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Aging better with ICTs: A neuropsychological recovery system (Fari)

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Abstract
Fari is a neuropsychological recovery system that provides solutions to support early detection, diagnosis, and quality of life for patients with Alzheimer's disease and their caregivers. The artificial intelligent system effectively registers and interprets signs of potential dementia, to give proper care long before getting out of hand. It is based on the seven areas of cognitive function which have been summarized in a tabulated form. As people age, they get affected by Alzheimer's disease which involves memory loss and major disorientation. There is a great need to assist the patient age healthy with ICTs to improve monitoring and schedule. There is a table entitled the seven areas of cognitive function which indicates a framework on which the system falls and outlines the graphical user interface designs and all the system components. The paper includes the percentage system effectiveness after testing and the indications of Fari's medical implementation. There are different packages of Fari found on the play store and their price listing, which is cheap and affordable. Any adult can use the AI system over the age of 30, those without the dieses for early detection and those with the dieses for monitoring progression. The Fari system includes a smart wristwatch, patient's smartphone, caregiver's smartphone, doctor's smart gadget (laptop/Smartphone), and headgear to record MRI scans.

Keywords - *Android, Alzheimer's disease, Fari, Health care, IOS, MRI, Older people, Web API, Machine Learning*

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I. Introduction

Within the 21st century, life anticipation increments in progressed social orders, and maturing populaces need to live up to a tall age in great well-being tall quality of life. In differentiate, the elderly are confronted with more ailments and negative results of maturing, which not as it were compound their quality of life, but regularly lead to the misfortune of self-reliance. Hence, they progressively require offer assistance from relatives or proficient caregivers. An expanding rate of maturing European populace endures from cognitive issues, causing expanding wellbeing and social issue. Agreeing to WHO's 2014 report, dementia is one of the greatest open wellbeing challenges confronting rising and display eras (Report, 2014). The quality of life of individuals with cognitive impedance proceeds to fall apart when they are simultaneously enduring other conditions (such as Parkinson's illness, etc.). Hence, there's a major got to organize complex and compelling care for the elderly and their relatives. Considering the current statistic patterns, the financing and sustainability of the care framework are increasingly challenging for human and budgetary assets. Subsequently, there's a developing need for complex programs that point to preserving the quality of life and self-reliance as long as conceivable through the viable participation of the distinctive sections of the care framework (Khosravia & Ghapanchia, 2016). Artificial intelligence has a great ability to revamp healthcare services. It can maximize productivity and throughput of care delivery and permit healthcare systems to offer more and better care, especially for the elderly. AI can assist the job of healthcare caregivers in spending more time in focused patient care and reducing overworking.

II. Related Works

A bibliometric method was used to come up with the literature for this paper. These methods can introduce a systematic, transparent, and reproducible review process and thus improve the quality of reviews (Zupic & Carter, 2015). Table 1 shows a list of different researches that have the same investigated approach.

When ICT came into existence, its main stance was to eradicate all the paperwork involved in companies' records, especially health records. This assisted in the clean flow of information, especially to and from insurance companies. Now technology has overlapped to artificial intelligence, which enables the health sector to be marginally better.

Table 1: shows a list of studies that used bibliometric analysis. The author has done elaboration.

References	Description
Clinical Decisions support systems	The system has Natural Language Processing (NLP), doctors use these systems to analyse and screen down information involved in the medical setup where records are large and extreme (Lafortune, Huson, Santi, & Stolee, 2015).
Robotic Surgeries	Focusing on high speeds, tough prediction analysis, optimal decision solutions, including revolutionized surgeries, involves robots on a more marginalized scale. Humans get tired and are bound to make mistakes, robots follow a species algorithm that can be replicated repeatedly without any mistake. Human error, fatigue, and break are limited by the efficiency of robotics (Irie, Otsuka, Hagiwara, Kamagata, & Kamiya, 2020).
Enhanced Primary Care and Triage through chatbots	A platform that offers multiple requests simultaneously through chatbots offers the three security components: CIA (confidentiality, integrity and accessibility) (Davis, Lasko, Chen, Siew, & Matheny, 2017).
Virtual nursing assistants	There is a strong need for patients to interact directly with their nurses, normally a nurse has got several patients they assist and care for. Virtual assistance, a strong artificial intelligence base, makes it easy to assist nurses and patients. The virtual assistants are available 24/7 for patients, responds to questions and queries and makes decisions in any way possible (Zhong , Xing, Li, Liu, & Fu, 2018).
Accurate diagnosis	Deep learning is based on algorithms that learn and grow by the environment they are in just like a normal human being, the only difference is that the algorithm keeps on growing and makes precise and accurate decisions. In terms of diagnosis, it makes accurate decisions based on previous results. The prognosis and diagnosis are precise and on point. These AI assist doctors in making decisions. In terms of cost it is effective in predicting diabetic retinopathy (Abbott, Orr, McGill, Whear, & Bethel, 2019).
HER systems	The leading artificial intelligence systems include voice recognition, language processing, processing of routine requests, dictation, prediction and response to multiple requests at a time. These functionalities enhance medical processes (Jaremko, Azar, Bromwich, Lum, & Alicia Cheong, 2019).

AI allows mammograms to be reviewed and translated 30 times faster and with 99 percent accuracy, decreasing the need for unneeded biopsies (Wilson, 2017). Patients can get individualized experiences thanks to an AI-powered virtual assistant. It assists people in identifying their condition based on symptoms, keeping track of their health, scheduling doctor appointments, and more. Rather than looking for purposes of the side effects that you are experiencing, you can ask the virtual nursing right hand to direct you through. The medical care aide won't possibly give clinical counsel when you have normal diseases or grievances yet additionally permit you to plan a meeting with a specialist or a trained professional. Also, the menial helper would be accessible day in and day out, implying it can address your inquiries and give answers progressively. This use of AI can be taken on to expand patient commitment and further develop their self-administration abilities to keep constant circumstances from deteriorating.

In conclusion, Zimbabwe, the elderly populace, accounts for 6% of the country's population of 16 million, according to Help Age Zimbabwe, a leading organization catering to the desires of senior citizens. As such, in numbers, it makes 760,000older adults, with 80% of them living in degraded destitution, concurring to insights from the Zimbabwe Insights Office (ZIMSTAT, 2012). Many older adults have dementia and Alzheimer's disease without resources to take care of these diseases. Mashonaland West has got many older people's homes. The main home that was used to test the system is Chengetanai people's home. They have more affected males than females with Alzheimer's disease. The females had only one member who was affected. The caregiver has a hard time taking care of these affected members because mostly they drift off and have numerous outbursts. The caregiver plays music to cool the members down when they encounter an outburst (Home, 2021). The caregivers need great assistance when it comes to the affected members. Alzheimer's disease (AD) is a dynamic neurologic clutter that causes the brain to shrivel (decay) and brain cells to pass on. Alzheimer's disease is the foremost common cause of dementia (Clinic, 2021) a ceaseless decrease in thinking, behavioral and social abilities that influence a person's capacity to operate freely.

Our discoveries delineate significant qualities of exploration to date on the utilization of AI that gives data to help people with Alzheimer's disease and health care officers. To start with, a couple of studies (N=30) have zeroed in on this point. Given the theme's interdisciplinary nature, we purposefully looked through data sets generally utilized in the wellbeing sciences and software engineering/designing. We discovered just 2 copies between these 2 arrangements of information bases, with more than 66% of the software engineering/designing data sets (32 from the wellbeing sciences data sets, 83 from the software engineering/designing data sets). On the subject of AI in Alzheimer'sdiseases, the executives via guardians,

there was little cross-over between the wellbeing sciences and PC sciences/designing data sets, proposing that the last data sets at present contain most of the existing examination. To audit improvements on this point, one should inspect the two arrangements of information bases (Wangmo, Lipps, Kressig, & Lenca, 2019). Future methodical writing audits ought to follow expected changes in the proportion of work found between these arrangements of information bases as a pointer of the development of the innovation and its applications in medical services. All things considered, as time passes by, when AI innovation and its applications in medical services are more fully grown, the exploration found in the wellbeing sciences data sets will increment. In contrast software, engineering/designing data sets might diminish (in outright number or relative proportion).

The health system has amassed enormous datasets, to a great extent, because of the presentation of electronic records, which incorporate segment data, clinical history, lab tests, and radiological examinations, history of careful mediations, medical history, and hypersensitivities, way of life, and so on. Such information can be utilized beneficially for: further developing conclusion and therapy, anticipation, analysis and fix of transferable, intense, and ongoing infections, thinking about data on way of life, general wellbeing and socioeconomics, help ideal finding and forecast/avoidance of sickness beginning at a beginning phase.

III. Ml And Dl Implementation In The Healing And Care And Elder Societies

Data learning and machine learning have similar characteristics, including graphical images and numerous points to design learning models for Artificial Intelligence. The model gives precise and time-lined use in medical arenas that as computer-aided diagnostics. Not many older people are using ML and DL modeling to date in clinical assistance or medical assistance. Machine language and deep learning differ from where they are used in the medical arena based on the accuracy (Irie, Otsuka, Hagiwara, Kamagata, & Kamiya, 2020). The preciseness of Artificial intelligence algorithms is mostly at its peak depending on particular variables that are in analyzing brief scenarios after syncope in older people (95% correctness, focusing on attributes less than twelve based on the history provided by the patient, ECG, and the situation exposed by syncope in a complete figure of 1845 subject (Constantino, Falavigna, Solbiati, Casagranda, & Sun, 2017). When variable numbers go up or maybe up to 27, the results also increase to a higher algorithm of approximately 98%, combining independent nervous system including TBI and its graph of progression to AD (Ho, Legere, Li, Levine, & Hao, 2017).

There was a great need for the algorithms to be examined for the second time by the study done by Finish on dementia detection, done to find out the accuracy of MLLL and DL in a larger population (n=1009, incident dementia 151). The preciseness of models based on DL and ML was 79% and 75% for major advanced subjects, focusing on the prediction of dementia development, age, memory conditions, and APOE genotype (Jiang, Jiang, Zhi, Dong, & Li, 2017). The algorithm works for those without dementia but who can develop it because of falling within the age range and those with dementia to predict the rate of progression and propose ways of preventing and sustaining dementia. A related solution of the artificial algorithm has identified frailty and perceived risk for falling in the elderly population (Patterson, Engstrom, Sah, Smith, & Mendonca, 2019). There are replica characteristics found in an AI algorithm used in recognizing the frailty within the population aged from seventy-five years to over (75%) (Ambagtsheer, Shafiabady, Dent, Seiboth, & Beilby, 2020).

PROBLEM STATEMENT

Older adults are at great risk of developing Alzheimer's disease, and it is known that this disease does not have a cure. Older adults in their best health develop mental disorders that affect memory, thinking, and behavior. When these symptoms or disturbing behaviors grow intense, they affect daily activities. Most patients become extremely disoriented to the extent that they behave like they have bipolar with several personalities. The disorder progression increases the loss of memory, difficulty in cognitive thinking and involves great changes in behavior. The caregivers and the patients are both having a hard time when it comes to dealing with these diseases. There are several risk factors for Alzheimer's disease at any point in its progression stages. The disorder results in loss of mental functions resulting from brain tissue changes leading to Alzheimer's, senile dementia, or Alzheimer's disease. Progressive nature and chronic state are characteristics of Alzheimer's senile dementia. Younger people are not at risk of this disease:-30 years and above are mostly at risk. It costs a lot to take care of a person with Alzheimer's disease-; not only are the costs high, but the caring nature is high on its own as the patient requires a lot of monitoring. In addition, physical, emotional, and cost-effective pressures can cause great stress to families and careers. There are a lot of issues that are involved which need a lot of support in this lifelike health, social, education, financial, and legal system for people with Alzheimer's diseases and their caregivers. It is of vital importance for people to age better, so there is a great need to detect the disease early and manage its progression as it also affects people in their 30s and 40s.

THE SOLUTION

The solution focuses on registering and interpreting signs of potential dementia, on giving proper care long before Alzheimer's diseases affect a person. In addition, the solution includes maintaining the quality of life, maximizing function in daily activities, enhancing cognition, mood and behavior. Focusing on the seven areas of cognitive functions (Lundqvist, Docent, Narkotikafrågor, & Universitetssjukhus, 2016)

Table 2: The seven areas of cognitive function

Areas in cognitive function	Subareas	Extended subareas
A. Metal focus	Attention	
	Visual Attention	Selective
		Divided
		Sustained
	Executive	
	Colour	Recognition
		Alertness
	Game Playing	
B. Recall	Memory	Number and letter game (reverse and correct order)
	Encoding	conveying conversations
	Storage	Spellings
		Location memory
		Read and recall books
	Retrieval	Long term
		Short term
		Immediate term
	Daily Activities	
C. Acuity	Perception	Environment recognition stimuli
		Response to stimuli
D. Interpretations	Reasoning	
	Game puzzles	Images
		Text
		Images and Text
E. Communication	Language	
	Word recognition	Oral letters
		Reading
	Virtual shopping	
F. Executive Function	Working memory	Game task
		Auditory
		Visual inhibition
	Flexible thinking	
	Self-control	
G. Symbolic expressions	Computer	
	Number identification	

ARTIFICIAL INTELLIGENCE WITHIN FARI

AI is a combination of several technologies grouped. Health services and health care can be transformed for the better by these technologies (Thomas). Fari is one of the systems that can perform well or better than humans at key duties and tasks of taking care of the elderly.

1. Machine learning combined with deep learning in Fari

Fari is a system driven by artificial intelligent applications and services routine predictions and balanced diet meal predictions. The system learns by itself how the patient exercises and eats each day, uses previous results to predict what exercises should be done and what balanced diet food should be prepared and eaten by the patient. Fari falls under smart assistants and proactive healthcare management systems. The system uses a heard band that scans the brain and sends MRI images to the doctor's dashboard. If there is an anomaly in the imaging, the doctor is alerted by the system's emergency system. The image recognition application helps to analyze and assess the MRI images.

2. Expected (Natural)language processing in Fari

Fari has a voice-over application system that includes recognition speech, analyzing text media, and translation. The Doctor's dashboard receives instant updates from each patient's daily routines. When it comes to reporting compilation, the system prepares reports, especially on the MRI examinations including all the data from the smart wristwatch.

3. Rule-based skilled systems in Fari

The Fari system records temperature, blood pressure, and sugar levels-; when these levels approach a zone outside the normal stipulated range, the system resolves that issue by sending emergency alerts to the doctor and caregiver. The system monitor's the levels 24hrs a day without fail. When the data is sent to the doctor, there will be suggestions on how to aid the patient on the caregiver's dashboard as they wait for the doctor. The system also has a question and answer segment available for both the caregiver and patient. The questions and answers are based on Alzheimer's disease. The system responds as if it is a human being responding to questions.

4. Robotic process automation in Fari

The Fari system auto exchanges information among different devices, sending appropriate information to appropriate devices. The processing does not take time, and it is automated. As the data is recorded, it is used for processing and analysis right away. The robotic process automation is mainly based on the information and applied on repetitive tasks like report updating and recording data from the wristwatch. When the headband reads the MRI data and sends it through an automated process, images are received at the doctor's dashboard.

FRAMEWORK AND TOOLS

Table 3: Proposed System Framework

All System functions		
- Location system (GPS) - Calendar - Information desk Voice-box		
a) Applicant	**b) Caregiver**	**c) Doctor**
- Registering - Q and A - Doctors contact - Head scan (MRI) - Virtual shopping - Exercise monitor - Pulse rate monitor - Games (mental focus, acuity, recall, interpretations, reasoning, communication, executive function, symbolic expressions) - Temperature monitor	- Doctors contacts - Patient record - Q and A - Caregiver schedule (eating routines, exercise schedule) - Patience handler (eating, sleeping, behavior (moody, talkative, absent-minded, outbursts etc)) - Low-density lipoproteins food list for patient	- Patients records - Alzheimer's appointments - Head scans imaging reports
Hardware	**Software**	
- Juno development board - Smartwatch - Portable real-time brain scanner	- Kotlin, Flutter, Figma, Android Studio, Visual Studio, Python, and Flask	

The framework above outlines all the systems' functions in full detail. As there are four parts to the system, each system is going to have its functionality. Focusing on the hardware, the Juno development board is a system control processor firmware for system initialization, cold boot flow, control clocks, voltage, power gating (Limited, 2021). The Juno board is the control processor for Fari. The portable real-time brain scanner sends MRI images to the doctor's dashboard in real-time. The smartwatch comes in three forms that are the android, windows, and iOS. Kotlin runs on android studio for the development of IOS platforms. Figma was used for system design. Flutter runs on visual studio for the development of android platforms. Finally, python and Flask worked on the development of the web API.

FARI: A NEUROPSYCHOLOGICAL RECOVERY SYSTEM

Fari is a four-way artificial intelligent voice system applied to participants with or without Alzheimer's disease. Individuals can use the system from the age of 30 to enable early detection, those with the disease to manage its progression.

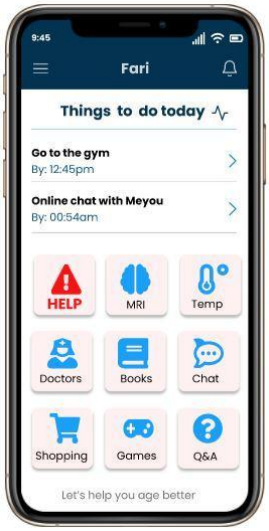
PROPOSED SYSTEM FRAMEWORK

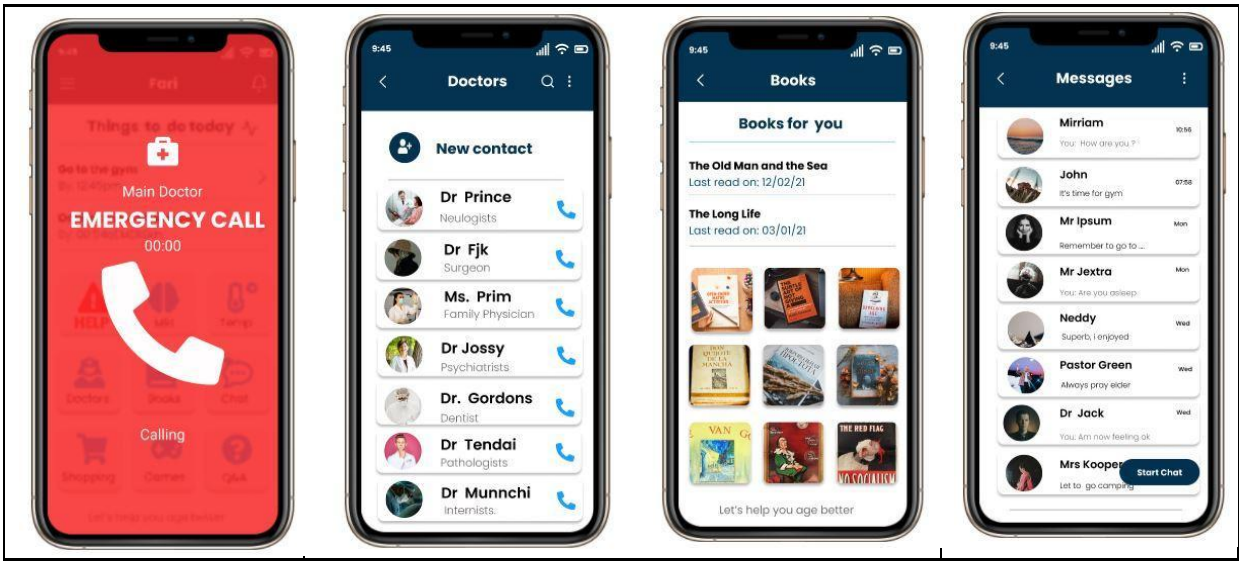
Table 4: The Watch

Home	Status	Workouts	Alerts

The first part of the system is a smart wristwatch that patient wears. This smartwatch tracks the patient's location, which is a timer reminder received as alerts. The best part of the smartwatch is its recording of blood pressure levels by measuring systolic and diastolic pressure. In addition to tracking fitness, statistics are recorded. All that is recorded by the smartwatch is sent over to the caregiver's smartphone. The doctor's computer receives the information which they require from the patient.

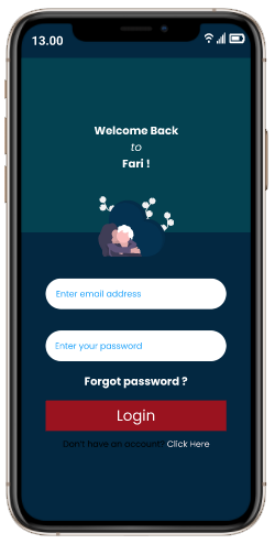
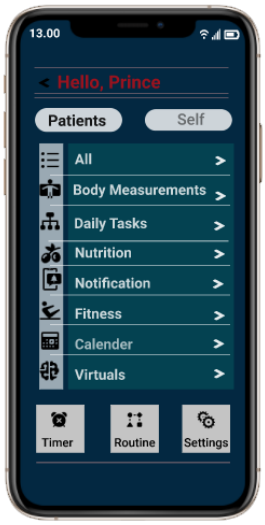
Table 5: Applicant Application

Home	Registration	Login	Dashboard
			
Emergency	Doctors Contacts	Books	Chats



The second part of the system is the patients or applicant system on a smartphone that provides a registration platform, numerous games, music, virtual shopping, Q and A segment on a chatbot, and images that include family members' images.

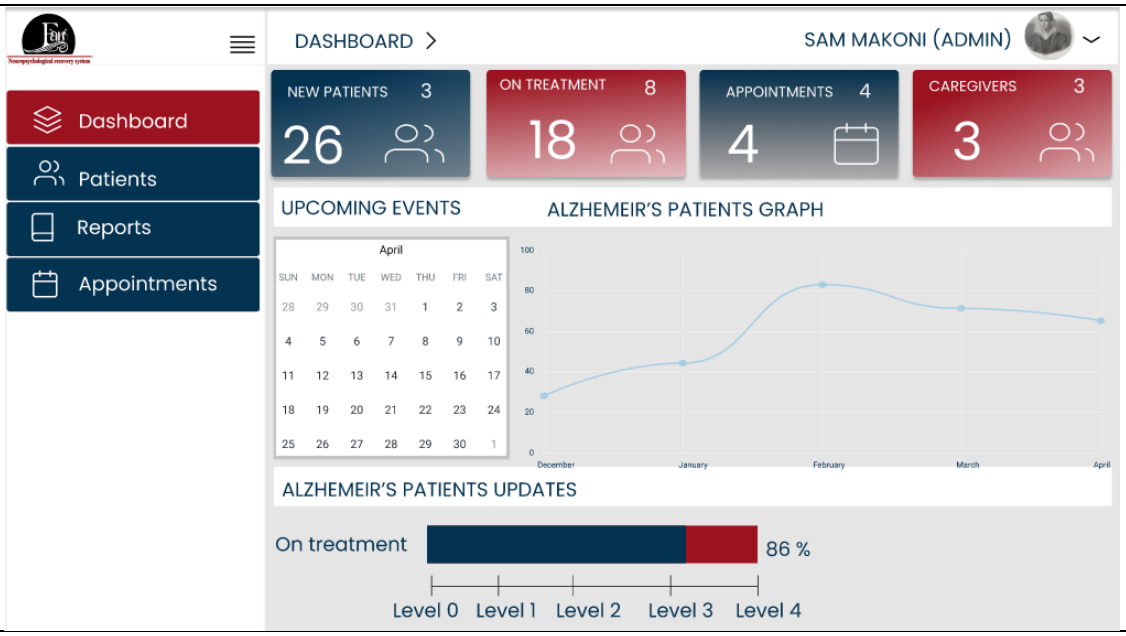
Table 6: Caregiver Application

Home	Login	Dashboard	Daily Schedules
			

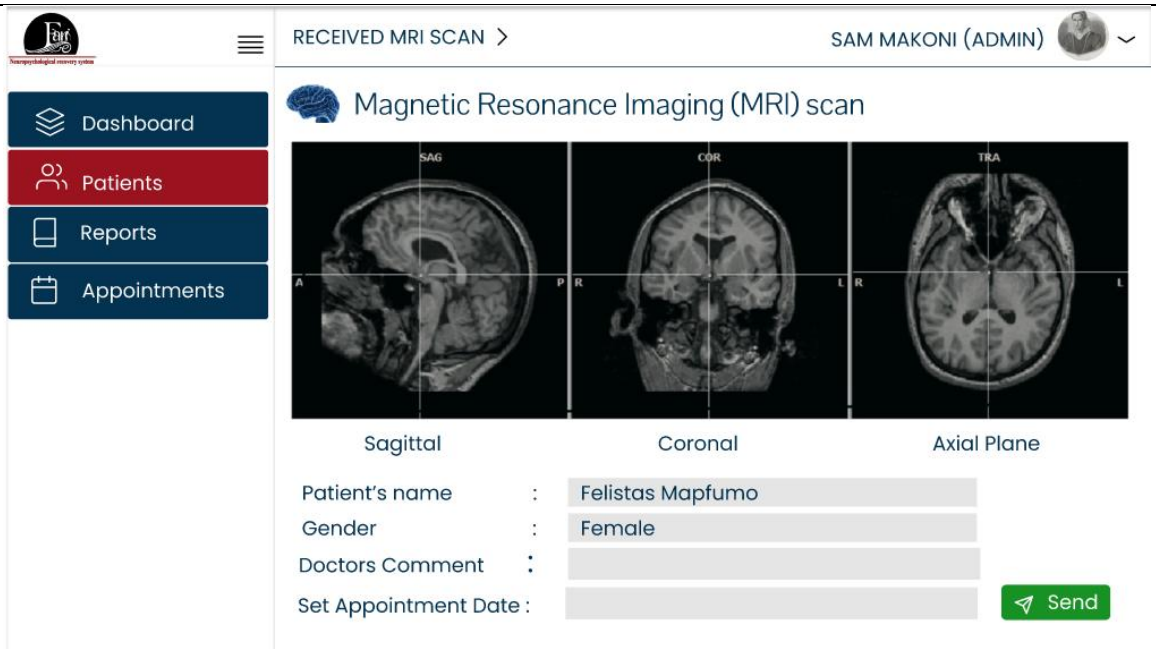
The third part of the system is the caregiver's system which contains the doctor's contacts, patients records which receive all the notifications from the smart-watch, Q and A segment chatbot, caregiver's schedule, patience handler (eating, sleeping, behavior (moody, talkative, absent-minded, outbursts)) and a list of lipoproteins food.

Table 7: Doctors Application

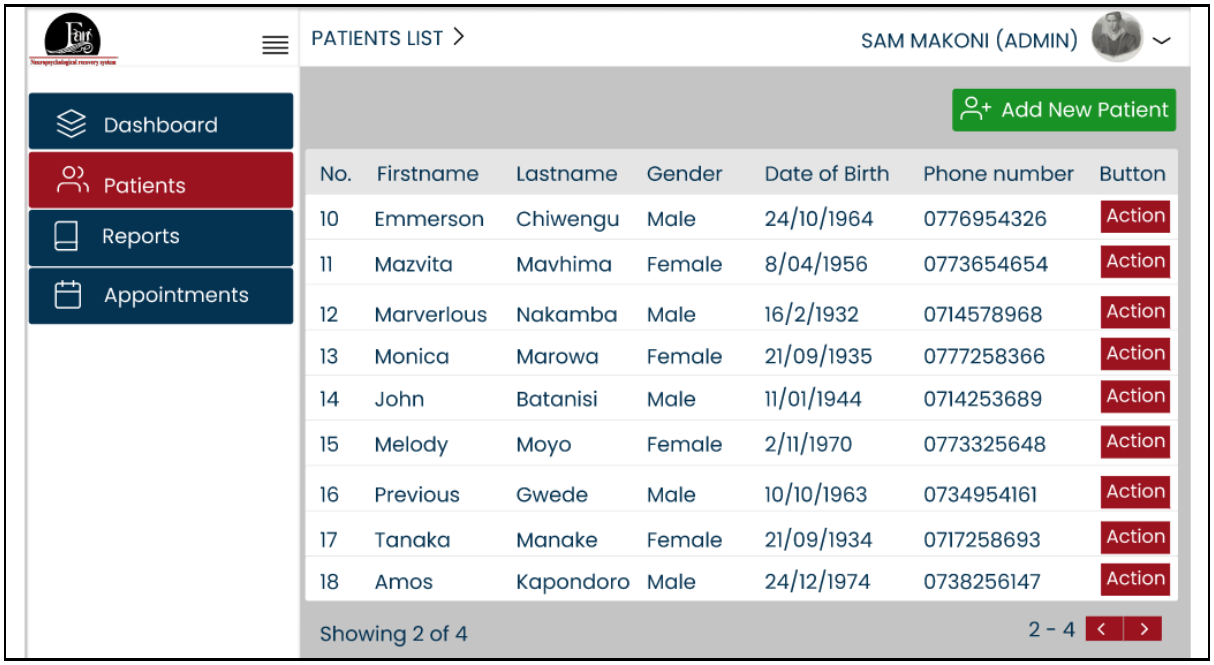
Dashboard



MRI Scans



Patient's list



The fourth part of the system is the doctor's system which will contain the caregiver's contacts for each patient, the patient's records, Alzheimer's appointments, and head scans imaging reports. The system and analysis combine the reports for each patient is done graphically.

IV. Conclusion

The Fari system was tested at the Chengetanai Home for the elderly in the Mashonaland West Province of Zimbabwe. The home for the elderly organization gave the system to test its effectiveness with the older people it was designed to assist. The system was tested based on specific variables: pulse rate, blood pressure, temperature, workout routines, MRI scans, and patient reports. The system's algorithm analyzed the patient's information recorded by the wristwatch to determine the progression of the dieses. The system's effectiveness was proven after one patient drifted off the premises and alerted the caregiver's application. Since the smart wristwatch has a GPS, the patient was located and escorted back to the premises. Another scenario was when one of the patients collapsed, and the wristwatch recorded a lower pulse rate, alerting both the caregiver and the doctor. The doctor's dashboard records the percentage of progression for each patient (98%effectiveness). This is based on the variables recorded by the system. For each new patient, the assigned doctors receive daily updates (100% daily updates). These include one-time MRI scans per week, which the doctor analyses. The system analyses the MRI scans by themselves, comparing them against previous MRI scans detecting the rate of dementia progression. Below is a table that shows the Fari system effectiveness, the datasets grow as the software application increases its imaging number.

Table 8: System effectiveness

	Smart Wrist Watch	Patient Applicant	Caregiver Applicant	Head Band	Doctor's Dashboard	Voice Assistance
Number of users	20	20	5	20	2	27
Effectiveness %	100%	100%	100%	90%	100%	100%
Entertainment	10%	100%	20%	0%	0%	0%
Reports	0%	0%	100%	0%	100%	0%

Table 9: Fari contribution in patients' medical journey: Medical implementation

Medical records Data mining of medical records to provide better and faster health services Reducing time on administration and making healthcare more patient-centric
Prediction and diagnosis of diseases Extracting MRI images Diagnostic imaging Disease monitoring
Drug development and improvement in therapeutic use

Identifying disease targets for therapeutic intervention Identifying drug candidates; repositioning of available drugs Identifying the best drug combinations for each patients' health requirements **Outcomes** Equalizing healthcare Reducing mortality rate and human error Reducing medical costs Reducing reliance on social services Exercise routines Patients reports
Entertainment Books Games Food menus

There was a great need to test the system so that adjustments and corrections would be made perfect. It was tested on the users it was designed for. The above table records the numbers of people who used the wristwatch, caregiver's system, the doctor's dashboard, and the voice assistance, including their effectiveness. This system is affordable as it can be found on google store. Therefore, it reduces medical costs. There are different packages on the play store platform: the bronze silver, gold, and platinum package. Officially the system works as it gives accurate patient reports.

The Fari artificial intelligent system plays a vital role in the aging for the better environment it provides. It provides a monitoring platform for older people as they will be carrying out their day-to-day activities. The platform monitors their blood pressure, sugar levels, and temperature nonstop without tiring. It also entertains through game playing, through reading books, through selecting different menus, and through remainders. As the disease progresses, more forgetfulness affects a patient, so remainders come into play. Since it is a four-in-one system, the doctor's dashboard and the caregiver's smartphone make it easy to monitor each patient from any location. Older people age healthily without much difficulty as prolonging life is the main health policy. An aging populace tends to have a better predominance of constant maladies, physical incapacities, mental sicknesses, and other co-morbidities.

Table 9: Play store packages

Fari artificial intelligence techniques detect progression by analyzing Magnetic Resonance Imaging (MRI) images in the brains of patients with Alzheimer's disease with an accuracy between 63% -70%. This technique recognizes or predicts response to treatment and prognosis in people with and without Alzheimer's disease. The accuracy increase (95%) when using (50 layers) architecture. Such findings can be forwarded to planning and predicting how patients with low-grade Alzheimer's disease respond to treatment.

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