Dementia Screening System based on SNS Agency Robot

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***Abstract*—We have developed the SNS Agency Robot that can be used for interactive communication between the elderly and the young via existing social media. We developed the Dementia Screening System by adding an AI conversation diagnosis method to the SNS Agency Robot. The feature of this system is that we could replace medical doctor's examination of dementia with the Robot. The results of the examination by this Robot will be reported to people around the elderly by SNS using the original function of the SNS Agency Robot. We conducted evaluation experiments of this system with patients of Nagasaki University Hospital. As the result, we confirmed a strong correlation between the results by medical doctors and by the Robot.**

Keywords—dementia; communication robot; AI ; IoT

I. Introduction

Due to a rapid increase in the number of people with dementia, social costs of dementia reached up to 145,140 billion yen in 2014 [1]. Therefore, we developed the Dementia Screening System [2] operated by a communication robot. We have already developed the Social Networking Service (SNS) Agency Robot [3] which can be used for interactive communication between the elderly and the young via LINE, which is a proprietary application for instant communications on smartphones in Japan (Fig.1, 2). We added an Artificial Intelligence (AI) conversation diagnosis method to the SNS Agency Robot. The AI conversation diagnosis method consists of the function to execute Q&A based on Hasegawa dementia rating scale-revised (HDS-R) [4]. This method also includes the function to calculate recognition scores through the Q&A. The results of the dementia examination by the Robot will be reported to people around the elderly by SNS using the original function of the SNS Agency Robot. The Dementia Screening System is comprised of a human-type communication robot and a cloud service. We carried out evaluation experiments of this system with patients of Nagasaki University Hospital. As the result, we confirmed a strong correlation between the results by medical doctors and by the Robot.

II. Related Work

NTT Data performs a proof examination to inspect possibility of a dementia diagnosis with a communication robot system [5]. In this system, an elderly person talks with the

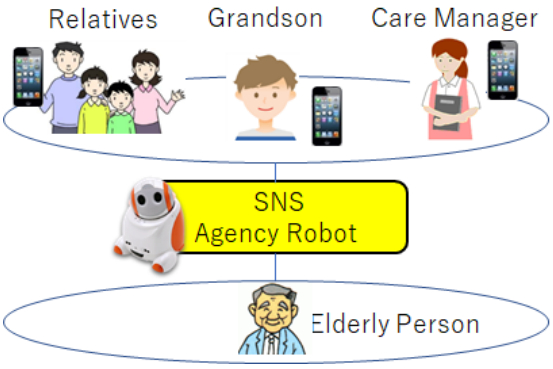

Fig. 1. SNS agency robot.

Fig. 2. SNS agency robot use case.

communication robot along a conversation scenario in a special room. The results are transformed to NTT Data Cloud Robotics Platform to diagnose dementia. In this case, the elderly person needs to go to the special site to take the examination. Therefore, there is a problem that this system puts a physical or psychological burden on the elderly.

Izutsu and his team proposed a dementia evaluation method using interaction with communication robots [6]. He made a dementia severity rating scale based on HDS-R aiming for not letting an elderly person be conscious of tests. However, his proposed method to generate a natural conversation from HDS-R is not clear. It does not have the notification method of the diagnosis result, either.

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III. Dementia Screening System

A. AI Conversation Diagnosis Method

The AI conversation diagnosis method is that we incorporate a natural conversation scenario according to HDS-R in the SNS Agency Robot (Fig.3). We made this conversation scenario based on Q&A that a medical doctor actually carries out to diagnose dementia. The scenario includes inspection items such as orientations of self/date/location, working memory, calculation and recent memory. The conversation scenario is conducted by natural language so that we decide to use an AI support system which can be used for understanding the natural language of the elderly and returning an appropriate reply to them. The examination results are automatically calculated in the same way as a medical doctor does.

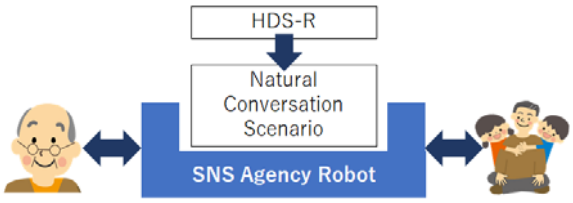

Fig. 3. AI conversation diagnosis method Outline.

B. System Configuration of Prototype System

The prototype system consists of the communication robot facing the elderly and the cloud service which controls a whole system (Fig.4). TABLE I shows a hardware and a software specification.

(1) Communication Robot

We used our developed SNS Agency Robot, PaPeRo i [7] produced by NEC corporation as the communication robot. We implemented Evaluation/Scoring, PaPeRo i Operation Interface and Maintenance Function as a subsystem in a single board computer embedded in PaPeRo i. Evaluation/Scoring carries out the AI conversation diagnosis method by communicating with Interactive Dementia Diagnosis Function assigned a main system of the cloud service.

(2) Cloud Service

- User Registration

  We implemented a user registration function which can be used for sharing the robot by some elderly persons. This function includes registrations such as birth date, address and face recognition data.

- Personal Identity Function

  We used NeoFace KAOATO [8] as a cloud service of a highly precise face recognition function offered by NEC Solution Innovator.

- Interactive Dementia Diagnosis Function

  This function includes the AI conversation diagnosis method we proposed. The voice data spoken by an elderly person is converted into text by Google Cloud Speech API [9]. Natural language conversation is managed by an AI support system that is IBM Watson Assistant. Then, the examination results based on the AI support system are calculated as scores. The highest score is 30 points.

- Message Transmission/Reception

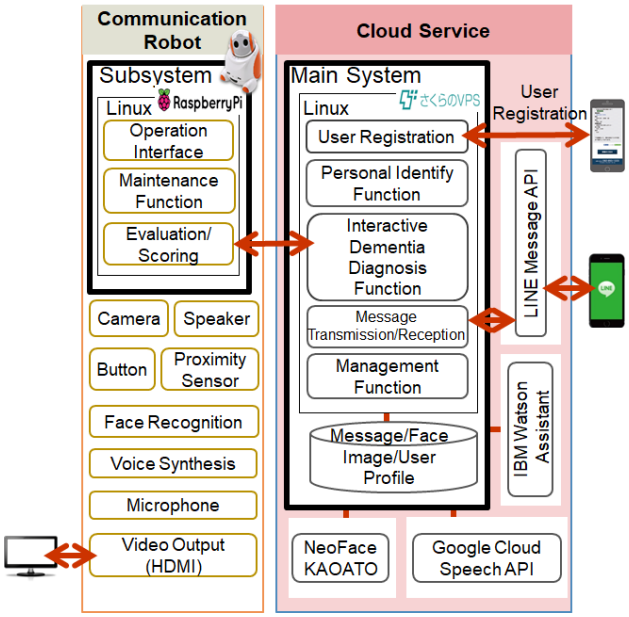

Fig. 4. System Configuration.

TABLE I. System Specification

	Subsystem (PaPeRo i)	**Main System** (Sakura VPS)
Hard-ware	・Raspberry Pi 3 Model B	・CPU: Intel(R) Xeon(R) CPU E5-26400 @ 2.50GHz ・Memory: 4GB
Soft-ware	・Raspbian GNU/Linux 8.0 (jessie) ・PHP 5.6.30 ・Python 2.7.9	・CentOS 6.8 ・Apache 2.2.15 ・PHP 5.6.18 ・MySQL 14.14 ・Python 2.6.6

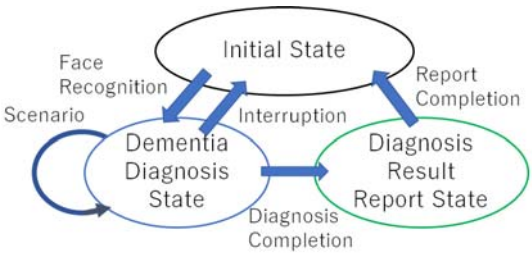

Fig. 5. State Transition Diagram.

This is the original function added to the SNS Agency Robot. We implemented this function by using Messaging API offered by LINE [10]. We use this function to inform the dementia diagnosis results to people around the elderly, like a family or a care manager through LINE.

- Management Function

  This function includes a log collecting function for trouble analysis.

C. State Transition of Prototype System

A state of this prototype system consists of an initial state, a dementia diagnosis state and a diagnosis result report state (Fig.5). A shift condition from the initial state to the diagnosis state is to execute the face recognition of an elderly person. We can carry out nine scenarios in succession or one by one. If all scenarios are carried out, the state will be changed to the diagnosis result report state. After reporting, the state shifts to the initial state. Moreover, in the initial state, the interactive message exchange through LINE which is the existed function of the SNS Agency Robot is executed.

IV. Evaluation Experiments

We performed two evaluation experiments with 10 subjects (male: 6, female: 4) from 60 years old to 78 years old who are patients of Nagasaki University Hospital and don't develop dementia.

(1) Cognitive function score automatic calculation using the prototype

(2) Cognitive function score manual calculation based on medical doctor interview according to the conventional way

We performed (1) and (2) experiments at Nagasaki University Hospital from 14. Nov, 2018 to 31. Jan, 2019. First, we conducted experiment of (1), then (2) one week later. Each experiment has been executed at the dispensary room of Hospital (Fig.6). After the experiments, we evaluated a precision of (1) comparing to the results of (2) as correct answers (Fig.7).

V. Consideration

Fig. 6. State of the experiment at Nagasaki University Hospital.

The average precision of the prototype system was 85% comparing to the conventional method. The precision of the prototype system is inferior to the conventional method from these experimental results. The main reason of that was the voice recognition accuracy. Therefore, by improving the accuracy of the voice recognition, we can expect performance enhancement of the prototype system. We confirmed that the prototype system and the conventional method had a high correlation of 0.93 as Spearman's rank correlation coefficient. We confirm that the purpose of the dementia screening system can be accomplished even if an absolute difference with the conventional method was not buried. That is why we could suggest to the elderly to go to see a medical doctor, if the cognitive function score informed by the Dementia Screening System would relatively worsen.

VI. Conclusion

We developed the Dementia Screening System based on the AI conversation diagnosis method. As the result of having applied this system to the evaluation experiments with ten elderly patients of Nagasaki University Hospital, we confirmed that the prototype system and the conventional method had a high association with 0.93 as Spearman's rank correlation

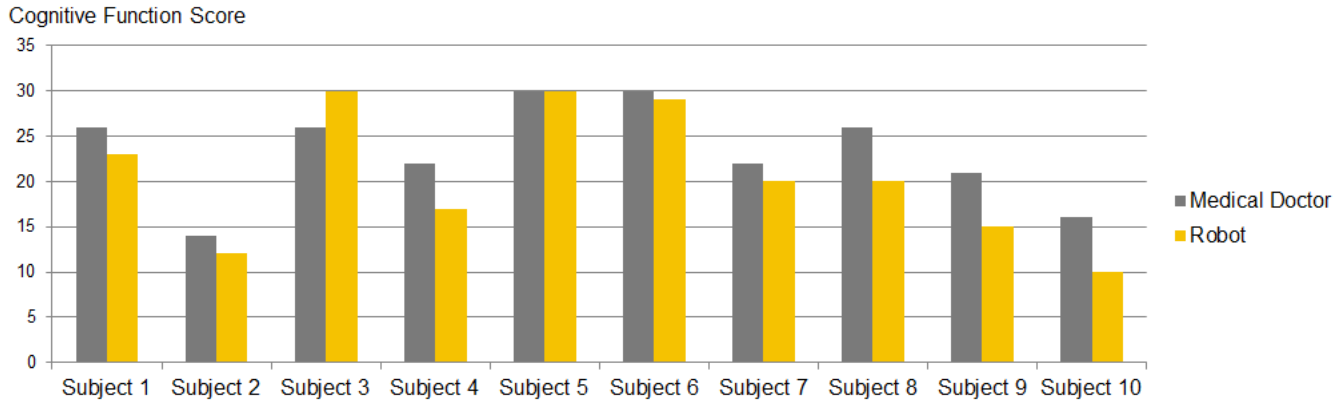

Fig. 7. Experiment Results.

coefficient. Our purpose is to screen dementia, not a definitive diagnosis. Therefore, the result of a high association between our system and the conventional method is a good evidence that our system is effective as the dementia screening function. In future work, we will improve the voice recognition accuracy in order to improve the screening precision.

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