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BEECAT: A ROBOTIC PET FOR PREVENTING DEMENTIA OF ELDERLY PEOPLE

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Abstract. *Loneliness is certainly a big problem for elderly in Indonesia and around the world. Elderly people are affected by neurological and mental disorders, including dementia which can trigger depression and anxiety. Dementia is currently the seventh leading cause of death among all diseases and one of the major causes of disability and dependency among older people globally, so we as researcher should take high attention with the dementia. We proposed a wheel-based robot cat that can give questions about simple mathematics and is able to sing a song and the robot also can avoid obstacle using distance sensor and servo. Passive Infrared (PIR) sensor is used for robot as an indicator that people around the robot in order robot able to stop moving. Robot is equipped with MP3 audio playback and touch sensor and controlled with Arduino. Based on the experiment, elderly people at nursing home really like the robot, because it can reduce feelings of loneliness and solitude, and improve his/her brain activities everyday, thereby can prevent dementia.*
Keywords: Robotic pet, Robot cat, Dementia, Elderly people, Depression, MP3 player

1. **Introduction.** Robotic pets have a role as companions to humans, especially in case of accompanying elderly people to prevent loneliness and dementia. Based on World Health Organization (WHO), dementia is a syndrome in which there is deterioration in cognitive function beyond what might be expected from the usual consequences of biological ageing. Although dementia mainly affects older people, it is not an inevitable consequence of ageing. Currently more than 55 million people live with dementia worldwide. WHO recognizes dementia as a public health priority [1].

Artificial intelligence systems are designed to interact with humans and satisfy the human need for connection. Combining assistive robotics and socially interactive robotics, Socially Assistive Robots (SARs) with audio, visual, and movement functions can assist and interact with individuals, such as robot PARO. PARO is an advanced interactive therapeutic baby harp seal robot developed by AIST, a leading Japanese industrial automation pioneer. In previous study by researcher, PARO was reported to have many benefits and staff found it useful and practical for people with dementia to use [2]. Pet-type robots could stimulate interaction, alleviate agitation, and have positive effects on depression in patients with dementia. For example, PARO can serve as a mental commitment robot that physically interacts with human beings [3].

As technology mimics the natural world more and more expertly, several social issues arise such as what standards and protocols for robot-assisted activities including Robot-Assisted Therapy (RAT) should be developed [4]. The robotic pet offered several interactive features. For example, sensors in two locations of the head and cheeks of the pet responded to user touch and activated a reciprocal nuzzling effect [5]. Behavioral and

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psychological problems affect most individuals with dementia at some point during the progression of the disorder, adding to the cost and burden of caring for them. A robot developed by a team at the University of Minnesota, Duluth, is meant to help patients remain independent longer. Researchers believe it is the first time the technology has been applied to nursing homes [6].

In this paper, the state-of-the-art research that has a similar approach with this research is previous research from [3,4], but with additional features. Our objective and contribution are to make a low-cost robot pet that can give question in math and singing so the elderly people can use his/her mind to keep thinking to minimize the potential of dementia. Experiment at nursing home in Indonesia was conducted. The structure of the paper is organized as follows: Part 1 is an introduction, Part 2 is about robotic pet and dementia, and Part 3 about audio and serial MP3 player module. We proposed a method in Part 4 and experimental results in Part 5. Finally, Part 6 gives conclusion. Figure 1 shows our prototype of the robotic pet named as BeeCat.

FIGURE 1. BeeCat, a robot cat that is able to give activities such as giving questions of math and singing to elderly people. This robot has the ability for obstacle avoidance and provided with touch and PIR sensor and MP3 player.

2. **Robotic Pet and Dementia.** According to Alzheimer's Disease International, the worldwide costs of dementia ($604 billion in US dollars) amounted to more than 1% of the global gross domestic product in 2010. The worldwide cost is projected to reach $1 trillion in 2018. Currently, over 46 million people are living with dementia. By 2050, this number will have risen to 131.5 million [5]. Companion Pets is designed to bring comfort, companionship, and fun to elder loved ones, with realistic pet-like sounds and sensors that respond to petting and hugs with familiar pet-like actions. While pet therapy is known to be a cost effective and therapeutic intervention for improving mood and behavior in older adults, little is known about pet therapy in adult day centers, despite logistical advantages such as socialization and group activities [7]. PARO's inventor, Takanori Shibata, was interested in coming up with a robot that would address the needs of senior citizens, particularly those who were in a depressive cocoon in nursing home. There are also ethical concerns involved in the use of robotic pets. One worry is that using robots for elder care could result in less social contact and more isolation [8]. The robotic pet offered several interactive features. For example, sensors in two locations of the head and cheeks of the pet responded to user touch and activated a reciprocal nuzzling effect. There are also ethical concerns involved in the use of robotic pets. One worry is that using robots for elder care could result in less social contact and more isolation as shown in Figure 2.

(a) (b) (c)

FIGURE 2. PARO (a), Tombot (b) and Nayacarya (c) used as part of robotics pets for dementia. Nayacarya developed by our team in Indonesia is a robot cat that has touch sensor and is able to give activities such as giving question for math and singing to elderly people.

3. **Audio and Serial MP3 Player Module.** The MP3 player module YX5300 has power supply 3.2-5.2 V with power consumption 200 mA and supports WAV/MP3 audio files. The module expects the directory names in the format "01", "02", "03", etc. on the SD card. The files in the directories must have the format "001xxx.mp3", "002xxx.mp3", etc. The module is addressed serially and has implemented a set of instructions that one would expect from an MP3 player. Figure 3 shows the layout and schematic of the module [9].

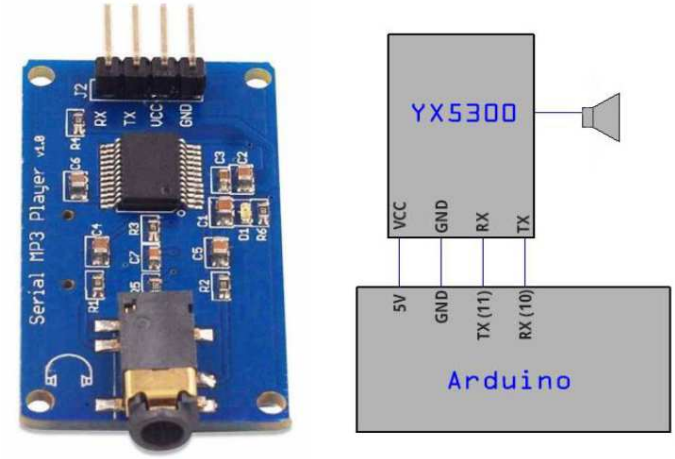

FIGURE 3. YX5300 serial MP3 player module [9]

4. **Proposed Method.**

4.1. **Architecture.** Many types of robotic research focus on how to control the movement of the robot with voice [10], but using voice is difficult for elderly people, so we propose using touch sensor for selecting audio. In order of smooth movement, we control the speed of the robot using Pulse Width Modulation (PWM). A Pulse Width Modulation (PWM) signal is a method for generating an analog signal using a digital source and the method is used in this research. We use minimum components, additional motor, and efficient power supply system's 7.2 V/1 A in order the weight of the robot enough light. The architecture of the robotic pet BeeCat is shown in Figure 4. We use ultrasonic distance sensor, PIR sensor and touch sensor as input to the robot.

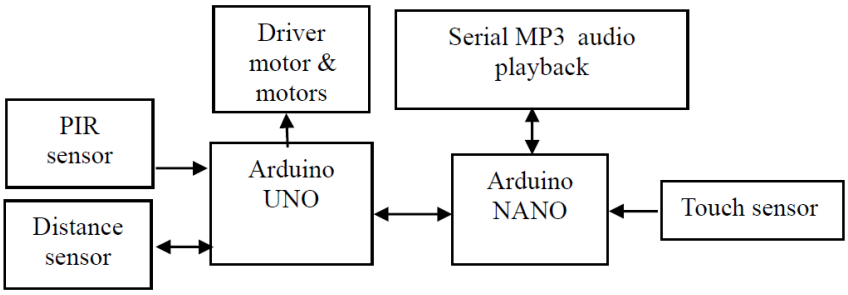

FIGURE 4. Architecture of BeeCat robot using low cost microcontroller system

4.2. **Algorithm.** First, the program will measure the obstacle in front of the robot. If no obstacle, then the robot may move forward. If robot detects a person using PIR sensor, then robot will not move as shown in Algorithm 1. User then can choose an option from the buttons in the robot.

Algorithm 1. Robotic pet BeeCat for maneuvering and action

```
Declare variables
configure input and output variables
configure MP3 audio
status==on
configure PWM
read PIR Sensor
begin
while people==empty //while no people in front of robot detected by PIR Sensor
//measure the distance of the obstacle
call distanceSensor
if distance > 30 cm then
      moving forward
end if
if distance left > right and distance > 30 cm then
   call turnLeft
end if
if distance right > left and distance > 30 cm then
   call turnRight
end if
if distance <= 30 cm then
   call backward
end if
end while
// if robot near the people, stop
if (button=playMath) then
   call mathQuestion
end if
if (button=playSong) then
   call playSong
end if
if (button=Next) then
   call NextAudio
end if
```

(continued)

```
if (button=stopPlay) then
  call stopPlay
end if
function mathQuestion
begin
  read question one by one
end
function playSong
begin
  play Song one by one
end
function NextAudio
begin
  play next Audio
end
end
```

5. **Experimental Results.** We developed a program for the robot using Arduino. We have 5 files, and each consists of 10 questions of mathematics giving to patient at nursing home in Indonesia. The questions are like what is $5+6$, $8/2$, $2+6+2$, etc. We also have 10 files of traditional songs that can be played using touch sensor. We have 5 participants that must answer 10 questions in pretest, and we calculate the total of correct answer and time needed to solve the questions. We also ask her/him to listen to the song that she/he likes. After 3 days, we ask them to answer again the 10 questions for posttest and calculate the correct answer and time needed. We visited a nursing house for testing our robot as shown in Figure 5.

FIGURE 5. Donation and experiment of robotic pets to nursing home at Indonesia [11]

Based on the experiment, the robot runs smoothly and makes the elderly people in nursing home happier, participant is able to answer more questions after posttest and time needed for answering the math questions is faster than before. The result of our experiment is shown in Table 1.

Some factors for robotic pets have benefits such as reducing negative emotion and behavioral symptoms, improving social engagement, and promoting positive mood. The positive impacts included improved mood and affect, improved communication and interaction, companionship, and other well-being outcomes studied by [12,13].

TABLE 1. Experimental results for improving brain activities for elderly people using 5 participants

No	Results			
	Action	Pretest	Posttest	Time needed
1	Participant 1	6	7	Faster
2	Participant 2	6	7	Faster
3	Participant 3	5	8	Faster
4	Participant 4	7	9	Faster
5	Participant 5	3	4	Faster

6. **Conclusion.** Loneliness can come with dementia, and robotic pet seems to be a source of great joy, especially for seniors that lack social interactions. The benefits of robotic pets are often said to be like those obtained from animal-assisted therapy. In this paper, we propose a model of a low-cost robot cat compared with others for preventing dementia for elderly people successfully. The robot can maneuver or give mathematics questions and singing, so it is supporting brain activities for elderly people. The program is able to play audio correctly and the participants in this research are happy with companion robot. We believe the robotic pets useful to be used in nursing home for the future. For future research, researcher should design a low-cost controller and integrate with the sensors and audio systems.

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