Smart Home Accessibility Application for the Differently Abled and Elderly

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Abstract—In this paper, we will discuss the accessibility of software such as mobile applications for the differently abled. Existing applications tend to neglect their needs due to complex requirements and small user base. Our paper will attempt to shed some light on previously overlooked parameters, features, and constraints to improve the lives of the differently abled and even elderly people and come up with a product to do the same in the context of a smart home. We will create a proof of technology application that allows differently abled users to control smart home features such as room temperature, fan speed, lighting as well as make emergency calls, all from within a single intuitive application. The app will be able to communicate with the house's cloud servers with API calls. For the POT, we will be using a firebase server as the simulated cloud server.

Index Terms— Accessibility, API, Appliances, Control, Differently abled, Elderly, Interface, Mobile application, Smart home

1 Introduction

As of 2017, there are 4.77 billion smartphone users and this number is expected to pass the 5 billion mark by 2019. 15% of the world's population experiences some form of disability out of which 2- 4% have serious difficulties. Good percentage of this population have access to smartphones but, may not use them due to lack of applications and features designed for them. Our goal is to adopt new techniques and methodology to introduce mobile applications in the market specifically designed to meet the various needs of this segment of the population. The applications may also make existing features easier to use and improve their smartphone user experience hence making their lifestyle easier.

2 Literature Review

Sharing, storage and presentation of information is done in the form of not only via text and words but also in the form of charts, diagrams, graphs and other graphics. There are methods through which a visually challenged person may understand and interpret the text documents like the Braille system and of course audio instruments, but no method exists to do the same for graphics and drawings which may contain very crucial information. This paper attempts to find ways to rectify the problems. It essentially uses a 2-phase methodology, in which a sighted person (moderator) produces a model of the graphic considering its many features, which is then converted to a form which can be interpreted by the visually challenged person. This model can be in the form of numbers representing the diagram and present tones of different pitches representing the numbers. Exercises for strengthening linguistic skills, and also integration of the comprehension of the text and images and audio strings are being considered. Also, presentation of story integrated with images and audio and text comprehension exercises on it is another way. Reading, interpreting and comprehending icons related to certain events is being looked into. Addressing the same issue, graphics-based user interface is proposed which contains a screen reader program converting the graphical information into auditory form.

Meticulously analyzing the components of a virtual 3-dimension system, mainly components for auditory interaction by a binaural processing-based headphone, this paper comes up with an idea of an auditory interface based on this concept. The components consist of spatialized verbal and nonverbal information. The main modules of the interface are as follows: module analyzing the natural sounds and musical tones and pitches for the auditory instruments, speech analysis module, analyzing the screen considering the spatial position and relations.

We now shed light on new types of augmentative interfaces to help the physically challenged people effectively access the personal computers and also to help them increase their personal communication possibilities. The modules include keyboard emulation in a tactile screen for speech recognition, word prediction modules to increase speed, conversation and speech module and output modules. Keyboard emulation modules => This module allows the keys, fonts, and size of letters and the basic overall keyboard's layout to be modified and configured. Emulating and simulation of the features of the keyboard by voice is also being considered. Based on the most common words, phrases and sentences and command used a frequency dictionary is developed which is updated to increase the typing and writing speed. Telephone conversation modelling is a module to emulate the features of the conversations carried out over telephones. A telephone call is managed from the computer and to transfer messages from the screen to the telephone lines

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synthetic speech is used. The output module converts text to a speech so that the user can hear the messages from the system. Various features of speech can also be emulated like tone, volume intonation level and gender. Properly applying the various perception modalities present within the sensory channels for the reason to provide a proper substitution of the richness given from the graphical image is an important feature to bring forth auditory information and data by the screen reader. To the screen reader, a headphone is used to generate the spatialized auditory interaction components, making use of intensive digital filtering and FIR-filter convolution processing

We now focus on the development of a travel aid to facilitate the mobility of the visually and physically challenged people. The system has been divided into 2 main modules, the MOBIC Pre Journey System (MoPS) to help in the planning and scheduling of travels. The other one is the MOBIC Outdoor System to help in analyzing the environment, surroundings, locations and features to suggest proper navigation, direction and orientation while travelling to the users. The data is obtained from a Global Positioning System, to perceive and understand the features in the vicinity of the user. The journey begins after a thorough analysis of the user needs. The MOBIC travel aid collects, analyses an provides information related to : Directions to reach the destination of the user, data on streets, localities and roads, the current location of the user, the shops ,malls, landmarks in the vicinity, data on construction, data on pedestrians, police stations, fire stations and hospitals, data on environment miscellaneous(street furniture, post box and public telephones.

Portable Optoelectronic Vision Enhancement System which might go a long way to solve problems like night and color blindness, and problems in visual perception, sensitivity and visual acuity. The system is battery operated and applies complex image processing and is a portable device worn like a spectacle consisting of CCD cameras and liquid crystal displays, with a pocket consisting of the image processor, the controls and the power supply. The main components of POVES are head worn spectacle and the pocket part, brightness and contrast adjustment module, contrast enhancement module especially for darker and brighter areas spatial filtering, enhancement an equalization of colors from the color spectrum, linear and nonlinear operations on the image.

A system for the elderly and challenged people will help them to lead a more comfortable life at home using a smart technological system which can be run via the applications on the mobile phones. The modules in this system which will provide data which can be accessed via an interface include : weather forecast, room temperature estimation , presence detection, electricity measurement, comfort temperature will be calculated based on previous settings and the temperature inside and outside the room, the presence or absence of the user can be determined from the data on previous habits which depends on time table, weather ,

commands can be sent to the heating elements in the room too, a database to measure the habits, schedule and interests and medical, physical and emotional conditions will be maintained.

Focusing on helping the visually challenged and the elderly people find, locate and grasp objects in their vicinity. The main modules are an Android phone interface, attention biasing enhanced object recognition and an object tracking algorithm. The tracking is done according to the movement of the user and her field of vision, and providing auditory feedback to help the user maintain locate and maintain the desired object in its field of perception. Android user command interface focuses on the front-end interface. A server client model is implemented with a server which contains the computer vision algorithms. The Android device transfers the required data in the form of strings while the server converts and transforms it into a format which can be interpreted by the rest of the object recognition chain. Object recognition using concepts like descriptors and Bayesian statistics the object's features are analyzed and recognized. These object recognition models use the concept of sliding-window detectors and the search is biased towards statistical features of the object. Object localization and tracking system includes a Context Tracker and an auditory feedback module. A bounding box encloses the object to be tracked while the system utilizes one video frame. The tracker detects the objects in the coming frames while continuously updating the data on the position of the object. Speed synthesized commands are the sent to the user based on the analysis above. After all the modules and components of the system are integrated, based on the position of the desired object a speech synthesized feedback to the user is provided. The attention-biasing, recognition, user interface, tracking and feedback modules are integrated as one.

3 PROBLEM FORMULATION

Cell phones have now become an inseparable part of our daily lives. It has been astonishing to see the exponential growth in the fields of mobile phones, internet and communication. We can make phone calls, send messages, access the internet and also use the phone as a digital camera, audio recorder, multimedia messaging, email client, web client, gaming platform, music player, computer adjunct etc. Exploiting the many and disparate features and functions of mobile applications, we propose a user interface application for the elderly differently abled to make their homes accessible and making their lives more comfortable.

4 MOTIVATION

The rising awareness of health, nutrition, education, personal and environmental cleanliness and hygiene coupled with significant advances in the field of medical science, diagnosis, prevention and treatment as resulted in exponential increase in the life expectance in many countries. But due to this increase in mortality rate and decrease in the birthrates, overpopulation and lack of resources is also a burning issue. According to the latest statistics by WHO, by the year of 2050, the number of people above the age of 65 will outnumber the children under the age of 14.

The elderly and the physically challenged segment are often deprived of proper medical attention and healthcare

needs, due to the lack of awareness, mobility, independence as well as rising costs of medical treatments. Another report published by WHO says that chronic disease if alone responsible for 60-70% of deaths. The main culprits in this regard are unchecked and undiagnosed diseases of heart, kidney, limbs, unregulated blood pressure, lack of awareness and overlooking early symptoms of possible diseases. Access to healthcare services is limited for a significant proportion of our population due to the increasing prices of prescription drugs, medicines, diagnostic tools, diagnostic procedures, transport difficulties, location of hospitals etc. Emergency medical aid can prove to be a financial burden, particularly if the stay in the hospital is for a long period of time.

The elderly users, many a times, require sudden medical intervention, which is sometimes the difference between life and death. Such emergencies can be avoided if the elderly and their diseases, symptoms, habits and schedule is continuously monitored. Hence the concept of home systems is gaining increased traction to record, store and analyze the data on the elderly user, their habits and schedules, symptoms and diagnosis, heart rate, body temperature, blood pressure, blood oxygen level and also increase accessibility to their own home by allowing them to control the temperature of the house, electric appliances like lights and fans, make emergency phone calls, remind him/her of his medicine and dose, and predict any future problems based on the previous data. To ensure and provide independence to the elderly, remote health monitoring systems and smart homes are picking up speed which allow the elderly to live a comfortable life with their loved ones.

5 METHODOLOGY

System Architecture- The elderly and the family members will have an application installed on their smart phones which will provide access to the various functionalities of the house like controlling the temperature, the electric appliances like lights and fans, and emergency calls. The data collected from the application will be stored on Firebase, hence providing a real time database and backend as a service. The database will contain data on the electric appliances like the technical details and manufacturers of the electric appliances, the list of contacts, temperature of each room of the house, the elderlys' habits and schedules, symptoms and diagnosis, heart rate, body temperature, blood pressure, blood oxygen level, medicine dose and prescription etc. A record of the inputs given to the appliances will be maintained, for example the speed of the fan in different rooms at different times of the day, temperature statistics etc. The database will be connected to the control module and local network of the house via a gateway. The control module will be connected to the communication module which will communicate data and commands to the modules of the electric appliances present in the house. Hence the elderly can control the appliances without having to move. In case of any emergency, the user has to click on the emergency button, and the smart phone will call on the emergency number.

Reason for Android- Complete: When developing the Android platform, a comprehensive methodology was adapted by the designers involved. To allow various application development opportunities, a secure operating system was designed on top of which a robust framework was built.

Open: Since the android applications are open source, a multitude of features and ideas from developers all over the world can be implemented.

Free: The distribution of android applications is much more easy, convenient as well as resourceful. There development of these applications is free.

Implementation- User Interface: This is the first interface which the user will encounter when the app is opened and has options for the user to select any of the four features, enabling access to the various electronic appliances. The features include functions to regulating the fan speed, switching on or switching off the light, increasing or decreasing the temperature and make emergency calls.

Emergency Number: When this option is selected, the app will automatically dial the emergency number. Hence, if an unfortunate event were to happen, like a medical emergency, fire, etc, the app will allow immediate connection to the police, hospital department, fire department etc.

Lightening: This feature allows the user to adjust the brightness or intensity of the lighting from the appliance. The working of this feature is similar to the feature which regulates the speed of the fan. The current value is fetched from the database and is presented to the user. The user can select the intensity or brightness by moving the pointer either to the right or to the left, as shown in the figure. The new value is then updated in the database.

Fan: When this feature is selected, the current speed of the fan is fetched from the database and is displayed to the user. The user can set the speed of the fan by moving the pointer along the boundary as shown in the figure below. The new value of the rotation speed of the fan will be automatically updated in the database

6 REQUIREMENT ANALYSIS

This chapter deals with requirements analysis – how functional, data and usability requirements are gathered – and documented.

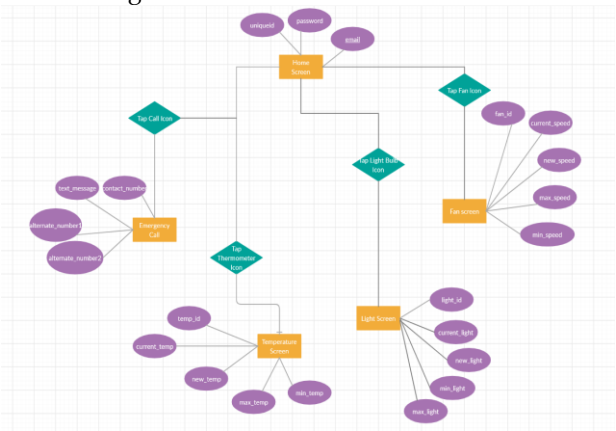
1. **Functional requirements**:

The application must:

- Provide an interface for the users to change room settings.
- Allow the user to call emergency services in case of an emergency with just a tap.
- Be intuitive so that the user experience is smooth and responsive.
- Not have a steep learning curve so that elderly users can easily learn how to use the app.

- Be optimized for all sorts of devices and compatibility issues should be minimized.

2. Data requirements:
The data requirements are illustrated in the form of a ER Diagram.

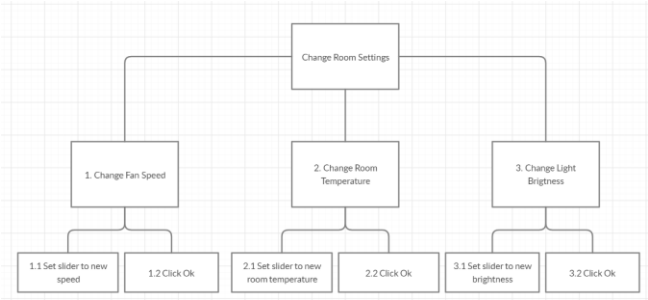


3. Usability requirements:
This refers to the acceptance level of user performance and satisfaction with the system.

- **Learnability**
  The app is very easy to get a hang of and users can start using immediately once the initial setup is finished.
- **Throughput**
  Task execution depends on the strength of Wi-Fi signal in the room. Better connection, better the responsiveness.
- **Flexibility**
  If a user does not have an internet connection at any point of time, the task will be queued and executed when connection is re-established. Emergency calls can be made even without cellular connection.
- **Attitude**
  The aim of the application is the wellbeing of the elderly and the success of this project is dependent on how easily they are able to form a trust with the application.

7 Data Flow

The Data Flow is illustrated with a hierarchical task analysis as follows.



The 3 data flows are:
1-1.1-1.2: Change Fan Speed
2.-2.1-2.2: Change Room Temperature
3.-3.1-3.2: Change Light Brightness

4. Conclusion

The late 20th and 21st century have been a witness to the rapid advancement in the field of science and technology. Technology has now become an absolutely inseparable part of our daily lives. Due to these developments, we can now claim that we live in a much safer world and the quality of our lives has improved a lot. Science has enabled us to reach out to the masses, the poor, the unprivileged, the sick and to provide opportunities to a significant portion of the entire world population still living without proper food, water, infrastructure and education. The world is now becoming a smaller and smaller place. The concept of having personal mobile applications to help the elderly in leading more comfortable lives via internet of things, smart homes etc is gaining increased momentum, with a lot of research being done in the area as well as ample investment both from the private and the government sector. Internet of things and mobile applications allow the elderly to control the various appliances of their own homes, make phone calls to their loved ones or to the emergency services, monitor their health conditions, maintain their schedule of medicine and exercise, reach out to the thousands of communities to share experiences, memories and problems, blend in the outside world, view the latest news on the politics, sports, weather, business, science and technology and stay up to date with the latest improvements in the medical field and diagnosis. The technology in the very near future will witness new ideas and methods to better help the elderly in leading more comfortable lives.

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