

Study of Early Screening Method of Dementia And Its Systemization

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Abstract

Japan is about to become a super-aging society. It is estimated that one out of four persons will be a senior citizen aged 65 or older in 2015 and some eight percent will have dementia. There has been an increase of serious traffic accidents in the past few years such as by drivers suspected of having dementia driving in the opposite lane on highways. License renewal for such people has become a big issue in the society. This study aims at developing a screening system to support early detection of dementia and at expanding the system into people's everyday life. This is to report a prototype of automatic screening system. It uses a Five-Cog test, an effective tool for dementia screening, which is usually carried out manually including its analysis. However, this prototype enables its automatic conduct. It is a system to recognize the characters and graphics entered as responses for testing tasks on a touch panel by image processing and to automatically output evaluation of cognitive functions. The structure of this system, testing method, an evaluation experiment on elderly subjects, and future issues will be detailed.

1. Introduction

Japanese society is aging at an exceptional speed. It is estimated that in 2015 one out of four will be a senior citizen aged 65 or older and about eight percent of those elderly people will have dementia[1]. Most dementia, as typified by Alzheimer's disease, causes cognitive dysfunction in memory, language and attention regardless of individual intensions. As its symptoms worsen, it becomes difficult for patients to not only function in a society but also live an independent life [2] [3]. Even with mild symptoms, traffic accidents by elderly drivers have been increasing and license renewal has become a big issue in the society [4] [5]. Incidence and morbidity of dementia increase with age. The rate has been reported to rise sharply among the elderly aged 75 and older [3]. If we hope to activate the super-aging Japanese society in the future, it is necessary to encourage the elderly to participate in various social activities by promoting their health and motivation in life. Prevention and early detection of dementia are also very important. In particular, if detected early (within one to two years of onset), it is possible to slow down the progress and QOL (Quality of Life) will be improved greatly.

In order to find dementia at an early stage, it is important to detect suspicious conditions early and see a dementia specialist, but it is not easy to assess preliminary stage (mild cognitive impairment: MCI) or early stage (mild dementia) accurately at home to consult a

medical specialist early. Most patients visit a clinic after dementia progresses enough to disturb daily life, and it is reported that cognitive functions fall down rapidly at that stage. In addition, it is also reported that although a "home doctor" is most often the first consultant upon suspecting dementia in daily life, their diagnosis is not always appropriate, resulting in delayed detection of dementia[6].

The purpose of this study is to build a screening method for early detection of dementia and to implement such a system. Due to the difficulty in finding preliminary or early stage of dementia at home, it is our goal to set a simple dementia screening system in a familiar community space (i.e. a facility where many elderly people gather) so that middle-aged and elderly people can test their cognitive functions easily and, if worried, can see a medical specialist. Since people in their 40s and 50s inevitably visit an optician for reading glasses, setting this system in their shop will help early detection. This report will first describe testing methods of cognitive functions (including dementia) in the society. Among them, the Five-Cog test [7], which is a group cognitive function test without a specialist, will be explained. A cognitive function test method by image processing based on the Five-Cog test screening and a simple automatic measuring system easy enough to be used by the elderly will be reported.

2. Current status of dementia and cognitive function testing method

Dementia is a condition in which normal social life fails due to disorders in memory and judgment caused by ailments in the brain and body. Dementia is mostly divided into Alzheimer's and cerebrovascular dementia. Main symptoms include decreased memory, decreased understanding and judgment, and dysfunction of orientation.

It is estimated that there are about 1.8 million dementia patients nationwide (as of September, 2005). In the past few years, traffic accidents caused by elderly drivers with dementia have been on the rise and their license renewal has become a big issue. As a consequence, it was decided that the elderly must take a simple test to have their cognitive functions checked at license renewal, which was made into the revised Road Traffic Law in June last year (2007). However, there are a few problems. Because it is an obligation for drivers aged 75 and older, younger dementia patients (in their 40s and 50s) are not covered. There is also a debate on the fact that medical experts are made responsible to make the final decision of license suspension or revocation of the elderly in question. Medical experts are capable of di-

agnosing dementia but not judging dangerous driving.

Most cognitive function test methods in the society can be divided into four categories: medical diagnosis, neuropsychological tests, mild cognitive impairment screening tests, and dementia screening tests. Medical diagnosis called clinical dementia rating (CDR) is difficult to utilize widely because the rater must be a physician who has received training. Neuropsychological tests such as Wechsler Adult Intelligence Scale (WAIS-R) require an expert who has received special training at its administration. Thus, they take time as well as labor. Dementia screening tests such as Mini Mental State Examination (MMSE) aim at screening of dementia, meaning it cannot assess cognitive functions of healthy elderly people. In contrast, the Five-Cog test, which is a mild cognitive impairment screening test, can be administered following its manual without a physician and can be used to examine the elderly at large. Therefore, this study examines a screening system based on the Five-Cog test.

3. Early screening method of dementia (Five-Cog test)

3.1. Features

The Five-Cog test is an excellent tool to identify levels of mild cognitive impairment called Aging-associated Cognitive Decline (AACD) and can be used to screen the elderly who are at high risk of developing dementia. It can also assess various cognitive function levels, including mild cognitive impairment, of healthy elderly people. Therefore, it can be used to evaluate effects of dementia-prevention programs for the elderly at large. In addition, it is a great feature that the test can be conducted for a group, not as individual interviews, and assessment can be made not by special physicians but by people without special qualifications.

3.2. Method

Figure 1 shows the contents of the Five-Cog test. The Five-Cog test consists of six tasks. "Motor task" (a) is to measure the speed of manual movement. A subject writes circles around numbers as quickly as possible in 15 seconds. "Position judgment task" (b) measures the attention split function. A subject writes a circle around the character "above," "middle" or "below" if it matches its position. "Word memory task" (c) measures the decrease of short memory of for a few minutes. A subject memorizes words along with cue categories, and then recalls the words based on the categories. "Clock drawing task" (d) is to measure the visuospatial cognitive function. A subject draws numbers and long and short hands correctly on a blank clock face. The subject's visuospatial cognitive function is assessed from where they are positioned. "Animal name imagination task" (e) measures the linguistic function. A subject writes as many animal names as possible in two minutes. "Common word task" (f) is to measure the abstract thinking ability. A subject writes the leading concept of the two words listed.

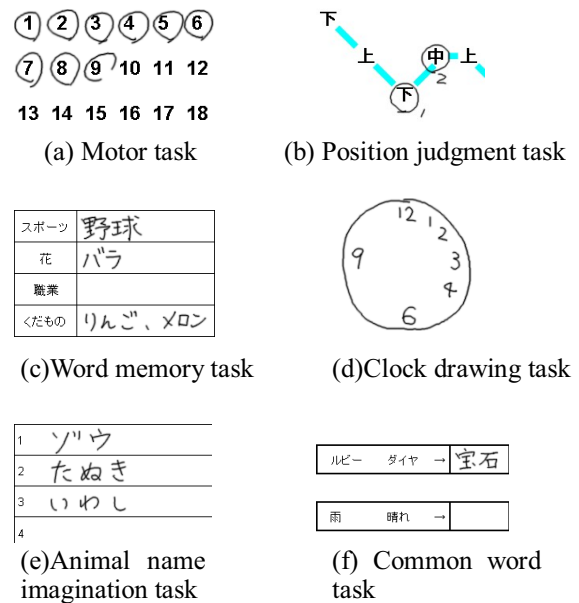


Figure 1. Five-Cog test

In each task, there are three ranks (from one to three points) of evaluation and scores for the five tasks, excluding the motor task, are totaled. There are three levels of assessment. If the total score is 15 points (a full score), the subject is evaluated as having "no problem." Somewhere between 11 and 14 points is marked as "AACD (pre-dementia)," and somewhere between 5 and 10 points as "possibility of dementia." The total test time is about 40 minutes.

4. Screening System

4.1. System configuration

Figure 2 shows the composition of the screening system.



Figure 2. Configuration of screening system

This system is composed of the touch panel (touch pen), a Japanese keyboard, the process computer, and the speaker. In the Five-cog test of the past, the subject fills in the answer form by the memo type (In longhand) while seeing the image screen for the inspection. In this system, the subject fills in directly on the screen with the touch pen while seeing the image screen on the touch panel. The touch panel has feature that the image screen is the same as the filling in screen.

4.2. Inspection method

Figure 3 shows the flow of the processing of the entire inspection.

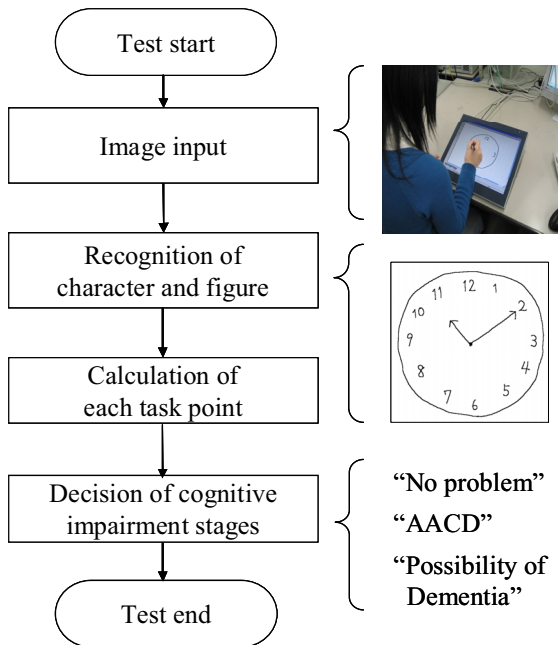


Figure 3. Flow chart of cognitive impairment test by screening system

After displaying the image in the question of each problem on the touch panel screen, the experimenter explains the way of the problem by the voice of the guide. After the explanation, the subject answers while seeing the image for the answer on the touch panel screen. The character and the figure are recognized from the input image by image processing in this system, and the score of each problem is calculated by using the grading standard. The cognitive function level of 3 steps is determined by a total point of each problem.

Figure 4 shows the flow of the processing of 'Clock drawing problem'.

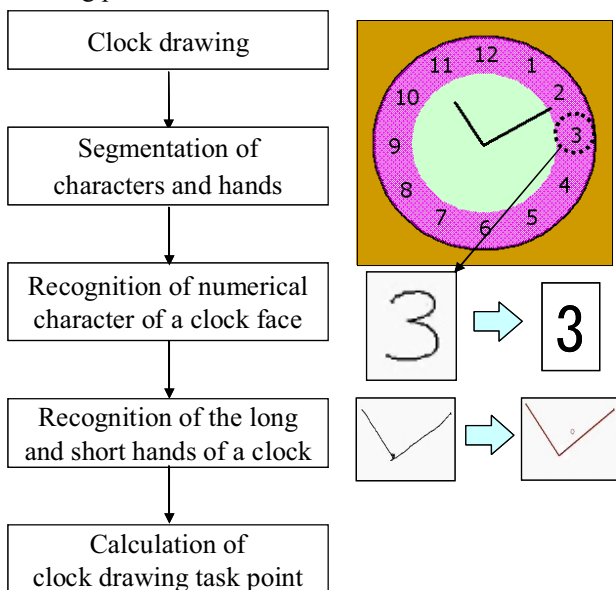


Figure 4. Flow chart of clock drawing task. The long hand and the short hand of the clock are excised from the image of the clock. Next, the kind of the figure and the order of the figure are recognized. Moreover, the direction of the

hour hand and the long hand is measured, and written time is recognized. Finally, the score of the clock drawing problem is calculated based on the grading standard. The grading standard consists of seven items (seven point full marks) such as "The figure of 1-12 is written", "The figure queues up sequentially", and "There are two needles", etc.

5. Evaluation experiment and result in senior citizen

5.1. Experimental method

Senior citizen's cognitive function was inspected with an experimental screening system. This purpose evaluates the system performance, and extracts the problem. Moreover, a past memo type (paper) was inspected at that time, and both a past memo type and the system convenience was compared. In addition, the survey of the questionnaire of this system was done. The content of the questionnaire is "Possibility of use when this system is set up in the place in which the senior citizen gathers", "when inspection result was possibility of the dementia, whether the subject consults clinician (specialist)" and "Place of the installation hope", etc. Subjects are 38 senior citizens of 65 years or more (Men are 31 people, women are 7 people, and the average age is about 71 years old).

5.2. Experimental result

First of all, result of the inspection of a past memo type is, 27 of 38 senior citizens are "The problem none", 8 people are "AACD", 3 people are "Possibility of the dementia". Problem of this system is false recognition of character at Clock drawing task (Figure 5 shows the clock drawing in that case), and about 1/4 of the subjects were answered that the inspection time was long.

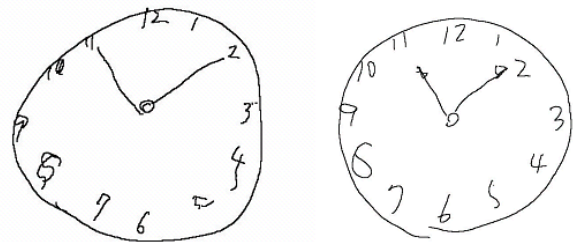


Figure 5. An example of clock drawing

Figure 6 shows the memo type (paper) and this system are compared with convenience. About 3/4 of the subject was answered that this system used easily. Therefore, this system is thought that convenience is roughly good. However, it was answered that many of subjects used the memo type (paper) easily. Moreover, many of subjects were not accustomed to the usage of the touch panel.

Figure 7 shows the effectiveness of this system installation and the possibility of consulting a physician the hospital (specialist) by the cognitive decline (possibility of the dementia). As to system installation, about 70 percent of the subjects said they will use this system and the effectiveness was confirmed. In respect of desired location of system installation, about 50 percent of the subjects said Silver manpower center, about 15 percent of them said sports center and each 5 percent of them

said hospital, department stores, library. About 3/4 subjects said they will consult a physician as a possibility of consulting a physician the hospital (specialist) by the cognitive decline (possibility of the dementia). Therefore, the screening effect for the dementia early detection was a result in which being admitted.

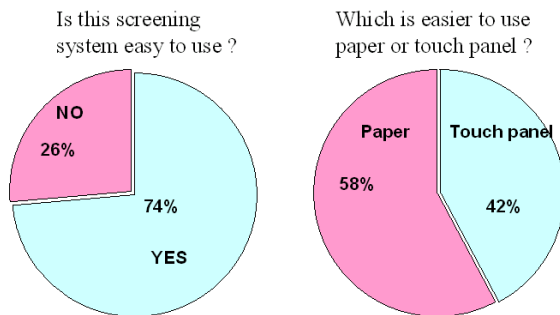


Figure 6. Questionnaire concerning usability of screening system

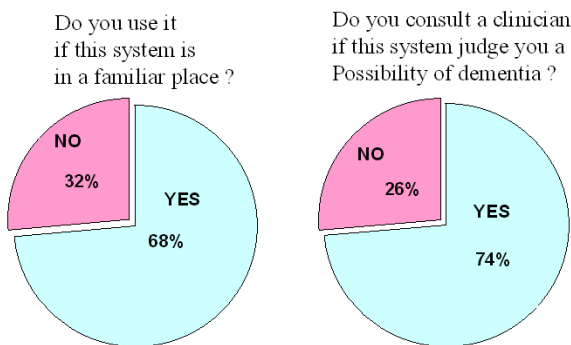


Figure 7. Questionnaire concerning availability of screening system

6. Conclusion

This study examined a screening system with a touch panel screen using the Five-Cog test as one way of early screening of dementia for the elderly. A trial system was made and an evaluation experiment was conducted on elderly people. As a result, it was confirmed that, although there remain some future issues of cognitive ability of the system and testing time required, this system can be used if set in places where elderly people gather and that this way of screening is effective because elderly people will visit a clinic (specialist) afterwards.

The remaining issues will be examined for solutions and further experiments and arrangements with dementia specialists should be conducted in order to improve the screening efficacy.

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References

- [1] Cabinet Office. 2007 White Paper on Aging Society. (2007). (in Japanese)
- [2] Nobutsugu Hirono eds. Clinical Dementia Guide. Kinpodo. (2001). (in Japanese)
- [3] Akira Homma et al., Diagnosis, Treatment and Caring guidelines of Alzheimer-type dementia, Japanese Journal of Geriatric Psychiatry, Vol.16, extra number- I , pp.3-126 (2005). (in Japanese)
- [4] Teruhisa Matsumoto et al., Reality of Elderly Driving Performance and Prospect in Future, Japanese Journal of Geriatric Psychiatry, Vol.16, No.7, pp.815-821 (2005). (in Japanese)
- [5] Manabu Ikeda. Research on Drivers with Senile Dementia and Advocacy. 2003-2005 Report of the Comprehensive Research Project on Longevity Science, Ministry of Health, Labor and Welfare. (2006). (in Japanese)
- [6] Akira Homma et al., Model Business for Promoting Dementia Diagnosis Technique by Home Doctor, Japanese Journal of Geriatric Psychiatry, Vol.16, extra number-III, pp.155-159 (2005). (in Japanese)
- [7] Naomi Yatomi. Effect Evaluation of Prevention against Dementia and Assignment, Japanese Journal of Gerontology, Vol.27, No.1, pp.74-80 (2005). (in Japanese)