This homecare

robot can perform various tasks such as house chore, entertainment, and the most important job is to assist older people with daily medical care at their home.

b. Specific Requirements of the system

i. Medical care aid

- Remind to take medication daily
- Communicate to elders from time to time to check that everything is ok. If not, call for help
- Detect people lying on the floor and call for help

ii. Entertainment

- Play game
- Play music and have the ability to update music selection over internet
- Access to news through internet and read them to the users

iii. Household aid

- Transport and lift objects up to 20 pounds
- Turn on and turn off lights
- Recognize and greet guests
- Write and send emails for the users
- Get mails from the mailbox

iv. Other functions

- Detect smoke, fire and hazard gas
- Memorize phone numbers and daily agenda
- Has learning capability

3. Derived Requirement

a. Technical Description: In order to satisfy the above customer requirements, from the system engineering's prospective, ELAR needs to have the following capabilities:

i. Functions of ELAR

- Walk
- Detect objects and surroundings
- Grasp and lift objects (up to 20 pounds)
- Recognize voice and take command
- Recognize face
- Talk
- Connect to wireless network
- Has ability to memorize
- Detect smoke, fire and hazard gas
- Has learning capability
- Preprogrammed with music and games selections.

ii. Detailed technology implemented in ELAR

- Walk: Servo motors are used on ELAR's leg and arm joints in order to help the robot move and turn.
- Detect objects and surrounding: In order to implement this function, ELAR's design includes two cameras installed at its eyes, floors surface sensors and

ultrasonic sensors. ELAR is preprogrammed to recognize different object shapes so that if it detects body shape on the floor, it will call for emergency help.

- **Grasp and lift objects (up to 20 pounds):** Several force sensors are placed on ELAR's hands which allow the robot to sense the weight of objects and calculate how much force it needs to lift them.
- **Recognize voice and take command:** 3 microphones are placed in front of the robot (2) and behind (1) to detect sound. An analog-to-digital converter is used to convert sound waves into digital data. Speech recognition software is installed to match the digital data with known phonemes in the appropriate language and then examines the results in the context to determine what the users say.
- **Recognize face:** With the two cameras at the eyes to capture images in 3D, software is installed in ELAR to analyze and match faces.
- **Talk:**
- **Connect to wireless network:** Wi-Fi device is installed in ELAR to give the robot capability to connect to the internet and the control center. Wi-Fi networks broadcast radio waves that can be picked up by Wi-Fi receivers that are attached to different computers or mobile phones.
- **Has ability to memorize:**
- **Detect smoke, fire and hazard gas:** ELAR should be equipped with smoke, temperature and gas sensors. What smoke sensor is essentially an ionization detector used to sense the smoke in the house. When smoke enters the ionization chamber of the detector, the smoke particles attach to the ions and neutralize them, which reduce the current and trigger the alarm. Infrared imaging is used for remote temperature sensing. A thermo-graphic camera installed on the body part of ELAR detects radiation in the infrared range of the electromagnetic spectrum and produce images of that radiation. When ELAR senses the unusual temperature in the room, it will alarm and send the message to the control center simultaneously. As for gas sensor, a carbon monoxide detector is used to detect the presence of the toxic gas carbon monoxide (CO), which is produced by incomplete combustion and lethal at high levels.
- **Has learning capability:** For this function, ELAR uses Strong Artificial Intelligence design. This installed software uses algorithms such as reinforcement learning and learning to learn. ELAR can learn based on the observation of the environment and previous experience.

4. System Validation

5. Concept Exploration

6. User Case Model

7. Design Model