\documentclass[conference]{IEEEtran}

% \IEEEoverridecommandlockouts

% The preceding line is only needed to identify funding in the first footnote. If that is unneeded, please comment it out.

\usepackage{cite}

\usepackage{amsmath,amssymb,amsfonts}

\usepackage{multirow}

\usepackage{algorithmic}

\usepackage{graphicx}

\usepackage{textcomp}

\usepackage[table,xcdraw]{xcolor}

\usepackage{booktabs}

\usepackage{url}

\usepackage[T1]{fontenc}

\def\BibTeX{{\rm B\kern-.05em{\sc i\kern-.025em b}\kern-.08em

T\kern-.1667em\lower.7ex\hbox{E}\kern-.125emX}}

\hyphenation{op-tical net-works semi-conduc-tor}

\begin{document}

%

% paper title

% can use linebreaks \\ within to get better formatting as desired

% Do not put math or special symbols in the title.

\title{A Survey on Different Augmented Reality Frameworks}

% author names and affiliations

% use a multiple column layout for up to three different

% affiliations

% \author{\IEEEauthorblockN{Farris Suhale - 16IT218}

% \IEEEauthorblockA{Information Technology\\

% National Institute of Technology Karnataka\\

% Surathkal, India 575025\\

% Email: farrissuhale@gmail.com}

%

% \and

% \IEEEauthorblockN{Vaishnavi Mishra - 16IT145}

% \IEEEauthorblockA{Information Technology\\

% National Institute of Technology Karnataka\\

% Surathkal, India 575025\\

% Email: vaishnavimishra050@gmail.com}

% }

\author{\IEEEauthorblockN{Farris Suhale\IEEEauthorrefmark{1},

Vaishnavi Mishra\IEEEauthorrefmark{2}}

\IEEEauthorblockA{\IEEEauthorrefmark{1}Information Technology\\

National Institute of Technology Karnataka,

Surathkal, India 575025\\ Email: farrissuhale@gmail.com}

\IEEEauthorblockA{\IEEEauthorrefmark{2}Information Technology\\

National Institute of Technology Karnataka,

Surathkal, India 575025\\ Email: vaishnavimishra0509@gmail.com}}

% conference papers do not typically use \thanks and this command

% is locked out in conference mode. If really needed, such as for

% the acknowledgment of grants, issue a \IEEEoverridecommandlockouts

% after \documentclass

% for over three affiliations, or if they all won't fit within the width

% of the page, use this alternative format:

%

% use for special paper notices

%\IEEEspecialpapernotice{(Invited Paper)}

% make the title area

\maketitle

% As a general rule, do not put math, special symbols or citations

% in the abstract

\begin{abstract}

We are on the verge of ubiquitously and unanimously adopting Augmented Reality (AR) technologies to enhance our perception and help us see, hear, and feel our environments in different and enriched ways. AR will support us in fields such as education, maintenance, design and reconnaissance, to name but a few. This paper describes the existing technological frameworks in the field of AR. It surveys the state of the art by reviewing some recent applications of AR technology as well as some known limitations regarding human factors in the use of AR systems that developers will need to overcome.

\end{abstract}

% no keywords

% For peer review papers, you can put extra information on the cover

% page as needed:

% \ifCLASSOPTIONpeerreview

% \begin{center} \bfseries EDICS Category: 3-BBND \end{center}

% \fi

%

% For peerreview papers, this IEEEtran command inserts a page break and

% creates the second title. It will be ignored for other modes.

\IEEEpeerreviewmaketitle

\section{Introduction}

With the age-old human tendency of escapism, heightened in the recent years, it is only natural that humans develop a virtual world where things are modified and changed as they will it. Imagine a technology with which you could see and hear more than others, and perhaps even touch, smell and taste things that others can not. Augmented Reality is the technology to perceive completely computational elements and objects within our real world experience, entire creatures and structures even that help us in our daily activities, while interacting almost unconsciously through mere gestures and speech. Many of us use touch-based interfaces frequently. However, such devices do not consist of any physical sensation and involvement and rely on the user's sense of sight to complete certain tasks.

With such technology surgeons could see ultrasound scans of organs while performing surgery on them, mechanics could see instructions what to do next when repairing an unknown piece of equipment, soldiers could see positions of enemy snipers spotted by unmanned reconnaissance aircrafts, fire fighters could see building layouts to avoid otherwise invisible hazards, and we could read reviews for each restaurant in the street we’re walking into or battle 10-foot tall aliens on the way to work [1]

Recent advances in the instrumentation technology of sensory substitution have presented new opportunities to develop human-machine interfaces by substituting one sense with another \cite{BACHYRITA2003541}. Sensory substitution has been the most common way to allow for increased accessibility, and voice assistants such as Google Assistant and Siri currently utilize this. ViaSight aims to include an additional dimension of interaction and substitution through gesture commands and haptic feedback, allowing for a more efficient and fulfilling experience. Voice commands alone reduce the ability to have a degree of privacy while using a smartphone, even when using earphones for audio output. In this light, ViaSight provides touch based commands to allow for more discreet access to commonly used functionality in smartphones.

\section{Literature Survey}

Most modern attempts at improved smartphone accessibility have been though voice commands and personal assistant style applications. Google Assistant and Siri form the primary means of voice based accessibility interaction with Android and iOS devices. However, these approaches do not allow for any haptic feedback or touch-based interaction with the device. Gesture based application launchers do exist, but so far do not have widespread usage with voice commands. Due to the large availability of affordable smartphone technology, such devices hold a lot of promise in the field of \textit{low vision rehabilitation} \cite{doi:10.3109/01658107.2013.874448}. Various steps have been taken to improve quality of life for the elderly using smartphones. One such step was \textit{PhonAge} \cite{10.1007/978-3-642-40498-6\_44}, an adapted smartphone interface for elderly people.

Many tools have been proposed for navigation using the many sensors available on smartphones to make life easier for the blind. These include, but are not limited to, \textit{BlindNavi} \cite{Chen:2015:BNA:2702613.2726953} and \textit{PERCEPT-II} \cite{6944417}. Specific research done on spatial processes in blind and visual impairment have proven to be effective in relieving some of the unintentional stresses arising due to the inherent nature of touch-based technology \cite{CATTANEO20081346}.

Since the exponential growth of IoT based systems since 2010, the technological market has seen a large number of wearable devices for various purposes. Wearable technology can prove very useful in providing an alternate ``view'' of the world by using the many sensors embedded in these objects. To minimize the costs involved in manufacturing such devices (PCB design, sensor integration), a large amount of research has been done in the field of smartphones as ``wearables''. Since smartphones have multiple sensors and are made with ever-improving technological standards, it is optimal to use such devices. Specific research on this topic has been done with respect to visually impaired people \cite{Ye:2014:CFM:2611247.2557085}.

\section{Problem Statement}

Commercially available solutions for improving accessibility do not have a large focus on integrating haptic and auditory feedback for effective use of smartphones. To overcome these shortcomings, we aim to create an accessibility application catering to the needs of the visually challenged, combining haptic and auditory feedback with voice controls to allow for a non intrusive, discreet and efficient means of interaction.

\subsection{Objectives}

ViaSight launcher must:

\begin{itemize}

\item Allow for visual sensory substitution through touch and speech.

\item Application must allow for discreet and non intrusive interaction with the device.

\item Minimizing number of commands to access functionality and execute commands.

\item Must enhance the experience of visually challenged persons with their smartphones.

\end{itemize}

\section{Methodology}

\label{section:methodology}

ViaSight was implemented as a \textbf{launcher style Android application}, acting as a layer to translate voice and gestures into the corresponding actions a user would normally perform. It acts as a replacement of the default system launcher and later relies on system-wide accessibility options to complete the experience.

Sensory substitution was done by providing different \textbf{vibration patterns}, as well as assigning \textbf{swipe gestures} to trigger various functionalities. Each pattern holds a different purpose. It helps train the user to rely on haptic feedback during certain events. These events (in the case of the app) are incoming notifications, positive TTS (Text-To-Speech) responses and negative TTS responses.

\begin{figure}[htb]

\centering

\includegraphics[width=88mm]{flowchart.jpeg}

\caption{App flowchart}

\label{fig:app\_flowchart}

\end{figure}

Swipe gestures implemented include:

\begin{itemize}

\item Swipe left to enable voice commands (as mentioned below)

\item Swipe right once to read notifications

\item Swipe right again to stop reading notifications

\end{itemize}

ViaSight currently supports voice commands with the following syntax:

\begin{itemize}

\item \textit{\textbf{open}} <application\\_name>

\item \textit{\textbf{what}} is the \textit{date}/\textit{time}/\textit{battery percentage}?

\item \textit{\textbf{call}} <contact\\_name>

\item \textit{\textbf{remove}} \textit{notifications}

\item \textit{\textbf{play}} \textit{tutorial}

\item \textit{\textbf{set}} \textit{volume} \textit{silent}/\textit{vibrate}/\textit{normal}

\end{itemize}

This is accomplished through acquiring permissions to set vibration, record audio, make calls and read contacts. However, all processing occurs completely on the device, keeping personal data secure. Moreover, the system does not rely on internet access (does not rely on Google Assistant APIs) and thus can be used \textbf{offline} with ease.

Since the app was made for visually challenged people and allows for near complete control of the device, the user interfaces involved are practically empty and only show incoming notification information. The rest of the app relies on audio, sensory and vibrational responses.

\section{Results and Analysis}

Due to Android's implementation of ``dangerous permissions'', the user must grant the app access to \textbf{contact information}, \textbf{notification information} and \textbf{make calls}. The app's simplistic design is owing to the fact that it is primarily targeted at those suffering from a visual impairment (not necessarily blind), and thus the only visual cue added is the notification information in large text as in \ref{fig:app\_screenshot}.

\begin{figure}[htb]

\centering

\includegraphics[width=80mm]{app\_screenshot.png}

\caption{App screenshot}

\label{fig:app\_screenshot}

\end{figure}

The rest of the app is aimed towards bolstering the user's reliance on auditory or haptic feedback from the device. Each time a notification is ``posted'', the device vibrates with a pre-set waveform that helps uniquely identify notifications. Additionally a sound is made to ensure that the user hears that there is a new notification. The notifications displayed are of the format:

\begin{enumerate}

\item \textbf{Package:} This tells which Android app the notification is from

\item \textbf{Title:} This is the title of notifications visible in the notification bar

\item \textbf{Text:} This is the content of the notification as seen in the notification bar

\item \textbf{Time:} This is the time at which the notification was posted

\end{enumerate}

The results of the various voice commands are discussed below:

\begin{itemize}

\item \textit{\textbf{Open} <application\\_name>}: This triggers a method to retrieve all installed apps on the system. It then filters out apps that match the processed result of speech synthesis. If a match is found, then the system says ``Launching <app\\_name>'' and launches the corresponding app. Otherwise, it asks the user to say it clearly by saying that the app was not found.

\item \textit{\textbf{What}} is the \textit{date/time/battery percentage}?: This is one the commands that is multi-functional. It begins with the keyword \textit{what} and is followed by either of the previously mentioned commands. The response for each is as follows: time in \textbf{24-hour} format, date in \textbf{DD Month YYYY} format, and the battery percentage is told as \textbf{87\%} (for instance).

\item \textit{\textbf{Call} <contact\\_name>}: This triggers a method to retrieve all saved contacts. It then filters out contacts that match the processed result of speech synthesis. If a match is found, then the system places a call to that contact. Otherwise, it asks the user to say it clearly by saying that the contact was not found.

\item \textit{\textbf{Remove} notifications}: This command simply clears all the pending notifications and makes the screen blank. It also invokes the TTS component to inform the user that the notifications have been cleared.

\item \textit{\textbf{Play} tutorial}: Upon hearing this command, the system invokes the TTS component, and it reads out the different possible commands supported by the system and the gestures that can be used.

\item \textit{\textbf{Set}} \textit{volume silent/vibrate/normal}: This command does exactly what it says. It sets the system volume to either of the three possible configurations.

\end{itemize}

Each speech-based commands that respond with auditory feedback are linked with sensory substitution that enables the user to pre-empt the response from the device. Positive responses from the system are linked to a ``positive vibrational waveform'', whereas negative responses (app not found/contact not found/command not recognized) are linked with a ``negative vibrational waveform''.

As mentioned in \ref{section:methodology}, swiping to the left invokes the speech commands. On swiping to the left, a sound is played signifying the start of audio recording, and the same sound is played later to signify the end of audio recording. Thus the user has audio cues to know when to start speaking. On swiping to the right, the system retrieves all the notifications and passes them to the TTS for speech. If no new notifications exist, the TTS responds by saying ``You do not have any pending notifications''. If the user, swipes right again after swiping once, the TTS is paused if it was speaking. Then the user can swipe to right again to listen to the notifications.

The speech recognition system is pretty robust and the app also handles any possible edge-cases that could arise like \textit{incomplete voice commands} (e.g., what is, call, etc), and also \textit{unknown commands} (e.g., turn off device, etc). Additionally, if there are any notifications that are unread when the app is closed (due to launching a new app or shutting down the system or closing the screen), it saves them to memory, and then restores them when needed.

The app design was done keeping in mind few key requirements:

\begin{itemize}

\item App must be lightweight (APK size=2.9 MB, download size=2.5 MB)

\item App must be fast and responsive (Specialized APIs were used to ensure that the models were serialized faster than traditional Java objects)

\item App must reflect modern standards and must use the best intended practices (App was written in Kotlin and uses special features available in the programming language. It also uses the latest libraries and targets Android Marshmallow to Android Pie)

\item App does not waste system resources and does not require heavy RAM usage (All acquired resources are released within the lifecycle of the app itself)

\end{itemize}

The major issues that the app faces are as follows:

\begin{itemize}

\item Very limited command set.

\item Each and every notification that is posted is read. This includes download progress, configuration changes in the system and constant barrages of repetitive notifications.

\item Lack of a richer UI

\end{itemize}

These issues can be addressed easily:

\begin{itemize}

\item The command set can easily be expanded to include more features. However, certain features like sending SMS to a contact are not possible as they violate Google's updated privacy policy.

\item This issue is slightly harder to address. A filter can be set to ignore system notifications, but most of this would require some sort of processing of the content (machine learning models) which could raise security and privacy concerns.

\item The UI was intentionally kept minimal as the system does not rely on visual aids. Its main purpose was to substitute visual aids with sensory, audio and haptic feedback mechanisms.

\end{itemize}

\section{Conclusion}

ViaSight is a holistic application aimed at bridging the gap between the differently abled and the real world. ViaSight is an immersive Android application aiming to improve smartphone accessibility for the visually challenged. By using haptic and auditory feedback we aim to simplify the working of the mobile phone and expand its scope to a larger audience. Since smartphones are becoming increasingly common with many people owning multiple such devices, it is important to give the differently abled a chance to be able to utilize the same technologies with a similar approach.

\section\*{Individual contribution}

\begin{figure}[htb]

\centering

\includegraphics[width=88mm]{gantt.png}

\caption{Gantt Chart}

\label{fig:gantt\_chart}

\end{figure}

\begin{table}[htb]

\centering

\begin{tabular}{@{}ll@{}}

\toprule

\rowcolor[HTML]{C0C0C0}

\multicolumn{1}{c}{\cellcolor[HTML]{C0C0C0}\textbf{Contributor}} & \multicolumn{1}{c}{\cellcolor[HTML]{C0C0C0}\textbf{Contribution}} \\ \midrule

Aayush Jain & App implementation, design \\

Aditi Rao & App design, testing, feature proposals \\

Vaishnavi Mishra & Idea proposal, feature proposals, user feedback analysis \\ \bottomrule

\end{tabular}

\vspace{2mm}

\caption{Individual contribution}

\label{tab:individual\_contribs}

\end{table}

% trigger a \newpage just before the given reference

% number - used to balance the columns on the last page

% adjust value as needed - may need to be readjusted if

% the document is modified later

%\IEEEtriggeratref{8}

% The "triggered" command can be changed if desired:

%\IEEEtriggercmd{\enlargethispage{-5in}}

% references section

% can use a bibliography generated by BibTeX as a .bbl file

% BibTeX documentation can be easily obtained at:

% http://www.ctan.org/tex-archive/biblio/bibtex/contrib/doc/

% The IEEEtran BibTeX style support page is at:

% http://www.michaelshell.org/tex/ieeetran/bibtex/

%\bibliographystyle{IEEEtran}

% argument is your BibTeX string definitions and bibliography database(s)

%\bibliography{IEEEabrv,../bib/paper}

%

% <OR> manually copy in the resultant .bbl file

% set second argument of \begin to the number of references

% (used to reserve space for the reference number labels box)

\bibliographystyle{IEEEtran}

\bibliography{references.bib}

S. K. Feiner. Augmented reality: A new way of seeing. Scientific

American, 286(4), Apr. 2002.

\end{document}