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Tracking the Activities of Psychiatric Patients Using Docker Containers

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***Abstract*: Day by day due to the increasing stress and depression, a huge percentage of people are affected by mental disorders and in certain cases, it is extreme and they need someone to monitor them always. It is observed to be a very tedious job in the current scenario. With the prominent use of sensors merged together and connected to Arduino, the device can monitor their activities throughout the day. Edge computing makes the classification of data easy. This paper deals with the system which detects human activity recognition and sends it to the remotely located caretakers. With the help of Docker technology this system can be implemented in any environment.**

***Keywords*: Docker containers, Edge computing, Human activity recognition.**

1. Introduction

In the current scenario, everyone is busy with their daily routine life; nobody has time to take care of the elderly people at home, patients who have undergone surgeries, Psychiatric patients, etc. These kind of people need to be monitored 24/7 and also it is not feasible to have caretakers all the time because it is not cost efficient nor reliable. Especially in the case of psychiatric patients, they need to be monitored always as they are mentally unstable, they tend to do troublesome activities and it is very difficult to control them.

The Internet of Things (IoT) and cloud computing are the prime focus of the current research and development in all the fields of study especially in the medical field. Edge computing is the integration of Cloud computing and Internet of Things (IoT) [1]. With the help of edge computing, the data can be processed in the local system therefore it requires less network bandwidth, it is cost efficient and is more reliable to conduct analysis [10].

The proposed system is designed to monitor the activities of psychiatric patients with the help of accelerometer sensors. The raw data collected from the sensors is sent to the Arduino where it is processed and then stored in the cloud. The caretakers can access the data stored in the cloud through, the given mobile application and also inform their friends or family if there is an occurrence of any issues.

2. Literature Survey

Now-a-days many advanced technologies are used for human activity recognition. Many authors and scholars researched about the same. This section consists of comparison of several authors related to the above technology.

In the survey paper, M. M. Hassan [11] -the system to monitor human activities is Vision based technique. In this technique with use of a camera, the sequences of images are detected to recognize the several activities of the patient. However, there are some disadvantages in this technique as it fails to capture the image and record the video if there is lack of light, it also hinders the privacy of the patient. The activities are classified as static and dynamic activities.

W. Wang, K. Lin [12], proposed a system, which contains lightweight wearable accelerometer sensors attached to different parts of the body. The various human activities are detected and raw data is sent to the server where the data is analysed and classified and then it is sent to the remotely located caretakers. This system is not cost efficient, consumes a lot of time to process the huge amount of data in the server and requires large network bandwidth.

In Hongyu Pan [9], Virtualization is used to deploy an application by creating virtual environments. The virtual machine is made up of both user space and kernel space of an Operating System. This makes VMs large in size and less efficient.

3. Proposed System

The proposed product will help to efficiently track the activities of psychiatric patients throughout the day. The accelerometer and temperature sensors attached to the human body, monitors the activities and sends the raw data to the Arduino Uno, in this the raw data is classified according to the detected activities and is converted to processed data. As seen the raw data is not sent directly to the cloud server, only after it is processed the data is sent, this is known as edge computing where the Arduino Uno is the edge node. By using edge computing the traffic of requests in the cloud can be reduced

and there is no data loss.

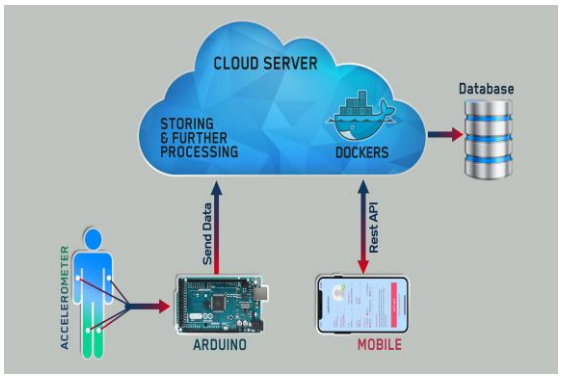

Fig 1. Architecture of the proposed system

The processed data is sent to the cloud server through a Wi-Fi-module. Wi-Fi module is a self-contained Soc integrated TCP/IP protocol stack that gives access to the internet connection. In the cloud server, the data is stored in the database as a Backup.

From the cloud server the data is sent to the user's mobile phone through REST API. In this system, the users are the allotted caretakers of the psychiatric patients. The data will be sent after checking for valid credentials.

Towards the end of the system, docker technology is implemented. Docker is a container technology which makes it easy to package and distribute software along with its other dependencies. It makes shipping of software code easy to staging or production or any other environment. Therefore, the developed system is portable.

4. Methodology

The Proposed System can be divided into five modules namely- Data Collection Module, Data Processing Module, Patient Monitoring App, Docker Deployment Module. The following are the components required for the system-

- *Arduino:* It is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boards are microcontrollers based on ATmega328P (microchip).
- *ESP8266:* ESP8266 is a complete and self-contained Wi-Fi network solution that can carry software applications.
- *ADXL335 Sensor:* It is an accelerometer sensor which can measure the static acceleration of gravity in tilt-sensing applications as well as dynamic acceleration resulting from motion.
- *LM35 Sensor:* is a temperature sensor that collects information about temperature from a source and converts into a form that is understandable by another device or person.
- *Storage (AWS):* It is a cloud computing platform that stores the classified data of the patients and further this data can be accessed by the caretakers.

A. Data Collection Module

The main objective of this module is to collect human activity data. An activity recognition sensor that is an ADXL335 accelerometer sensor and a LM35 temperature sensor will be connected to the human body which will read the human activity data.

ADXL335 accelerometer sensor has a 3-axis acceleration measurement system which detects various static and dynamic activities. In the proposed system, five activities are detected- Sitting, Sleeping, Standing, Walking and Jumping. LM35 is used to measure the body temperature of the patient. The raw data which is collected from the sensors is sent to the Arduino Uno.

B. Data Processing Module

The main objective of this module is to process the data collected from the sensors and make it available for further use.

Arduino Uno board reads the inputs from the sensors. The raw data is processed using Arduino Programming Language (C language) and the Arduino Software (IDE). The data is classified according to the respective activities (as mentioned above) recognised and is sent to the AWS cloud server to be stored and also for further processing.

ESP8266 Wi-Fi module can be used to send processed data from Arduino to cloud server. This module is a low cost Wi-Fi microchip which enables internet connectivity. With a set of AT commands, the system can communicate with the ESP8266.The ESP8266 hosts an application or offloads all Wi-Fi networking functions from another application.

C. Patient Monitoring App

In this module, all the patient's details will be displayed in the mobile Application. A mobile application is created using Android, where the caretakers can login using their valid registered credentials. After successful login all the patient details related to the caretakers is displayed. The information is obtained from the AWS cloud server through REST API. RESTful API (Representational State Transfer) is an architectural style used in web services development for communication purposes. It uses HTTP requests to GET, PUT, POST and DELETE data. This technology provides efficient internet usage as it uses less bandwidth. Every five minutes the activity of the patient is updated along with the body temperature. In case of any emergency a message will be sent to the mobile number of the registered caretaker.

D. Docker Deployment Module

Docker [13] is an open source OS-level virtualization software platform. It makes it easier to create, deploy, and run applications by using containers, and containers allow a developer to package up an application with all of the parts it needs, such as libraries and other dependencies, and ship it all out as one package.

In this module, towards the end of the project the proposed system creates a docker image so that it can be easily implemented in other machines without any installation of software. It is portable, less in size, and cost efficient which helps in rapid deployment of an application with all its dependencies in a self-contained environment called Containers.

Steps to create docker image-

- Create a Base Container
- Inspect Images
- Inspect Containers
- Start a Container
- Create an image from a container
- Tag the image
- Create Images with tags
- Delete the Original Container
- Observe the running Container

E. Results

The experiments were conducted on an Arduino Uno and the two ADXL335 accelerometer sensors used in this framework have a measurement range of ±3g minimum which is sufficient to detect each activity within a specific range. LM35 sensor used provides calibrated output 10mv per degree centigrade.

On each experiment, the stimulated sensors generated classification requests to the Arduino Uno, which results in recognition of the patient activity. The data is then sent to the AWS server from where the information of the patient is sent to their respective caretaker. Once the caretaker logins he/she can view the current activity, last activity and the body temperature of the patient, also it displays the duration of time since when the last activity has not been changed. The phone numbers of the caretakers are registered and if the body temperature of the patient is more than 100 degree Celsius or less than 90 degree Celsius, also if there is no change in activities for more than two hours an alert message will be sent.

5. Conclusion

This paper aims to provide a precise and an efficient way of tracking the activities of psychiatric patients with minimal cost. The proposed system is an integration between sensor networks, edge computing and cloud computing. The edge computing focuses on the network's edge instead of centralized cloud computing. By implementing the Docker Technology, it provides the ability to package and run an application in isolated environments called containers. This framework with intelligent edge applications and container platforms resulted in more adequate communication, reduced delays and rapid decision-making.

6. Future Work

This proposed framework will allow researchers to shape, broaden and improve its elements in the future in order to adjust it to various use cases and individual demands. Future work will be devoted to the real implementation of the presented and simulated system. Moreover, different use cases will be conducted and more advanced performance metrics will be calculated to facilitate the comparison with similar solutions.

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