

Cloud Based Framework for Autism Spectrum Disorder Therapy App

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Abstract— In the current era of connected devices like smart phones, the demand for data storage is increasing drastically for some set of applications involving multiuser. We require a centralized storage system where data can be accessed from any part of the world using various devices like mobiles and tabs. The cloud provides services for storing data on remote servers which can be accessed through the Internet. It is maintained, operated and managed by a cloud storage service provider on storage servers that are built on virtualization techniques and has large computational power compared to the mobile devices. The paper presented here proposes a cloud based framework for the application “AshaDeep” which was developed to provide technological support for autistic children. This mobile application generates huge number of images and data in a multiuser environment as a part of learning and evaluation activity. In this app we aim to unite multiple users by developing a common platform to track the progress of the autism children and combat autism.

Keywords: *Cloud Storage, smart phones, Autism, multiuser environment.*

I. INTRODUCTION

Autism spectrum disorder (ASD) refers to a group of pervasive neuro-developmental disorders that involve moderately to severely disrupted functioning in regard to social skills and socialization, expressive and receptive communication, and repetitive or stereotyped behaviors and interests [9]. A child with ASD faces problems in communication, social interaction, inability to recognize emotions and has restricted and repetitive behavior. The “AshaDeep” App is developed to counteract these problems and help them improve in the above mentioned aspects. It has large amount of images to help them learn and recognize basic real world objects and activities to increase their motor, visual, social and communication impairments. The child’s progress is measured on a weekly basis under various subsets. To provide support for large amount of images and processing of data we have proposed the Cloud framework.

Cloud storage is a service where data is remotely maintained, managed, and backed up [2]. This service allows the users to store images online, so that they can access them from any location via the Internet [1]. Mobile cloud computing is defined as integration of cloud computing technology with mobile devices to make the mobile devices resource-full in terms of computational power, memory, storage and context awareness [4]. Mobile cloud computing refers to the framework where both data storage and data processing can be done outside the mobile devices due to their resource restrictions like storage, battery life, lack of high computation power [3].

Mobile cloud computing is a solution to all these problems. Mobile devices are connected to cloud via the Internet. Google drive is one of the most well-known and popular cloud storage services available. The need for cloud computing is that it provides us the opportunity to perform large computations on the server side instead of running them locally and favors us to overcome the handset’s limitation of limited resources to a great extent [5].

II. RELATED WORK

The Android SDK (software development kit) is a set of development tools used to develop applications for Android platform. Android SDK allows the app to connect to Google cloud platform through app engines. Google app engines are a cloud computing platform for developing and hosting apps in Google managed data centers [4].

Recent advancement in mobile technologies has opened the gates for creation of android and iphone apps to combat autism. Autism Therapy with MITA (Mental Imagery therapy for autism) App has focused on improving tunnel vision problem associated with autism children, mental integration ability. Toby app helps in improving autism’s child social, language and cognitive skills. Proloquo2 App focuses on improving autism’s child speech problems. Autism Speech Diego Says, is the second highest ranked app in the list of top autism Android applications. Autism Speech is another communication assistor [6]. This app utilizes pictures and voice functionalities to help give those with autism a voice [8].

There has been a lot of research on Autism disorders and providing basic solutions for improvement in some of the disabilities through mobile apps with integration to cloud framework. A cloud based framework was introduced for autism screening, confirmation and intervention. The focus is on integration of screening, diagnosing and monitoring intervention through a mobile app [10]. Based on a screening test algorithm, a child is diagnosed of having ASD or not. If child is having ASD then are conformation methods to be exactly sure of it. They provide solutions through YouTube channels meant for improving social and behavioral skills. The above proposed scheme does not provide any visual support for autistic children in the form of images or any finger related activities improve motor disabilities.

These solutions do not track or provide any support for the child to apply and test what they have learnt by watching videos. In order to overcome these limitations, a cloud based framework has been proposed for the “AshaDeep” app for image and data storage as well as for computation which takes place in cloud thereby reducing the size of the app and the latency in data availability. The following section describes the system architecture, cloud framework and how to it can be implemented in various modules of the “AshaDeep” App.

III. PROPOSED CLOUD FRAMEWORK FOR THE APP

AshaDeep App is a mobile app developed by us to cater the special needs of ASD child. This app has different learning modules addressing generalization, improving motor skills. By integrating the Mobile app with the cloud services, the AshaDeep app for autism therapy has many advantages. The cloud provides the cross-platform capability which makes the app available to different users on multiple devices. Since the app has lots of images to achieve different objectives it is not reliable to expect each and every user of the app to have huge amount of storage in their mobile devices. The evaluation module designed requires large computations to be performed on the data sent from the app which the device cannot handle due to low processing capability. Using a cloud framework, ensures that different users such as the children, parents, tutors and the medical experts are connected and can view the progress of the child on a weekly basis.

The assistive technology app for ASD has a requirement of large number of images under various categories and a real-time database for computing the score of the child using different subsets in different activities. The images and the data produced and required by the app is sufficiently large and cannot be handled by the device storage or a traditional database system. Hence, a cloud framework has been proposed for the as shown in figure 1. Hence a cloud framework is proposed to handle the image library, learning module and evaluation module.

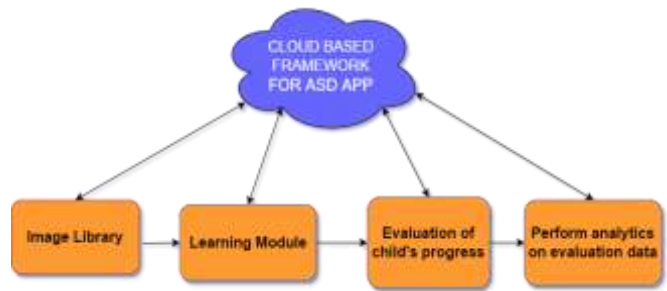


Figure 1: Proposed System Architecture

1. **Maintaining a huge Image library:** The app for autism therapy contains a lot of images under different categories and hundreds of images get added up as the app is used for a long interval of time.
2. **Learning Module:** Different activities like learn, match and coloring have been provided in the app. So, the cloud has to provide different images for different levels of activities.
3. **Evaluation Module:** Based on the activities played by the child, huge amount of data flood into the cloud under various subsets for every child who uses the app.
4. **Perform Analytics on Evaluation Data:** Based on the data going to the cloud, the cloud has to perform several computations to evaluate the child using the different subsets.

A. GOOGLE CLOUD SERVICES MIDDLEWARE INTEGRATION WITH THE APP

Firebase is an example of ‘BaaS’ or ‘Backend as a Service’ cloud model. Traditionally, while configuring a server the programmer has to use an API to write the code for the front end to connect and retrieve data from the database and also write the SQL code for the backend to handle the tables. Essentially, with Firebase with only few lines of code the programmer can write the database and handle the front end also.



Figure 2: Firebase Connectivity

The connectivity of firebase to the Google Cloud Storage and the ASHADEEP app in operating in different devices is shown in figure 2. The Firebase acts an interface to connect the different users like the students, parents and tutors running in different devices to the centralized Google Cloud Storage. This is achieved by providing necessary APIs to upload and download the images and data. The data and the images are stored in JSON format where the images are encoded in Base64 scheme and sent to the cloud by providing necessary APIs. Firebase also provides an offline support by maintaining the data in the local database while offline. As soon as it gets connected to the cloud, it automatically synchronizes the local data changes with remote updates that occurred when the device was offline, transfers all its contents to the cloud and the local database gets cleared providing more convenience to the different users of the ASHADEEP autism app. It is very robust in nature and performs uploads regardless of the network quality. Firebase also provides authentication for the backend services to authenticate different users to the app. This provides security for users' data in cloud and allows app to securely save user data in the cloud and provide the same personalized experience across all of the user's devices.

B. IMPLEMENTING CLOUD STORAGE FRAMEWORK FOR THE "ASHADEEP" APP

All the data in Cloud Storage is contained inside a project. Buckets are the basic containers that hold data. Everything that is stored in Cloud Storage must be contained in a bucket. A bucket can be described as a global namespace containing objects. Objects are the individual pieces of data that are stored in Cloud Storage. Objects in the bucket are to be accessed from our app through functions provided by the Firebase API [7]. In order to do so, we create a reference to these objects in bucket. Now these references are used to upload/download/delete the objects in buckets. There are three types of users of this app. User1 is autism child, User2 is parent/teacher of autism child, and User3 is the doctor. By using the above stated model, we implement it into "AshaDeep" App as follows. The project refers to "AshaDeep" App. The project provides the necessary APIs and monitoring settings for those APIs. Buckets are the different categories of images designed for the app [7]. E.g. in the figure 4, the app has different categories for images like fruits, vegetable, emotions. These names acts like a bucket. Bucket is a container for large number of images which are stored inside it. Object refers to the individual images. E.g. in the figure 5, each bucket as images with image names as img1, img2, etc. Objects in the bucket are to be accessed from our app. In order to do so we create a reference to these objects in bucket. Now these references are used to upload/download/delete the objects in buckets.

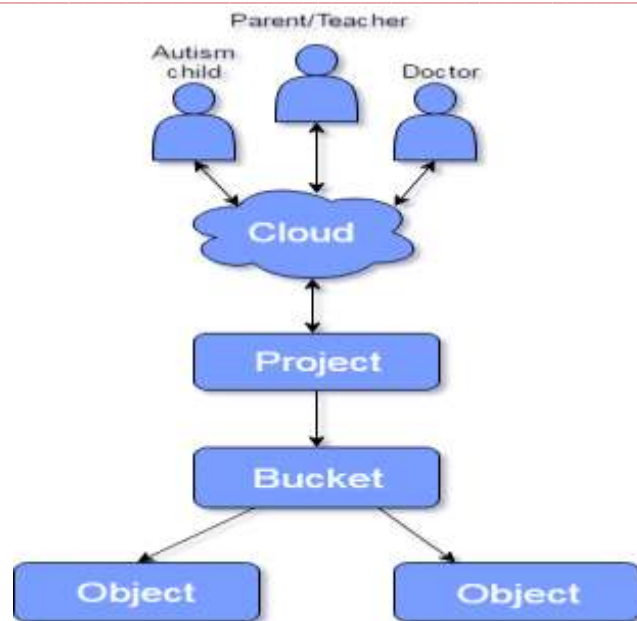


Figure 3: Basic Framework of cloud storage

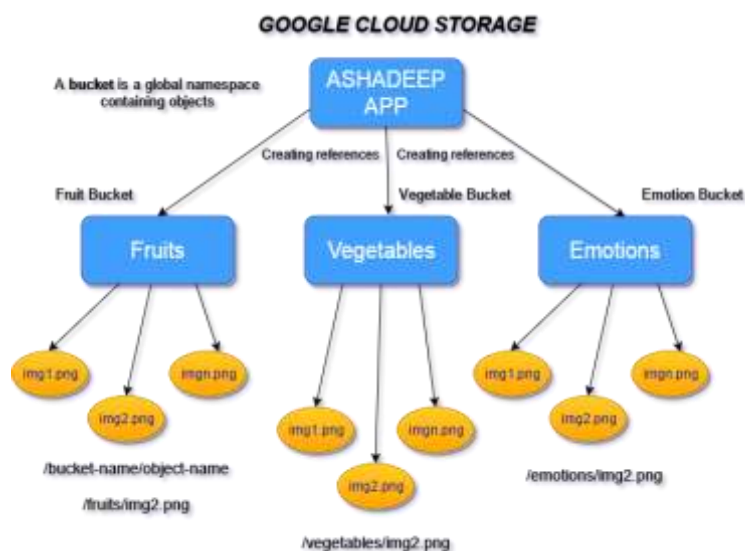


Figure 4: Framework for Image Library for the App

IV. EXPERIMENTAL WORK

A. FEATURE OF CAPTURING REAL WORLD IMAGES THROUGH THE APP

The main screen of the app allows the tutor or the parent to select the camera to capture the image, crop it according to their needs and make a new category or add them into the existing sub categories if they find that the existing images are insufficient. The user interface for uploading images to cloud is as shown in figure 5. The newly added images come along with the existing categories when the app is opened. The image captured is uploaded to cloud storage. The user specifies the category and the sub category names and the image is going to sit as objects in those category buckets. Then, the uploaded image is shared with all the different users of this app. This

helps the users to themselves build an enormous image library other the provided, which is shared to all users of this app. The notifications are sent to the users of this app as firebase storage knows users of this app through firebase authentication sdk.



Figure 5: Interface to capture real world images in the app which is transferred to the cloud

B. EVALUATION MODULE TO ASSESS THE CHILD'S PERFORMANCE AND GENERATION OF REPORT

The autism child is made to play the different activities specified in the app. The images for the activities are provided by the cloud. Each time the child plays the activities, the evaluation data under the different subsets are sent to the cloud. The cloud becomes a warehouse of huge amount of data which is not possible for a mobile device to handle. Based on the data stored in the cloud, analytics is performed on the data which involves intensive filtering of data. The filtered data is clustered based on different machine learning models. The whole process of computation happens in the cloud itself. Finally, a report is prepared and is distributed to the parents, tutors and the doctors so that they can observe the overall progress of the child. The complete process is proposed as given in figure 6.



Figure 6: Cloud Framework for Evaluation Module

C. ANALYSIS OF EXPERIMENTAL DATA

The data was taken from the experiments conducted on the autistic children of the ASHA Autism Foundation with the AshaDeep app. The data was taken for 10-15 students who gave a trial with the different activities presented to them along with the app. Large amount of data was sent through the app to the cloud, for every child who used the “AshaDeep” app. Based on the data collected, computations were performed at the server side and the child’s progress was evaluated based on different subsets. An example of the graph plotted by the app for one child under the subsets motor delay, grasping time, object recognition time and attention time is shown in figures 7, 8, 9 and 10. This graph was plotted after performing some computations at the cloud. As different people are connected through the app with the help of the cloud, each one of them can view the child’s progress. For a sample experiment conducted itself, megabytes of data flood into the cloud. Hence, we can make an estimate how much data would be generated over continuous usage for which above mentioned cloud framework was proposed.

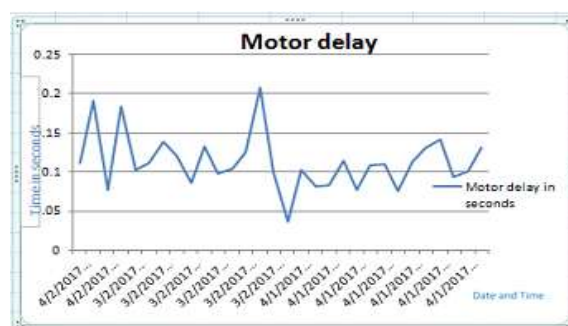


Figure 7: Graph of time in seconds versus Date and Time plotted for the data from the Cloud for Motor Delay

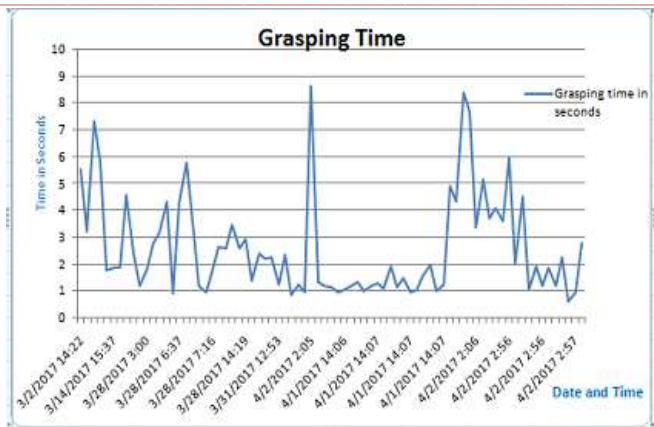


Figure 8: Graph of time in seconds versus Date and Time plotted for the data from the Cloud for Grasping Time

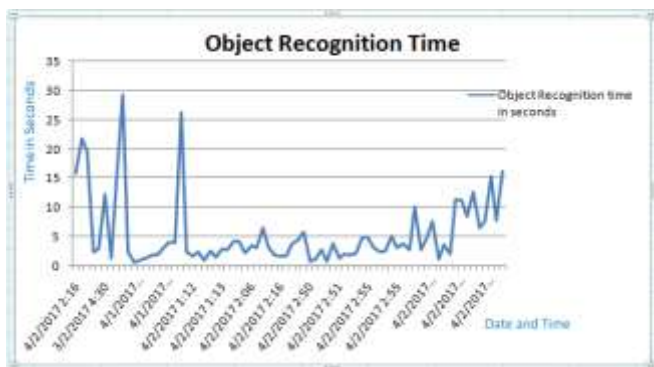


Figure 9: Graph of time in seconds versus Date and Time plotted for the data from the Cloud for Object Recognition Time

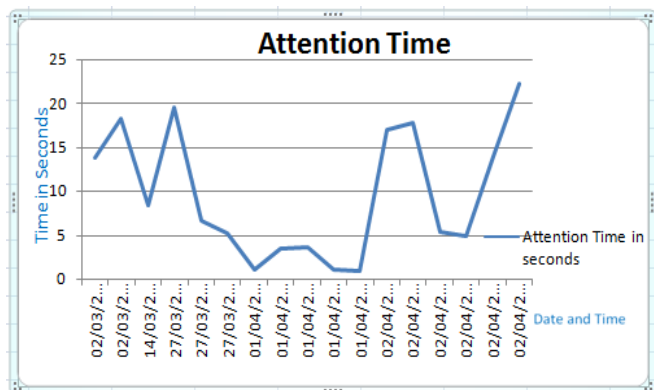


Figure 9: Graph of time in seconds versus Date and Time plotted for the data from the Cloud for Attention Time

V. CONCLUSION

This paper aims at integrating Cloud services and a Mobile application developed for Autism spectrum disorder (ASD) children suffering from pervasive neurodevelopment disorders. We have proposed a cloud framework to integrate image library and evaluation module of Mobile app developed for ASD children. Integrating with cloud storage drastically reduce the storage requirement at end device. Users can access image library directly from cloud storage. The learning module and evaluation module of our “Ashadeep” app helps in monitoring

the ASD child’s progress. Teachers and parents can use this cloud based mobile application for monitoring the ASD child’s learning. Evaluation reports on a daily basis and weekly basis are generated.

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