IoT-Vision Enabled Assistance for Epileptic Patients

Project Proposal

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1 Introduction

IoT-Vision Enabled Assistant for Epileptic Patients is an innovative and comprehensive solution that aims to detect, prevent and forecast seizures in real time to improve the lives of epileptic patients. The system uses cameras to monitor patient's activities in real time then send it to cloud server to analyze the data where it detects any abnormal patterns or symptoms that can lead to seizure. The system generates an alert notification if any seizure or its symptoms are detected and send it to its caretakers or family members through mobile and web application.

The main objective is to detect and forecast seizures by utilizing a personalized model technique which improves the accuracy of seizure detection and forecast and reduce false positive rate. System uses machine learning algorithms to learn activities and symptoms of each patient. This personalized model technique enables learning models to identify and understand unique behavioral patterns and triggering activities of each individual patient, which helps in forecasting and improving user's outcome with epileptic disease.

The system has user-friendly and accessible mobile, web and desktop application which provides a high level of flexibility and convenience to patients, their family members and caretakers. The applications are simple to use, interactive and provides real time monitoring which makes it easier for caretakers to give response in case of any emergency. The system is designed to be cost-effective. It provides round -the-clock safety and comfort and assistance only when epileptic patient needs it. Hence, it reduces the burden on caretakers and nursing sector and maintains an independent, comfortable, healthy and private life of epileptic patients.

In conclusion, it is revolutionary system that uses cameras and machine learning algorithms to detect and forecast the seizures. Personalized model technique used in this system helps in improving the accuracy of seizure detection and reduce false positives. The user-friendly and accessible mobile, desktop, and web applications provide a high degree of flexibility and convenience to patients, their family members and caretakers, making it easier for them to respond in case of any emergency hence improves the quality of life of patients and caretakers. Overall this project has potential to make significant impact on the lives of millions of people suffering with epilepsy.

2 Problem Statement

IoT-Vision Enabled Assistance for Epileptic Patients focuses to improve the quality of life and enable independence for older patients suffering from abnormal activities like seizures, a cost-effective, reliable, and accessible system for monitoring daily activities, pre-seizure detection and notification, and risk analysis is being developed. The main goal of an Internet of Things (IoT) and Computer Vision (CV)-enabled assistant for epileptic patients is to research the use of multiple cameras for seizure detection before they occur, recording of lifestyle patterns, and the development of intelligent mechanisms for converting visual input into precise and accurate situational assessment and quick response.

3 Objectives

3.1 Industry Objectives

The following industry objectives will be achieved:

- To make a contribution to the advancing field of healthcare technology
- To develop ways to integrate our system with the existing healthcare systems to improve nursing care for epileptic patients
- To ensure the compatibility of the system with the devices such as smartphones and laptops.

3.2 Research Objectives

The following research objectives will be achieved:

- To determine and analyze existing mechanisms/solutions for managing seizures in epileptic patients
- To examine the viability of system in the detection and prevention of seizures.
- To explore and identify research gaps in the management of epilepsy.
- To publish the findings in journals and present them at the international level.

3.3 Academic Objectives

The following academic objectives will be achieved:

- To get a deep understanding of various computer vision and machine learning algorithms used in the management of epilepsy.
- To practically implement the algorithms and analyze the results.
- To provide an opportunity for the students to explore the area of healthcare technology.

4 Literature Survey

According to the review of Andres M. Kanner, MD and Manuel Melo Bicchi, MD published on 5 April 2022, [8], epileptic seizures are abnormal and excessive or synchronous neuronal activity in the brain. Epileptic seizures cause serious bodily injuries like fractures, burns, and concussions if it is not properly treated.

With ongoing population growth, the healthcare sector faces many challenges including limited staffing, lack of trained professionals, limited hospitals, excessive need for monitoring, and unnecessary documentation. National Library of Medicine [7] states that a nurse-to-patient ratio is 1 to 500. NLH (National Library of Medicine) also provided ratios of population growth to growth in death rates, and growth rates of disability due to lack of attention [11]. These researches illustrate the desperate need for an electronic monitoring system in society that reduces the burden on the nursing sector and raise the living standard of patients.

IoT-Vision Enabled Assistance is a system that provides aid for people with epilepsy. It is a promising system that can improve the lives of patients with epilepsy. The system uses technologies of the Internet of Things and Computer vision to monitor patients and provide assistance in their time of need. In this literature review, we will explore existing work done on smart assistance for epileptic patients and their impact on society.

There are several types of systems available in the market for epileptic patients. The most popular approaches to these systems are sensor-based and camera/vision based. Popular sensor-based devices are Embrace 2 [5], Epi-care mobile [14], Emfit [4], Brain Sentinel SPEAC [12], MedPage [16], AlertIt Companion by AlertIt [15]. And some vision-based devices are SAMi [3], and Epihunter [6]. A rough estima tion is that 50-60% of projects in the market are based on sensors and 12-15% of projects are based on vision/camera.

Sensors in a patient monitoring system are used so far that it's now common for both the patient and the nursing sector. The first sensor for patient monitoring was used in 1896, a blood-pressure cuff, in the world. Also, after many advancements in the medical health sector, sensors have made their place in society. These sensors come with many prominent qualities [13] like mobility in use, cost-effectiveness in installing or in maintenance, time-saving in integrating with quick and accurate responses, non-invasive in nature for patients, and compactness in size. Due to these stunning attributes, global IoT manufacturers are expected to reach USD 87.9 billion by 2026 [9]. But on the other side of the image, these have some limitations that sometimes make the whole story infeasible to use them. Some

most common shortcomings include water or other fluid sensitivity, patient body attachment requirement, allergic to the patient, discomfort to the patient due to its visibility and disclosing their condition to others, different environmental constraints like temperature or humidity to work due to different materials used in them, and false readings due to environmental change [1].

In contrast to other devices used in healthcare, the camera has broadened the concept of monitoring, both for the patient and the nursing sector. Now a surgeon/nurse or any caretaker of the patient can see the patient from a remote place at any time. This visual monitoring satisfies the caretaker as 50-80% of the human brain processing is dedicated to visual input. This makes smart cameras more compatible with the monitoring system. The use of smart cameras is not just limited to monitor a patient from a remote place, cameras could be used for vital sign monitoring without being in the vicinity, rehabilitation, disease monitoring, anomaly detection or fall detection, and in remote and telemedicine care systems. Instead patient has no need to attach different sensors to their body and deattach them to go to the washroom. Patients can move freely in the room without the constraint to sit at a particular place. These distinctive qualities of smart cameras motivate researchers for monitoring systems that based on cameras. But using a smart camera has its own constraints and limitations. The patient feels fear and hesitation in the environment where cameras are installed because the thought of being constantly monitored feels uncomfortable. Camera restricts the patient to stay in single room where the camera is installed. Camera streams have larger resources required to process and high rates of security threats. The system designer should take steps to overcome these limitations.

We are targeting patients with epilepsy. Epilepsy could be defined as the condition of two or more seizures. Medical science has proved that epileptic seizures have rhythmic patterns and triggers [2]. That's the reason why a caretaker of epileptic patients forecasts that the patient will suffer a seizure in the near future. Because the caretaker has learned the patterns of his patient. These patterns may include food patterns, sleep patterns, and medicine patterns. Then what if we apply the approach of the personalized model [10] technique? Our hypothesis is that the personal caretaker of an epileptic patient could predict a seizure before time same as our personalized model would predict seizures before time. In easy words, this technique would allocate a smart caretaker to every individual patient that knows and understand the patient's condition severity and its triggers. Then instead of a caretaker, a model would care for the patient. Then burden on the nursing sector and caretakers would be minimized. Through this the constraint of the

presence of a caretaker every time will be eliminated. And this all could be made possible by monitoring the daily activities of the patient like food activity (what the patient eats and at what time). Through this model would learn the seizure as an abnormal activity of the patient. In case of abnormal activity, the model has to notify the caretaker when it is predicted or forecasted.

In conclusion, IoT-Vision Enabled Assistance for Epileptic Patients is a system that provides monitoring to epileptic patients. It uses IoT vision (camera) technology to capture the daily activities of the patient. A personalized model works behind the video-captured data of the patient and predicts abnormal activity (seizure) of the patient before time.

5 Proposed Methodology

By continuously monitoring the epileptic patient with a camera and sending the collected data to the cloud or server where it will be analyzed, this project is expected to produce an accurate IoT-Vision-enabled assistant that can detect seizures or predict about its happening before it actually happens. This allows seizures, if they occur, to be detected, forecasted, and prevented. If the system notices any seizure activity or symptoms of a seizure, it will produce an alarm that will be sent to the patient's caretaker, who will then respond by rescuing the patient. Moreover, our system will provide an electronic nursing record (ENR) feature which will be very helpful for the behavior modeling of the person. Using ENR, the nurses will record all the person-related activities which will be very helpful in terms of measuring, reporting and monitoring quality and effectiveness.s

Our system will primarily use personalized model techniques, which will enhance the system's prediction, and accuracy and lower false-positive responses. Abnormal physiological activities differ from person to person. The personalized model technique will be highly helpful since it will enable learning models to learn specific physiological symptoms of each individual patient, improving the user's outcome with epilepsy. The generated alarm will be sent to caretakers by an alert feature of the Web/Mobile app of our system. This app will be handy, simple to use, and interactive, and will give caretakers and guardians constant access to real-time patient monitoring. Our proposed solution will be cost-effective as it will lift the financial burden of guardians, which will ultimately lead the epileptic patient to live an independent, comfy, and healthy life, as well as lessen the burden on the shoulders of caretakers.

5.1 Algorithm

The following algorithms would use in the whole flow of our proposed solution:

- Face Detection
- Gaussian Blur
- Activity Detection and Recognition
- Activity Forecasting

5.2 Block Diagram

Here is the given block diagram of the project:

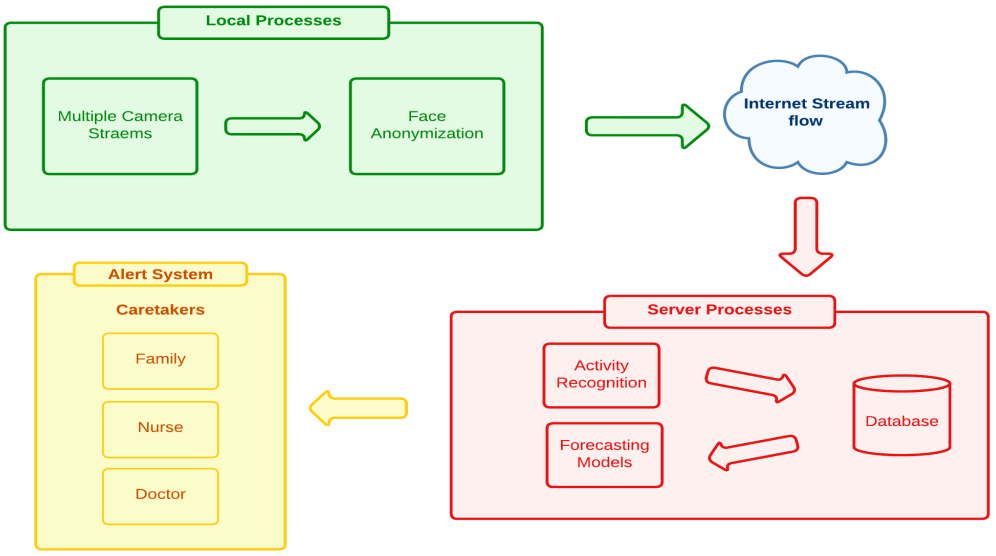

FIGURE 1: Block Diagram of Project

5.3 Flowchart

Here below is the figure that demonstrates the workflow of the project:

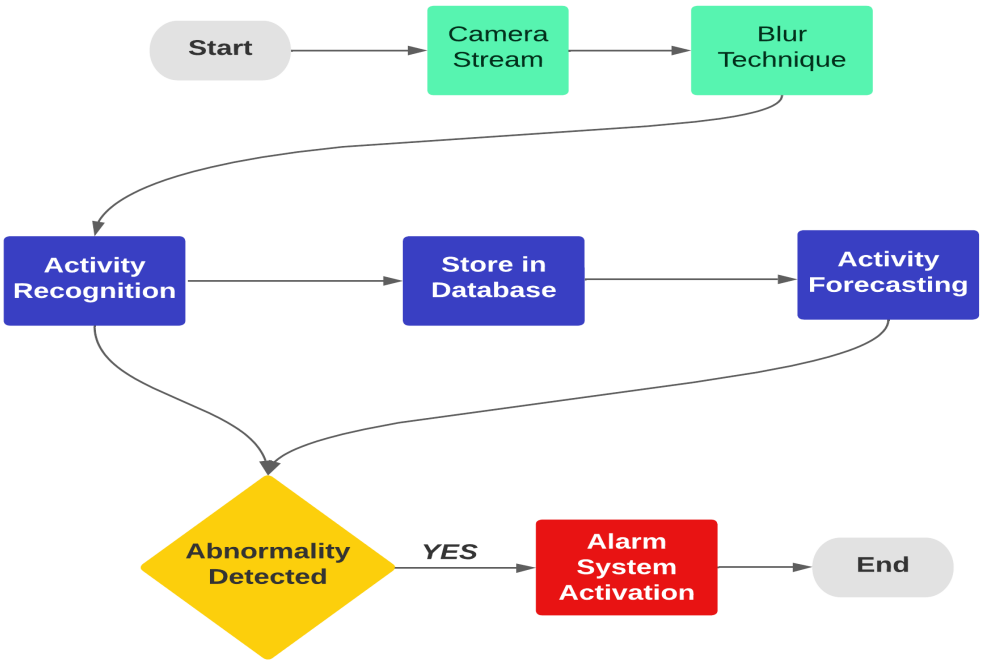

FIGURE 2: Flowchart of Project

6 Innovativeness in Proposed Solution

Following are some unique application features of the project:

Forecasting using behavioral modeling:
After training the model for a certain amount of time, the system will be capable to forecast the seizure activity ahead of time. It will be accomplished using behavioral modeling, the activities of the patient will be monitored and the model will extract patterns from it for the seizure. For instance, after having a meal or any specific type of meal, a person suffers from if this happens repetitively, the model will learn from it, and it will generate an alarm next time if the person does the same thing.

7 Hardware Software Requirements

Following are some hardware and software requirements:

7.1 Hardware Requirements

- Project requires cameras to monitor the patient.

7.2 Software Requirements

- Video Processing and analysis algorithms
- Seizure Detection algorithms
- Real Time Monitoring of patient
- Real time alerts and notifications
- Integration of system with server
- Security and privacy issues control

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