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SMART Evacuation System

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Abstract— "Whoever saves one life, saves the world entire" - Oscar Schindler. Human life has always been the most sacred of resources and is protected with the utmost care. Even though there are hundreds of protocols defining precisely what to do when there is a fire emergency, no one follows them. The Smart Emergency Evac System aims at giving the occupants of the building the fastest and safest way out of the building to safety. The sole intention of the system is to save the human life, and eliminate the need to know the building plans of a building you just entered. This project is an attempt to explore the various techniques that can be used to ensure safety in the event of a fire and how they'll be used in this application domain.

The Smart Evacuation System encompasses three main components; fire detection, sensor analyzing/relay, route prediction through NFC, and message broadcasting. In the first phase, fire detection, the (smoke, sound, or fire) sensors pickup any occurrence of fire and relay it to the intermediate microcontroller. The intermediate microcontroller then relays the sensors information to the standalone system through the use of ZigBee transmitters and receivers which is the next major component of our project. Another major part of our project is the message broadcasting through an SMS gateway, which will send a broadcast message detailing the current area of the fire and to approach the nearest NFC terminal to obtain instructions on exiting the building. The final phase is route prediction through NFC, based on the location of the NFC card we can then predict the route of the closest possible fire exit.

Keywords— Fire Evacuation, Fire Safety, Fire Detection, Evacuation Protocols, Inside Positioning Systems.

I. INTRODUCTION

The Internet has become a primary medium of information access and has its impact in all the fields like education, business, entertainment and many more. Thus web accessibility is of major concern. Voice enabled browser provides the interaction between the user and the browser. As browsing was designed to cater to only normal people with no physical disabilities, the physically handicapped were isolated from accessing the internet. Voice enabled browser will help enable the handicapped to browse the internet easily. A voice enabled browser is a web browser that presents a voice user interface to the user and renders pages in visual manner. It is easy to use for people with less knowledge of computer and will allow the users to multi-task, that is to access the Web when carrying out their daily routine. The browser can receive commands in English as well as in a regional language Kannada. This helps people who are not comfortable speaking English to use the browser.

II. RELATED WORK

A number of voice browsers are on the market, and more are under development. Conversational Computing's Conversa is a web browser that accepts speech input, but renders the pages in the traditional visual manner. The Home Page Reader, from IBM, renders web pages in audio format, but accepts commands only via the keyboard's number pad. Pipe Beach is a system that affords both audio rendering of web pages as well as speech input. LIASON, from Siemen's, Inc., is a system designed for use while driving an automobile. Other systems are application-specific. VADAR, from BBN, allows users to track shipments over the World Wide Web, while Talk'n'Travel, also from BBN, is an interface for commercial-travel websites that allows users to access flight and train schedules. The GALAXY project at MIT is a system that will access the web to find information in response to a user's queries. Apple's Siri, Opera voice and Google Chrome have speech recognition feature incorporated in English language.

Speech Recognition technique is used in all these softwares. This technique involves four steps [7]. First step is speech analysis where a suitable frame size is selected for segmentation of input speech signal [9,10]. Next step is feature extraction where useful information is retrieved from speech signal by discarding unwanted information. Mel frequency Cepstral Coefficient (MFCC) is the most superior method used for feature extraction [11]. Next step in Speech Recognition is Modeling where a speaker model is generated using feature vector [13]. Hidden Marcov Model (HMM) is the most efficient modeling technique [16,17]. The last step is Matching where detected word is matched with known word to give text output [14].

The speech recognition systems can be classified based on type of utterances they recognize. Isolated word, connected word, continuous speech and spontaneous speech are different type of utterances.

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III. PROPOSED SYSTEM

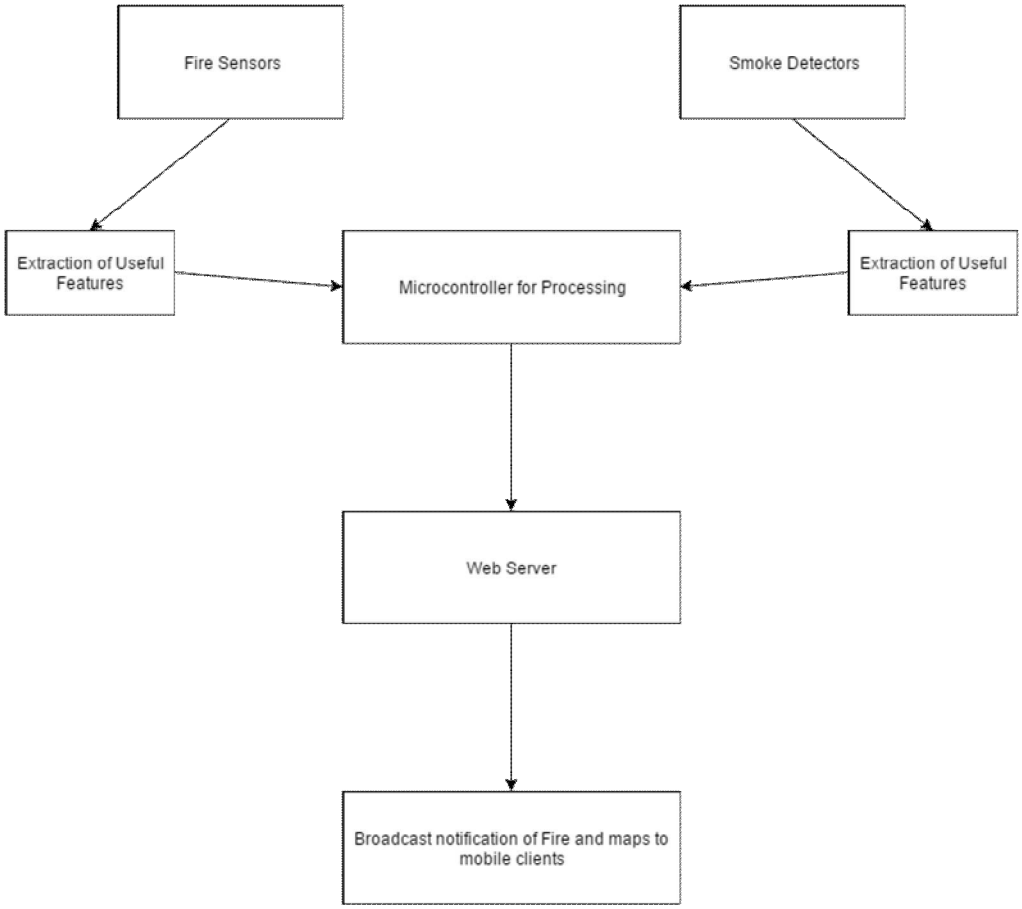

Fig 1.

The general architecture of the proposed system is shown in Figure. The system initially starts in the idle state awaiting for the event to occur, in this case fire, after the particular signal has occurred both the fire and smoke sensors will start checking for conditions that have been fulfilled. If the conditions are indeed present the sensors are activated. The utilization of two sensors is used as a failsafe in case one sensor fails or is transmitting inaccurate data (false alarm) the other sensor will be used as a backup/error-checking mechanism. In the event of a fire, it's absolutely vital that at least one of the sensors remains functional in order to update the occupants of the building of the situation present as well as any present fire brigade. After activation both sensors will relay their information to an intermediate microcontroller for error checking of the data sent by the sensors and confirmation of the situation. Using an intermediate processor will greatly reduce the computational load on the server and provide an independent fast-acting processing unit for dynamic update of separate floors concurrently. After processing the information sent by the sensors, the intermediate processor will detect the closest exits to take to avoid the fire. This will then relay the information to the main server, wherein a standalone application is housed, which will in turn broadcast the message to the various devices connected to it.

The principal idea behind this process is to provide fast detection of the fire before it gets out of hand and provide the occupants of the building with the fastest and safest route of exit. Each floor will have its own intermediate processor, which will take in information about the fire and pin point the origin of the fire, which helps the occupants in avoiding those areas. The system will load the map with the position of the occupant along with the emergencies exits of the building.

The necessity of the proposed system lies in:

A. Ability to quickly evacuate people safely in an ordered way while reducing the levels of panic and chaos that arise in situations of crisis.

B. A constant update of the situation is sent to the security team and fire brigade so they can know the point of origin of the fire as well as how aggressively it is spreading (assuming they are able to connect to the network.

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C. The risk of losing life in the event of a fire is greatly reduced.

D. Eliminates the need for occupants of the building to memorize the numerous, sometimes obsolete, protocols present in manuals.

IV. ARCHITECTURE OF THE SMART EVACUATION SYSTEM

The following figure depicts the basic architecture of our system.

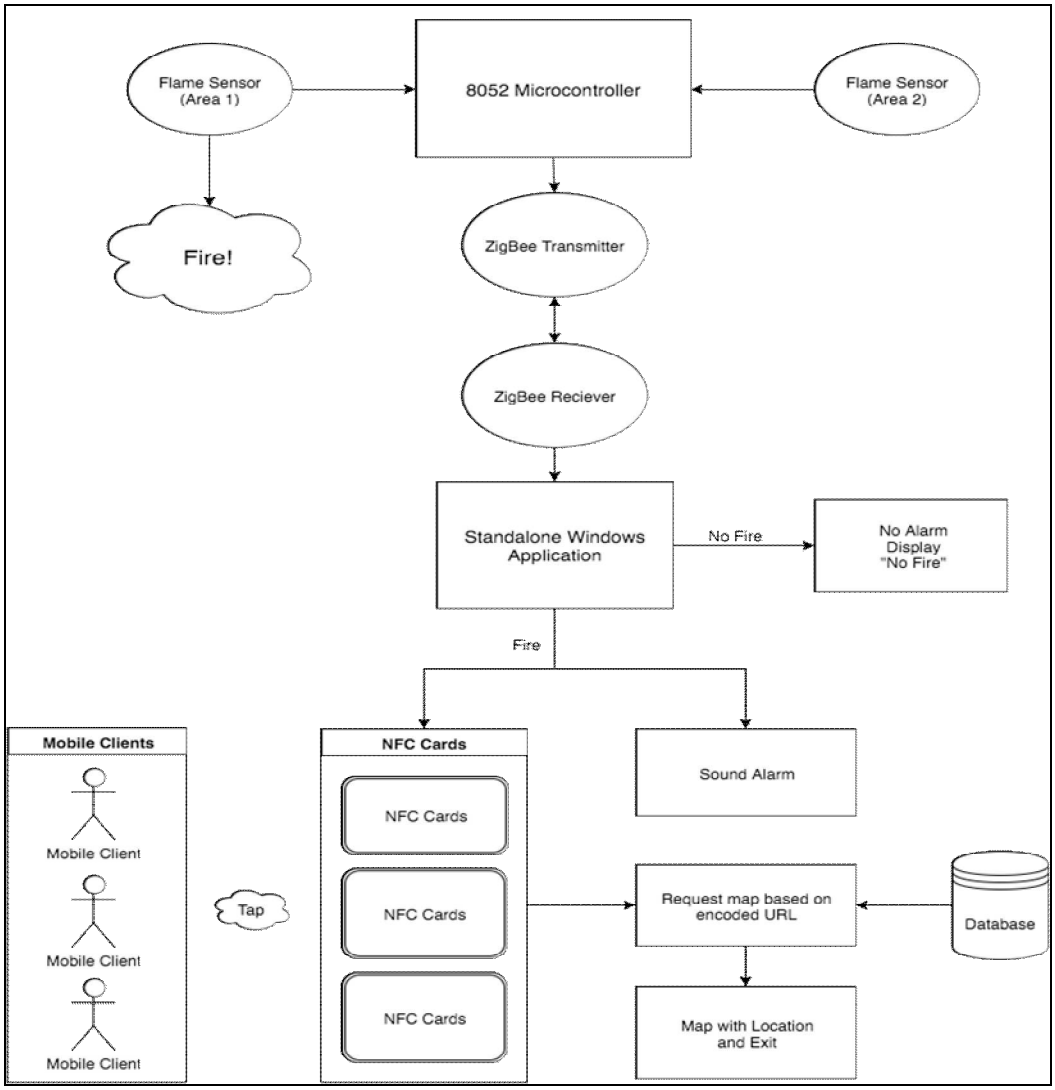

Fig 2. Smart Evacuation System Architecture

The various sensors are appropriately placed throughout the building and are assigned areas. The microcontroller monitors the sensors and relays information the standalone system through ZigBee transmitters. After a fire occurs, the status is updated onto website and an SMS is sent to the occupants. The website can then be accessed through NFC cards.

V. IMPLEMENTATION

A. Technology Used

1) Microcontroller 8052: A **microcontroller** is a small computer (SoC) on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips

Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable

medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems

The 8052 microcontroller is the 8051's "big brother". It is a slightly more powerful microcontroller, sporting a number of additional features which the developer may make use of:

a) 256 bytes of Internal RAM.

b) A third 16-bit timer, capable of a number of new operation modes and 16-bit reloads.

c) Additional SFRs to support the functionality offered by the third timer.

Few advantages of microcontroller 8052 technology are:

i) The micro-controller 8052 requires lesser computing power than the raspberry pi hence It's more efficient than to use a whole raspberry pi just to monitor sensor responses.

ii) The micro-controllers are considerably cheaper than raspberry pi or arduino boards which makes them more economical to use.

iii) The 8052 microcontrollers are very flexible due to their programmable nature (i.e. Embedded C used for sensors)

iv) Faster Speed of Execution since microcontrollers are fully integrated inside the processor i.e. "computer on a chip," these devices operate at faster speeds to execute instructions compared to general purpose microprocessors.

v) The sensors are directly connected to the GPIO pins on the microcontroller instead of using intermediary devices for the microprocessors.

2) IR Flame Sensors: A **flame detector** is a sensor designed to detect and respond to the presence of a flame or fire. Responses to a detected flame depend on the installation, but can include sounding an alarm, deactivating a fuel line (such as a propane or a natural gas line), and activating a fire suppression system. When used in applications such as industrial furnaces, their role is to provide confirmation that the furnace is properly lit; in these cases they take no direct action beyond notifying the operator or control system. A flame detector can often respond faster and more accurately than a smoke or heat detector due to the mechanisms it uses to detect the flame.

Most IR detectors are designed to ignore constant background IR radiation, which is present in all environments. Instead they are designed to detect suddenly changing or increasing sources of the radiation. When exposed to changing patterns of non-flame IR radiation, IR and UV/IR detectors become more prone to false alarms, while IR3 detectors become somewhat less sensitive but are more immune to false alarms.

The basic features of an IR flame sensors are:

a) Sensitivity is adjustable by using embedded programming.

b) Fast response time.

c) Detects from 4-5 meters away for a small fire, the range is increased for bigger fires

3) NFC cards: Here NFC stands for Near Field Communication which are a set of communication protocols meant to enable communication between two electronic devices.

Using NFC chip available in the smart phones, when tapped on the NFC cards they produce a particular URI based on the NFC at specific positions. They contain a small amount of memory to store the URI.

4) ZigBee: ZigBee is a mesh network specification for low-power wireless local area networks (WLAN) that covers a large area (75mts approx...)

ZigBee was designed to provide high data throughput in applications where the duty cycle is low and low power consumption because many devices that use ZigBee are powered by battery. ZigBee is often used in industrial automation and physical plant operation, it is often associated with machine to machine communication (M2M) communication and internet of things (IoT).

ZigBee enables broad based deployment of wireless networks with low-cost, low-power solutions.

The ZigBee has particular features such as:

a) It has a network range of up to 75 – 500 mts depending on the ZigBee used.

b) No need to recharge batteries as they last up to 10 years

c) They are one of the most economical devices for wireless transfer between different machines.

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d) It has a maximum network speed of 250 Kbit/s.

The ZigBee constantly monitors and collects information from the status of the flame sensors on the microcontroller and transmits it to the receiver ZigBee which sends this data to the standalone application that processes this information. The U-ART protocol is used to transmit data serially and asynchronously.

5*) Sound Alarm:* The buzzer used in the current project is Piezo buzzer. Piezein is a Greek word which means squeeze, Piezo buzzers are used to make sound. They are used in various alert systems. It has 2 pins, 1 positive and 1 negative. A high voltage is given for the buzzer to start the beep and a low voltage is given to stop the beep. Both high and low voltages are given to the positive pin. The negative pin is grounded.

B. Implementation Details of Modules

The system is divided into following modules:

1) Graphical user interface
2) Voice to text conversion
3) Building web browser

1) Graphical user interface: Graphical user interface provides visual appearance of functionalities of Brower. Windows style task pane provides easy access to common operations and gives appealing look. Standard Toolbars, popup menus and shortcut keys make operation of software easy for all type of users. Easy to Use, Easy accessibility to functions and Appealing appearance are the main features of GUI.

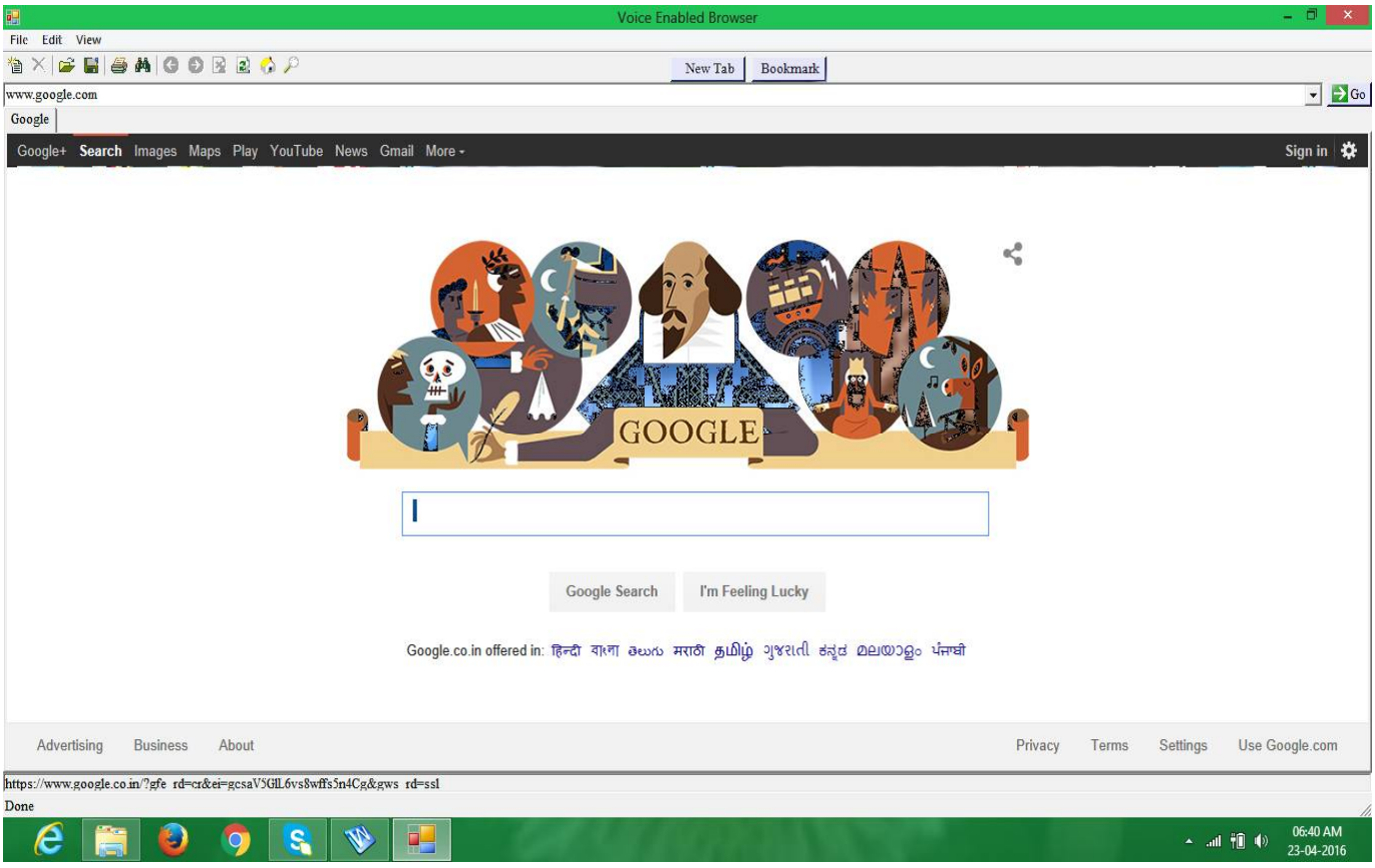

Fig 3. Graphical User Interface of the web browser

The GUI is implemented by using various .Net libraries. System.Windows.Forms library is used to design GUI. It provides controls like button, text box, panel, tool bar, menu, Tab control, Combo box, etc. These controls can be properly positioned in the window frame by setting dimensions property. Different properties and events are assigned to these controls to carry out desired operations

efficiently.

As shown in Fig 3. Graphical user interface of web browser contains different buttons, toolbar, toolbar buttons, menu, menu items, combo box, status bar and so on. The .NET libraries allow to design such interface which is easy to understand and easy to use.

2) Voice to Text Conversion: The core part of our system is voice to text conversion. Microsoft Speechlib API for converting this voice to text.

The Speechlib C# library has been designed on Hidden Markov Model (HMM) layer to represent acoustic models. In speech to text conversion, firstly the audio signal is taken which includes strings, numbers and various pitches. This audio signal needs to check among the data store in the database. When the user speaks anything, it is observed by the system through a speech recognizer and then HMM algorithm is implemented with the use of the grammar builder class, where grammar is present. The extracted and segmented word is matched with the grammar. If the match is found, then suitable functionalities are carried.

Before Speech Recognition is carried out .grammar has to be designed. It is necessary to use an event handler as a callback function so that every time the browser recognizes a word from the grammar, it invokes the event handler. These words have to be added to the grammar before Web browser can use them. The speech recognition engine interacts with applications using events that could be subscribed to by the application. A couple of the most important events are the recognition event and the hypothesis event, these event are raised when the engine make a good recognition or a hypothesis respectively.

The commands used in browser are added to the grammar using AddWordTransition method. The code to add "Find" command to the grammar can be written as:

```
menuRule.InitialState.AddWordTransition(null, "Find", " ", SpeechGrammarWordType.SGLexical, "find", 1, ref PropValue, 1.0F);
```

TABLE I
COMMANDS USED IN WEB BROWSER

Command Name	Function
New Tab	New tab will be opened
Go back	Go back to previous page
Forward	Go to next page
Open	Open file
Web Search	Search for websites
Go home	Go back to home
Tab Close	Close the current tab
Save	Save the web page
Print	Print the web page
Find	Find for particular word or phrase from the web page
Stop	Stop loading
Scroll up	Scrolling up page
Scroll down	Scrolling down page
Cut	Cut selected portion
Copy	Copy selected portion
Paste	Paste to selected region
Source	Show source
Refresh	Refresh the web page
Hinde	Kannada command for go back
Munde	Kannada command for go forward
Huduku	Kannada command for find

Table above shows the voice commands recognized to carry out specific browser functionalities. These commands are provided in grammar using the code. The table shows both English and Kannada commands used in the web browser.

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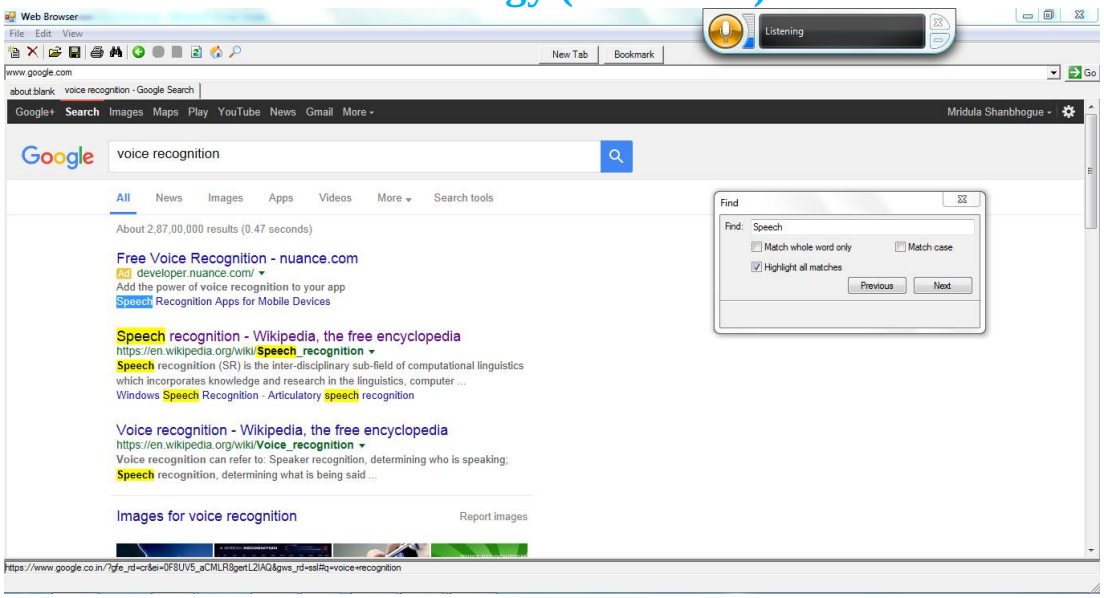

Fig 4. Voice Recognition by the web browser

As shown in Fig 4. inputs can be given through voice commands. If input matches any word in grammar with which some function is associated, then corresponding function is performed.

3) *Building web browser:* The browser is built on .Net framework and it uses WPF (Windows Presentation Foundation) rendering engine. C# programming language is used design the browser and make various browser functionalities work. The browser can perform basic browser functionalities such as loading an active browser, navigation, showing progress change, showing status change, opening and closing tabs, save to file, open a document, print a page and so on.

Loading an active browser is achieved by writing a method in c#. This method loads a blank web page. The users can easily navigate by writing address of desired page in combo box. The method written in c# retrieves the URL, navigates and loads corresponding web page. With the help of progress change event object and status change event object the browser can retrieve current progress and current status of browser process respectively. The retrieved information are displayed on the browser for user. The functions like save, open, print, cut, copy, paste, etc are given command ID in c#. All these operations are carried out by sending their respective command ID to ExecCommandID method whose definition will be mentioned in browser's code.

VI. RESULTS

To test the system all the code snippets are executed in the same package and the code is run to see the outut. The output of the program is matched with the expected output.

During testing various performance variables are evaluated. Speaker distance is one such variable. Performance varies with difference speaker distances. From testing it is revealed that voice has to be read at a range of 5 to 7 centimetre. Interference from external noise is an important factor affecting performance of speech recognition. If more noise signals interfere with voice inputs the performance decreases. Degree of interference also depends on quality of microphone, surrounding medium and accuracy of the system. Accuracy of speech recognition software is another important factor affecting the performance. The accuracy increases with more and more training of speech engine the user. When the testing is performed by taking few test cases involving commands, efficiency of 83% is obtained. For a total of 300 cases, the correct words recognized were 249 indicating a good overall performance of the system.

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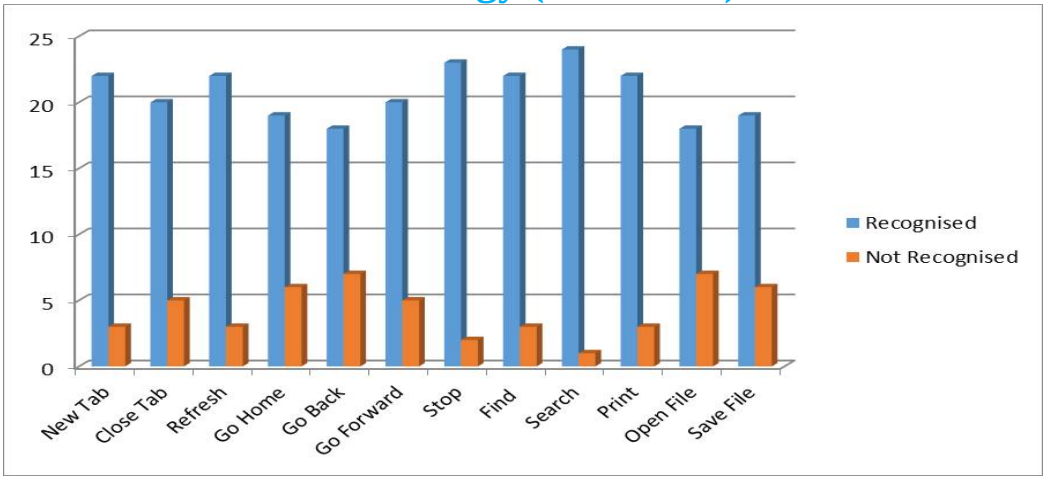

Fig 5 Benchmark analysis

VII.CONCLUSION

The project aims at creating a browser on voice based platform, which provides potential, technical solution that will help both persons with disabilities and general community. Our proposed model of the browser is efficient and thus possibly falling under the scope of a new technology. We are able to create a browser with takes in speech, convert it to text using voice to text tool and then be linked with the event driven controls of custom browser .With all the accumulated efforts invested in Voice enabled Browser, there are reasons to believe that at the end of the project, speech recognition finds itself in a much better shape and quite closer to industrial acceptance than it was. We summarize the progress with respect to the main objectives of the project, namely, convenience and accessibility.

Convenience: The pleasant user interface of the browser clearly makes the usage of internet a pleasure to use for any user. It has been demonstrated in the project that it can accessed with the general speech, something which disabled community had troubled in doing so. The project also showcased that the system can be trained to the needs of local community, thus eliminating the language barrier. As of the projects' concern, Kannada has been implemented into the system.

Accessibility: By this term we understand the increased usage in the user disciplines and the application domains which can be used for certain specific activities. Unlike other browsers which provide only option of search, we are able to recreate the entire dynamics of using the complete functionalities of a browser, thus enabling any kind of usage as per the specification of the user.

VIII. ACKNOWLEDGMENT

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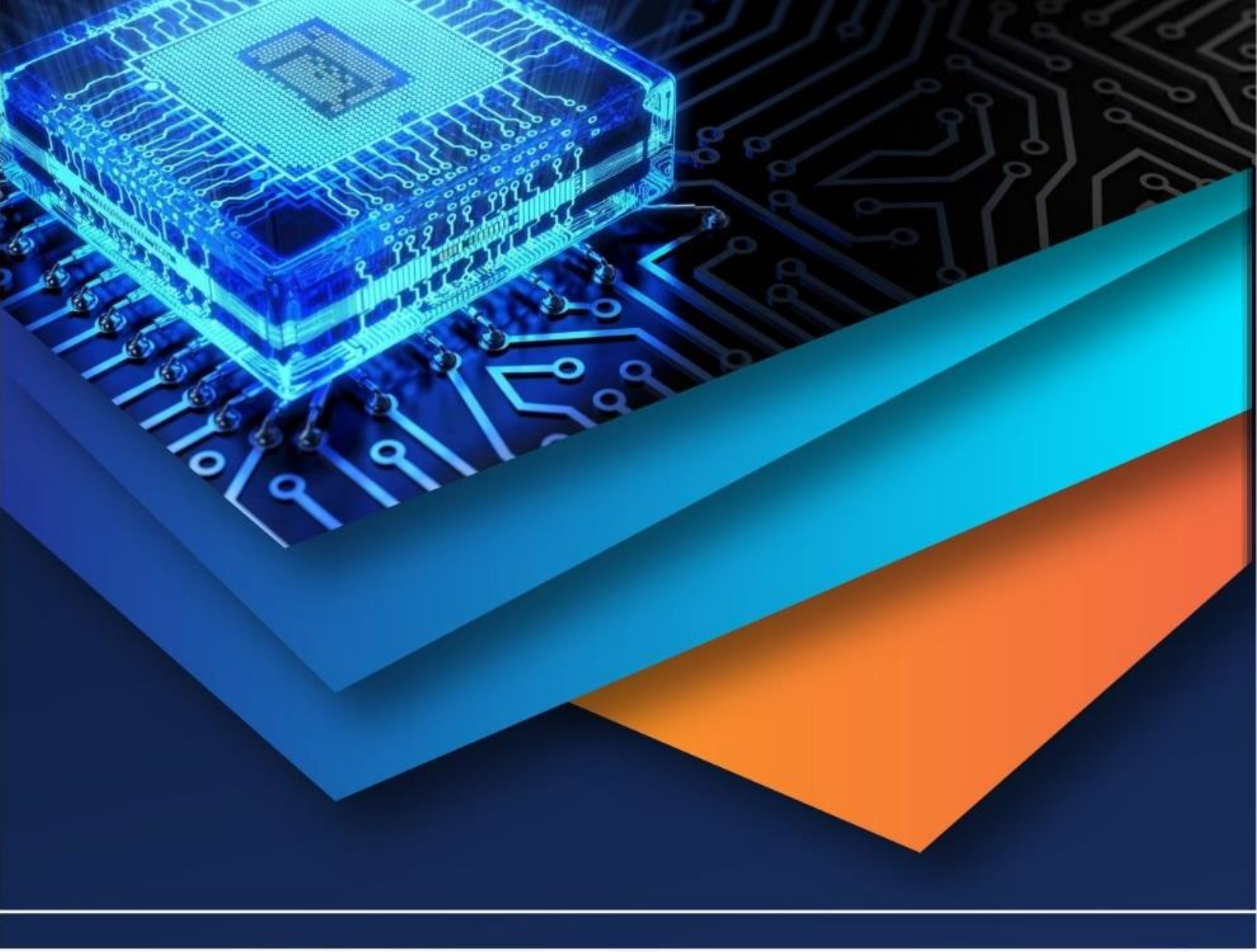

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