*Journal of Statistics & Management Systems*
ISSN 0972-0510 (Print), ISSN 2169-0014 (Online)
Vol. 26 (2023), No. 1, pp. 213–223
DOI : 10.47974/JSMS-960

# A report on early prediction, detection & diagnosis of Alzheimer's disease

Rashmita Khilar *
*Department of Information Technology*
*Saveetha School of Engineering*
*Saveetha Institute of Medical and Technical Sciences*
*Chennai*
*India*

T. Subetha §
P. Kayal @
*Department of Computer Science and Engineering*
*BVRIT Hyderabad College of Engineering for Women*
*Hyderabad*
*Telangana*
*India*

**Abstract**

Alzheimer's Disease (AD) is significantly increasing for older adults in the world nowadays. It affects 10% of people over the age of 65 and 50% of people over 85 years of age. The majority of patients live at home and they are cared for by their family and friends. AD disease is an unavoidable neurological type of disorder, where brain cells die slowly and result in memory loss, leading to Dementia. Sometimes AD disease also affects people of lower age groups. There are three stages of Dementia: 1) Mild, 2) Moderate and 3) Severe. Mild and Moderate stages are treated to some point and in the third stage, there is no treatment for the people. Therefore an early diagnosis is required for this type of disease to avoid a significant loss. As a result, early detection and prediction of infection are needed. Apart from medical researchers, researchers from IoT, AI, Machine Learning have also identified various techniques by which the disease can be predicted and the patient can be monitored for their daily activity. In this paper, various routines to diagnose Alzheimer's disease are analyzed. The interpretation and evaluation techniques available are also listed out to the

*E-mail: rashmita.khilar@gmail.com (Corresponding Author)
§ E-mail: subethiyagu@gmail.com
@ E-mail: kayalpaddu@gmail.com

early diagnosis of the disease. We have also highlighted early detection and prediction techniques and the promising methods are emphasized.

***Subject Classification:*** *SOA33, 03C45.*

***Keywords:*** *Alzheimer's disease (AD), Dementia, Artificial intelligence, IoT, Prediction techniques.*

## 1. Introduction

Ambient Assisted Living (AAL) [1] is a subdivision of the Human-Computer Interaction domain and the research is growing more in India due to population aging. A research report in India says aging is burgeoning earlier than predicted. A report released by United Nations Population Fund (UNFPA) termed "India Ageing Report 2017" [2] apparently expounds that people over the age of 60 could upsurge exponentially. The thriving amount of the elderly generation deteriorates their physical ability and several age-related chronic related to cognitive decline. Subsequently, physicians experience dementia with elderly people at a growing occurrence of the aged population, the fatal dementia disease conveys substantial allegations for affected role and their surroundings. Since they start forgetting about themselves, it is crucial to building solutions to embellish their quality of life. They need so many assistive systems that are adaptable, robust and safe with low outlay healthcare systems [23]. The requirement mentioned above will be accomplished by assimilating new technologies like Machine Learning [25], IOT, etc. Hence, the attention is shifted towards building an ICT-enabled device to strengthen older adults' independent livelihood.

Dementia [3] comprises the worsening of a person's intellectual actions through which the person gradually falls apart daily tasks like remembrance loss, reasoning, attention, verdict making, etc.. In general, Dementia persons have an unexpected change in their actions in both the private and public places. This gradually leads to Alzheimer's disease that will stay long for decades with the person and there is no remedy for the disease. Dementia occurs either in a reversible or irreversible way. [4] Reversible Dementia are infrequent and can be cured if it is diagnosed early and treated. The symptoms comprise of nutritional deficiencies, depression, pressure and endocrine disorders. The next type of Dementia, as the name suggests, it is not reversible; hence it cannot be cured and needs a correct treatment. This disease has three stages and each step has its own consequences. Thus, a health worker needs to diagnose early about this disease. Depending upon the stage of identification, the treatment is performed for the patient. The druggist is working for a permanent cure as

the cases are surging in the world day by day. There are a massive number of people being affected by AD disease day by day. The above graph reveals the number of people involved in European countries. Since there is no permanent solution for this disease, researchers started focusing on alternative solutions to the dementia peoples, such as reminders to alert themselves, lost person tracking, etc. Researchers are working towards Alzheimer's patients' betterment through various techniques like Machine Learning, IOT, wearable devices,etc. This paper aims to provide all the related works carried out in dementia peoples in recent times. This paper also comprises of various methodologies, wearable products that are available for them in the market. This paper also highlights the evaluation parameters they have taken to undergo this research. The challenges and future research directions in this area are also disclosed[5-7].

This paper is organized as follows: Section 2 discusses the state of the art methodologies for helping AD (Alzheimer's Disease) patients. Section 3 illustrates the most popular wearable products available for AD. Section 4 defines the estimation constraints accustomed to validate the developed system and Section 5 describes the research and future research directions followed by the conclusion in Section 6.

## 2. Related Works

Alzheimer's disease research can be extensively grouped into medical-based and IoT based research. In medical-based research, the focus is on monitoring the brain and monitoring hand and leg movements.A mobile application is built to assist Alzheimer's patient[1] to remind about the person and objects. The developed mobile app can perform location tracking and Augmented Reality techniques to remind the person about their food and drug intake. The main fall in this paper is about privacy for AD patients. An iOS app is built for AD people with the help of IoT technology to find the people's location. The smart wearable watch [3] monitors the heart rate and sends the statistics to the iOS app, which will keep track of the vital signs. The major hindrance is the amount of the wearable device. The sleep pattern detection, daily life activity, physical activity of the patients are analyzed through sensor technology[4]. This system's drawback is the generalized view of the system developed for the patients, which will not be suitable for the individual person. Sleep analysis of AD patients [5] is done to find the correlation and a wrist-worn smartwatch is used to find the patients' sleep pattern. Intelligent Assistive Technology (IAT) [8][6] confirms physical confines' determination to

positive acceptance, including partial lack of clinical validation and insufficient focus on patients' needs.

## 3. Wearable products

Various wearable products are developed for dementia patients. In this section, we will see a brief about some of the designed and available wearable devices in society. Most of the designed wearable focuses on providing mental support to Alzheimer's patients to live independently despite their health. German researchers have developed a wristband [8] to monitor dementia patients' vital signs, environmental data and physical activity. The main advantage of this system is it gives a personalized treatment of the patients by monitoring the vital signs. Alzheimer's patients have abnormal eye movement and so this wireless eye-tracking glass will monitor for the abnormality in eyes using Electrooculography (ECG) [9]. The device is planned to integrate with virtual Reality and control the device using eyes instead of hand gestures. GPS smart sole [10-13] is fit in the shoes of the dementia patient to track the location of the beloved ones as wandering is the most common side effect of dementia patients. The caregiver can track the location of the person through the smartphone application and so the patients can wander independently, which can improve their peace of mind.

## 4. Evaluation parameters

The developed wearable devices are evaluated with consideration of the number of parameters such as participant count, assessment accuracy, rate of patients acceptance, user fulfillment, detecting the fall accurately, intervention based mental state improvement, feedback and indoor localizing accuracy. The evaluation parameters are envisaged in Figure 1. The researchers prefer mostly on assessment accuracy over other

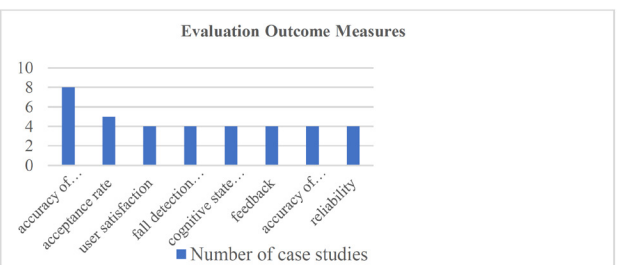


**Figure 1**

**Evaluation parameters**

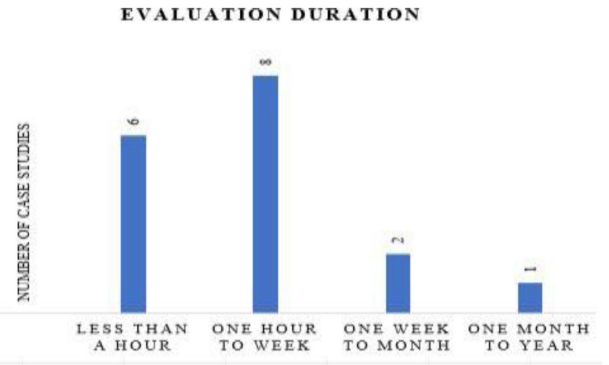


**Figure 2**

**Evaluation duration of the research**

evaluation methods as they found that to be decisive [15-17]. The problem in assessing wearable devices is the participator's aversion to investigate the device as it has a remarkable influence on the market deployment.

4.2 *Participants*

The most essential characteristic of the study is the statistics of the participants. Since the success of the system merely depends on the evaluation of the participants. From the table, it is inferred that most probably all the reviews are carried out above 60 years. The number of participants also has a significant impact on the development of a reliable system. The number of participants ranges from one to hundreds depending upon the user acceptance rate in evaluating the system. The

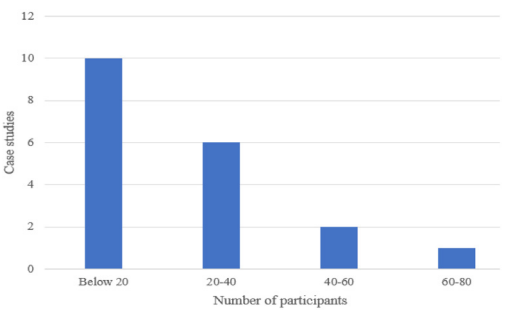


**Figure 3**

**Number of participants evaluated the system**

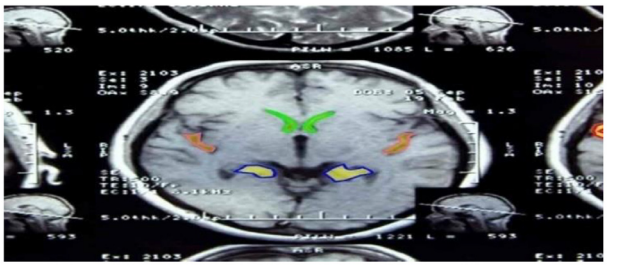

**Figure 4**

**Kaggle dataset**

bar chart shown below in Figure 3 shows the number of participants and their case studies.

## 5. Results and Discussions

Various benchmarking datasets23 are available to researchers for experimental evaluation of Alzheimer's disease. These datasets vary from their biological data, MRI data, Neuroimaging data, etc. Detecting Early Alzheimer's using MRI Data and Machine Learning datasets contain the MRI data of patients ranging from 60-80 years and the sample dataset is shown in Figure 4.

The dataset consists of Longitudinal MRI data for 150 right-handed patients aged between 60 to 96. The dataset is balanced because it contains 72 nondemented and 78 demented data. The dataset has seven columns: education qualifications, societal status, mini mental state examination, clinical dementia rating, estimated total intracranial volume, normalize whole brain volume and atlas scaling factor. The inferences obtained from the dataset are that the disease is more inclined to men getting affected than women and they have lesser brain volume. After Exploratory Data Analysis(EDA)21 the dataset is given to various classifiers such as logistic regression, SVM, Decision Tree, Random Forest and AdaBoost for comparing the performance accuracy for predicting Early Alzheimer [18-20]. The table 3 below shows the performance comparison of early Alzheimer using various algorithms and the results suggest that accuracy is high in the AdaBoost algorithm and higher recall and AUC using the Random Forest algorithm

It is implicit from varied studies that numerous technologies such as Computer Vision, Internet of Things, Sensors, Augmented and Virtual Reality, etc. are used. The early diagnosis is preferable as they give more

**Table 1**

**Details of the case studies**

| Ref | Number of participants | Age | Duration |
|---|---|---|---|
| [23] | 3 | Above 60 years | 15 weeks |
| [24] | Deployed in dyad homes(Dementia patients along with their caregiver) | - | Phase 1-7 days<br>Phase 2- 30 days |
| [25] | 10 | F-80.6±4.3M-78.7±6.8 | 30 days |
| [26] | 178 | F-averagemean85.3<br>M-average mean-83.68 | 7 days |
| [31] | 10 | 61-73 | 7 days |
| [32] | 20 | Mean age: 67years | 7 days |
| [33] | 51 | 60-80 years | 6 months |
| [36] | 4 | 75–92 | 2-4 days |
| [37] | 72 | 36(76±7) years<br>36(70±8) years | 2-3 hours |

**Table 2**

**Comparison of various ML algorithms**

| Algorithm | Accuracy | Recall | AUC |
|---|---|---|---|
| Logistic Regression(w/ imputation) | 0.789474 | 0.75 | 0.791667 |
| Logistic Regression(w/ dropna) | 0.75 | 0.7 | 0.7 |
| SVM | 0.8157 | 0.70 | 0.822 |
| Decision Tree | 0.8157 | 0.65 | 0.825 |
| Random forest | 0.8421 | 0.80 | 0.844 |
| Adaboost | 0.8421 | 0.65 | 0.825 |

**Table 3**

**Comparison of various ML algorithms**

| Algorithm | Accuracy | Recall | AUC |
|---|---|---|---|
| **Logistic Regression(w/ imputation)** | 0.789474 | 0.75 | 0.791667 |
| **Logistic Regression(w/ dropna)** | 0.75 | 0.7 | 0.7 |
| **SVM** | 0.8157 | 0.70 | 0.822 |
| **Decision Tree** | 0.8157 | 0.65 | 0.825 |
| **Random forest** | 0.8421 | 0.80 | 0.844 |
| **Adaboost** | 0.8421 | 0.65 | 0.825 |

ease to the patients. Researchers cannot find the solution for severe Alzheimer's disease21 and the techniques described above will guide or warn the custodian if there is a change in the behavior. Various techniques are in the process of reducing the size of wearable devices. Virtual Reality paves the way for handling AD persons

## 8. Conclusion

This survey contributes to numerous researches in constructing assistive technologies for Alzheimer's patients. This survey's main intention is to highlight the contemporary wearable assistants accessible nowadays for aiding the patients grieving from AD disease. The paper also confers various evaluation measures and datasets applicable for Alzheimer's patients. The survey highlights various research opportunities in aiding the AD people. In the future, the various issues mentioned in this survey are considered in developing a useful wearable device for Alzheimer's patients to trail up with their beloved ones.

## References

[1] Kanno, K. M., Lamounier, E. A., Cardoso, A., Lopes, E. J., & de Lima, G. F. M. (2018, March). Augmented Reality System for Aiding Mild Alzheimer Patients and Caregivers. In 2018 IEEE Conference on Virtual Reality and 3D User Interfaces (VR) (pp. 593-594). IEEE.

[2] Nasir, E. M., Sahar, N. M., & Zainudin, A. H. (2016). Development of augmented reality application for dementia patient (DARD). *ARPN Journal of Engineering and Applied Sciences*.

[3] Aljehani, S. S., Alhazmi, R. A., Aloufi, S. S., Aljehani, B. D., & Abdulrahman, R. (2018, April). iCare: Applying IoT Technology for Monitoring Alzheimer's Patients. In 2018 1st International Conference on Computer Applications & Information Security (ICCAIS) (pp. 1-6). IEEE.

[4] Lazarou, I., Karakostas, A., Stavropoulos, T. G., Tsompanidis, T., Meditskos, G., Kompatsiaris, I., & Tsolaki, M. (2016). A novel and intelligent home monitoring system for care support of elders with cognitive impairment. *Journal of Alzheimer's Disease*, 54(4), 1561-1591.

[5] Westerberg, C. E., Lundgren, E. M., Florczak, S. M., Mesulam, M. M., Weintraub, S., Zee, P. C., &Paller, K. A. (2010). Sleep influences the severity of memory disruption in amnestic mild cognitive impairment: results from sleep self-assessment and continuous activity monitoring. Alzheimer disease and associated disorders, 24(4), 325.

[6] Bharucha, A. J., Anand, V., Forlizzi, J., Dew, M. A., Reynolds III, C. F., Stevens, S., &Wactlar, H. (2009). Intelligent assistive technology applications to dementia care: current capabilities, limitations and future challenges. *The American Journal of Geriatric Psychiatry*, 17(2), 88-104.

[7] Smagula, S., Gujral, S., Capps, C., &Krafty, R. (2019). A systematic review of evidence for a role of rest-activity rhythms in Dementia. Frontiers in psychiatry, 10, 778.

[8] Ienca, M., Fabrice, J., Elger, B., Caon, M., Scoccia Pappagallo, A., Kressig, R. W., &Wangmo, T. (2017). Intelligent assistive technology for Alzheimer's disease and other dementias: a systematic review. *Journal of Alzheimer's Disease*, 56(4), 1301-1340.

[9] Yousaf, K., Mehmood, Z., Awan, I. A., Saba, T., Alharbey, R., Qadah, T., & Alrige, M. A. (2019). A comprehensive study of mobile-health based assistive technology for the healthcare of Dementia and Alzheimer's disease (AD). Health Care Management Science, 1-23.

[10] Yawale, K., & Thorat, S. (2019, March). Comparative Analysis of Various Technologies used for the People Enduring through Alzheimer's Disease: A Survey. In 2019 Innovations in Power and Advanced Computing Technologies (i-PACT) (Vol. 1, pp. 1-5). IEEE.

[11] Husebo, B. S., Heintz, H. L., Berge, L. I., Owoyemi, P., Rahman, A. T., &Vahia, I. V. Sensing Technology to Monitor Behavioral and Psychological Symptoms and to Assess Treatment Response in People With Dementia. A Systematic Review.

[12] Thorpe, J. R., Forchhammer, B. H., & Maier, A. M. (2019). Development of a sensor-based behavioral monitoring solution to support dementia care. JMIR mHealth and uHealth, 7(6), e12013.

[13] Raad, M. W., Sheltami, T. R., & Shakshuki, E. M. (2015, June). Ubiquitous Tele-health System for Elderly Patients with Alzheimer's. In ANT/SEIT (pp. 685-689).

[14] Ianculescu, M., Alexandru, A., & Tudora, E. (2017, October). A RFID-based tracking approach for building up smart solutions for consumer's safety. In 2017 5th International Symposium on Electrical and Electronics Engineering (ISEEE) (pp. 1-7). IEEE

[15] Ienca, M., Fabrice, J., Elger, B., Caon, M., Scoccia Pappagallo, A., Kressig, R. W., & Wangmo, T. (2017). Intelligent assistive technology for Alzheimer's disease and other dementias: a systematic review. *Journal of Alzheimer's Disease*, 56(4), 1301-1340.

[16] Woodberry, E., Browne, G., Hodges, S., Watson, P., Kapur, N., & Woodberry, K. (2015). The use of a wearable camera improves autobiographical memory in patients with Alzheimer's disease. Memory, 23(3), 340-349.

[17] Mahoney, E. L., & Mahoney, D. F. (2010). Acceptance of wearable technology by people with Alzheimer's disease: Issues and accommodations. *American Journal of Alzheimer's Disease & Other Dementias®*, 25(6), 527-531.

[18] Thorpe, J., Forchhammer, B. H., & Maier, A. M. (2019). Adapting Mobile and Wearable Technology to Provide Support and Monitoring in Rehabilitation Processing and Information Technology (ISSPIT) (pp. 1-5). IEEE.

[19] Gacem, M. A., Alghlayini, S., Shehieb, W., Saeed, M., Ghazal, A., & Mir, M. (2019, December). Smart Assistive Glasses for Alzheimer's Patients. In 2019 IEEE International Symposium on Signalfor Dementia: Feasibility Case Series. JMIR Formative Research, 3(4), e12346.

[20] Aruanno, B., & Garzotto, F. (2019). MemHolo: mixed reality experiences for subjects with Alzheimer's disease. Multimedia Tools and Applications, 78(10), 13517-13537.

[21] Rashmi Parameshachari, Supriya Maganahalli Chandramouli, Building Enhanced Chaotic Map Encryption Method for Medical Informa-

tion System, *Journal of System and Management Sciences*, Vol. 11 (2021) No. 1, pp. 176-192 DOI:10.33168/JSMS.2021.0111.

[22] Alzheimer' Disease and Related Dementias Guideline Development Panel Agency for Health Care Policy and Research, U.S. Department of Health and Human Services Early Identification of Alzheimer's Disease and Related Dementias: Quick Reference Guide for Clinicians, *Journal of Pharmaceutical Care in Pain and Symptom Control*.

[23] Vinayak K.Bairagi,Improved epileptic seizure detection using singular spectrum empirical mode decomposition and machine learning approach, *Journal of Statistics and Management Systems*, Volume 25, 2022, Issue 1.

[24] Anshul Bhatia, Application of extreme learning machine in plant disease prediction for highly imbalanced dataset, *Journal of Statistics and Management Systems*, Volume 23, 2020 - Issue 6: Intelligent Decision Making using Best Practices of Big Data Technologies (Part-I).

[25] Shikhar Seth, Basant Agarwal,A hybrid deep learning model for detecting diabetic retinopathy, *Journal of Statistics and Management Systems*, Volume 21, 2018 - Issue 4.