INTERACTIVE SPEECH RECOGNITION AI HOME AUTOMATION SYSTEM FOR DISABLES

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Abstract: This paper aims to provide an interactive environment for disables by speech recognition and device control with embedded systems. Home automation system is now a simple concern in the world of smart technology but always requires flexible implementation to perform well. A concept of machine learning is used which is a method of data analysis that automates analytical model buildings. An interactive device control system (IDCS) is going to implement which used algorithms to iteratively learn from data, machine learning allows computers to perform tasks and provides output without being explicitly programmed. The system uses machine learning methodologies by observing behaviour of a person at a particular time, condition, weather and daily routine tasks and then provides output in an effective manner. As the system learns itself and takes decisions, it is designed especially for disables so that they can control devices of their home and manage household activities to live easy.

Keywords: **Artificial intelligence, speech recognition, machine learning, hypothesis, signal processing, Ant Colony Optimization, decision tree, K-mean.**

I. INTRODUCTION

Machines are becoming more competent even in case of complex problems it handles the situation and gives output within seconds. Machine can learn faster although it is human programmed code; Machines are getting high level of intelligence as humans, a bit worried for the future. Natural language is an artificial intelligence specialization that processes the human natural language and prepares computers to give response. In this decade AI has become less artificial but more intelligent. One of the most exciting areas of the AI is machine learning which turns the concept very interestingly to think that how machine can learn so fast. In the computer science world AI is creating actually another different world for the humans.

Home automaton is not a current highly research domain but it was always a challenging area on which new features required to add to match with new technology of world. Machine learning is a such concept which can be used in home automaton to provide output with high performance. A large database is required to understand any behaviour and reach to the final decision.
Speech recognition is one of the most complex areas of computer science and partly because of it's interdisciplinary. It is the process of converting speech signal to a sequence of words in the form of digital data, by means of an algorithm implemented as a computer program. It involves a mixture of linguistics, mathematics and computing itself. Speech is naturally dynamic in nature. There are many approaches used in speech recognition namely artificial neural networks (ANN), pattern recognition, language modelling and statistical analysis. In the basic model of speech recognition pre-processing, feature extraction and modelling is performed but it always required a new & fast development to recognize all kind of human voice.

II. RELATED WORK

In the field of speech recognition various methodologies have developed and many are in developing stage. In the paper[1] some models are discussed like Acoustic models, Lexicon model, Language model and Hidden Markov model. The algorithms which have used are converted speech into words and vice versa to achieve result for correct recognition. It is requirement of system to achieve output correctly with the fine performance. Speech recognition is such a powerful invention which can provide a better environment for those people who cannot provide input from keyboard or unable to move. Paper[2] discussed this concept for the disabled to improve their life routines. Home automaton with speech recognition can work well for these people and this field can be enhancing to achieve high performance.

Machine learning is the subset of artificial intelligence. Enormous algorithms are working in the field of machine learning which categorize the data and results output with the set of parameters. Combination of machine learning and home automaton can work efficiently [3]. Information technology is rapidly changing area and performance of voice recognition systems varies from machine to machine and according to trained systems for particular user[4]. Decision tree algorithm is the type of supervised algorithm which can

be used to supervise machine to take final decision. [5] paper discussed the general rule for decision tree algorithm to categorize data and help to select a particular parameter to finalize.
Conclusively home automaton requires better implementation which can be done using machine learning to understand the behaviour of user and learns itself to take action with the speech recognition.

III. PROPOSED ALGORITHM

3.1 System architecture:

Embedded systems are a combination of hardware and software which is specifically designed to perform certain tasks. A special purpose computer system designed to perform one or few dedicated functions often with real time computing constraints. It is a system designed within a large mechanical or electrical system, often capable to do many tasks depends on programming. It is embedded as a part of complete device often including hardware and mechanical parts. Embedded systems control many devices in common use today. Digital cameras, home appliances machines, mobile phones, sensors etc are many real examples of these systems.

3.2 Basic model of speech recognition:

The input of speech recognition system is voice which is a kind of sound waves will reach to a transducer condenser microphone through air particles. These signals will convert into electrical signal by using transducer or some other such devices. It will generate potentials of some micro-voltage which will amplify and generate analog data of input.

Digital signal processing deals with signal phenomenon. It performs wide variety of signal processing operations. Speech processing has been an important catalyst for the development of DSP theory and practice. It recognized speech directly from digitized waveform. Digital signal processing performs some form of feature extraction to handle large variability of speech signal. A DSP circuit is able to differentiate between a human voice and chaotic noise. A method is used here which is known as pulse code modulation (PCM) to digitize analog signal received from microphone.

Pulse code modulation- It is a method used to digitally represent sampled analog signals. In a simple term it converts analog signals into digital signals. PCM process consists of three steps.

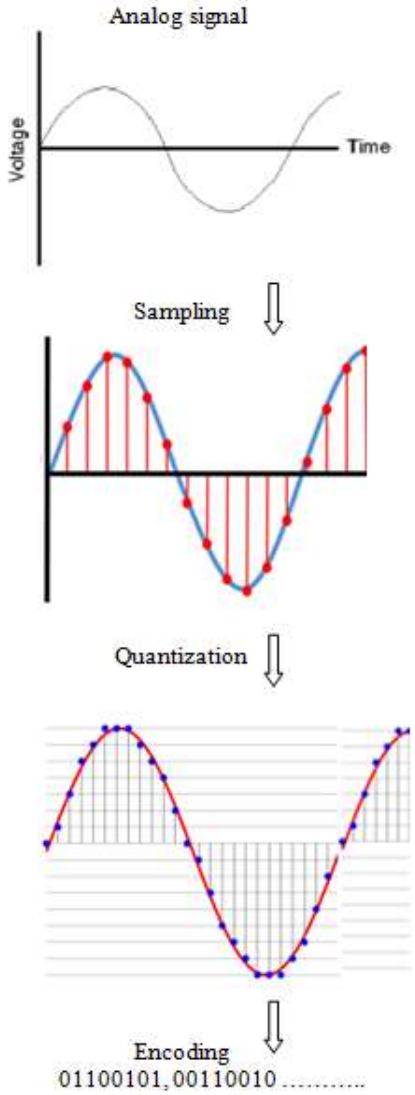
1. Sampling
2. Quantization
3. Coding

In a sampling process the magnitude of voice signal is sampled regularly at uniform interval. These sampled signals then converted in discrete values in quantization process. Here approximate values are considered for sampled signals and then at the time of encoding bits are compared with the phonemes of word.

When the speech signal generated, it is sampled by taking precise measurements of the sound wave at frequent intervals. The system filters the digitized sound to remove unwanted noise, and sometimes to separate it into different band of frequencies. Input signal can be of different speed at different time, so the signals are adjusted to match the speed of template sound samples already store in the system's memory. As shown in fig (1.2) a speech engine is used which figures out the spoken word. Phonemes which were generated in the process of digital signal processing are then compared by speech engine.
For example the word pronounced as "hello"
Hello -> phonemes will be generated as Ha-el-ll-lo-oo
At different voltage level and frequency bands words are recognized by taking approximate values. Combination of training, predetermined text patterns, voice quality, pronunciation and preferred vocabulary, speech engine recognizes words better.

- Speech engine recognizes spoken sampled signals by comparing with template word. Here iterations are matched and on the basis of matched values the system either recognizes the signal or predicts words with hypothesis.
- At the time of comparison of strings if the iterations are matched 80% to some pre specified strings, it will come into the process of recognition and appropriate output will be generate.
- In the process of hypothesis a nearby value is considered to provide output and this input string is saved in a different location to match same input next time so that learning of system will maintain a new term.
- A dictionary is maintained by the speech engine to store new terms and recognize next time.

3.3 Process of pulse code modulaton:



Fig(1.1) Pulse code modulation

3.4 How IDCS Works:

The aim of the research is to provide dataset to the machine to analyse & take decision itself. Here the decision tree algorithm is used to generate final output. For the learning of the system Ant colony optimization will merge with decision tree and K-mean algorithm to help the system to take accurate decisions. Every new command will be put in a memory for learning purpose and will be act as a pheromone in ant colony. All the relative information will be collected for a particular time interval. Each time system will keep track to the all relative information. While completing the time interval either the system updates the final solution with the use of K-mean algorithm or it will abort some irrelevant actions as per the user permission. Decision tree algorithm will take final decision which have updated by K-mean algorithm.

$$f(str_o) = P_{ij} = \begin{cases} \frac{\tau_{ij}^{\alpha}}{\sum_{i=0}^{k} \tau_{ij}^{\alpha}} & \text{if } j \in A \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

Where , $\tau_{ij} = \tau_{ij} + \Delta\tau^{k}$ (Pheromone change)

$f(str_1) = \sum_{i=2}^{4}(f(str_o2) + f(str_o3) + f(str_o4))$

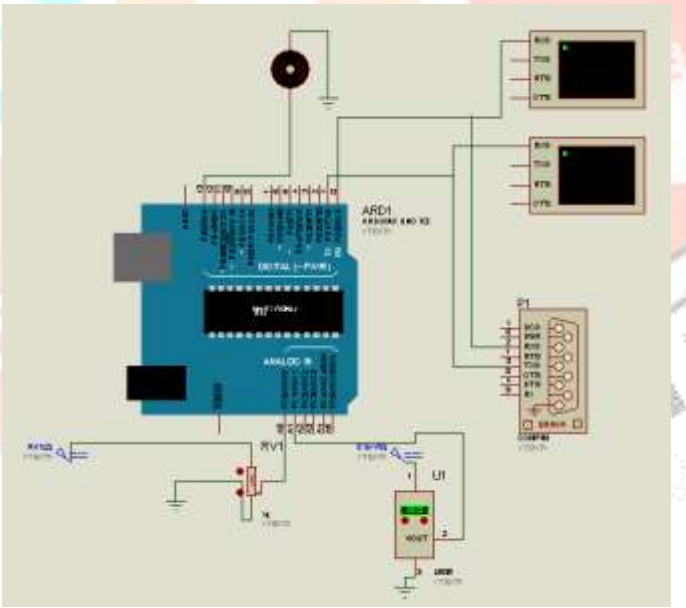
=> $f(str_2) = f(str_1) \bmod 3$ (2)

Entropy $S= \Sigma - p(I)\log_2 p(I)$ (3)
Here, S = entire sample set;
p(I) = proportion of S belonging to class I.
$f(str_2) = f(str_2 1), f(str_2 2), f(str_2 3)$
$I= f(str_2)$

3.5 Proposed system:

3.5.1 Microcontroller:
Arduino1.0.5 is used & it consists of physical programmable circuit board and software used to provide connection. It is programmed to simulate to show embedded system which accepts command & provide interaction between them.

3.5.2 Proteus:
It is used to show simulation between system and other hardware devices. Many hardware have used to show working of home automaton. Some of them are temperature sensor, Arduino board, fan & registers. Here is the snapshot which represents Arduino board with other hardware devices.



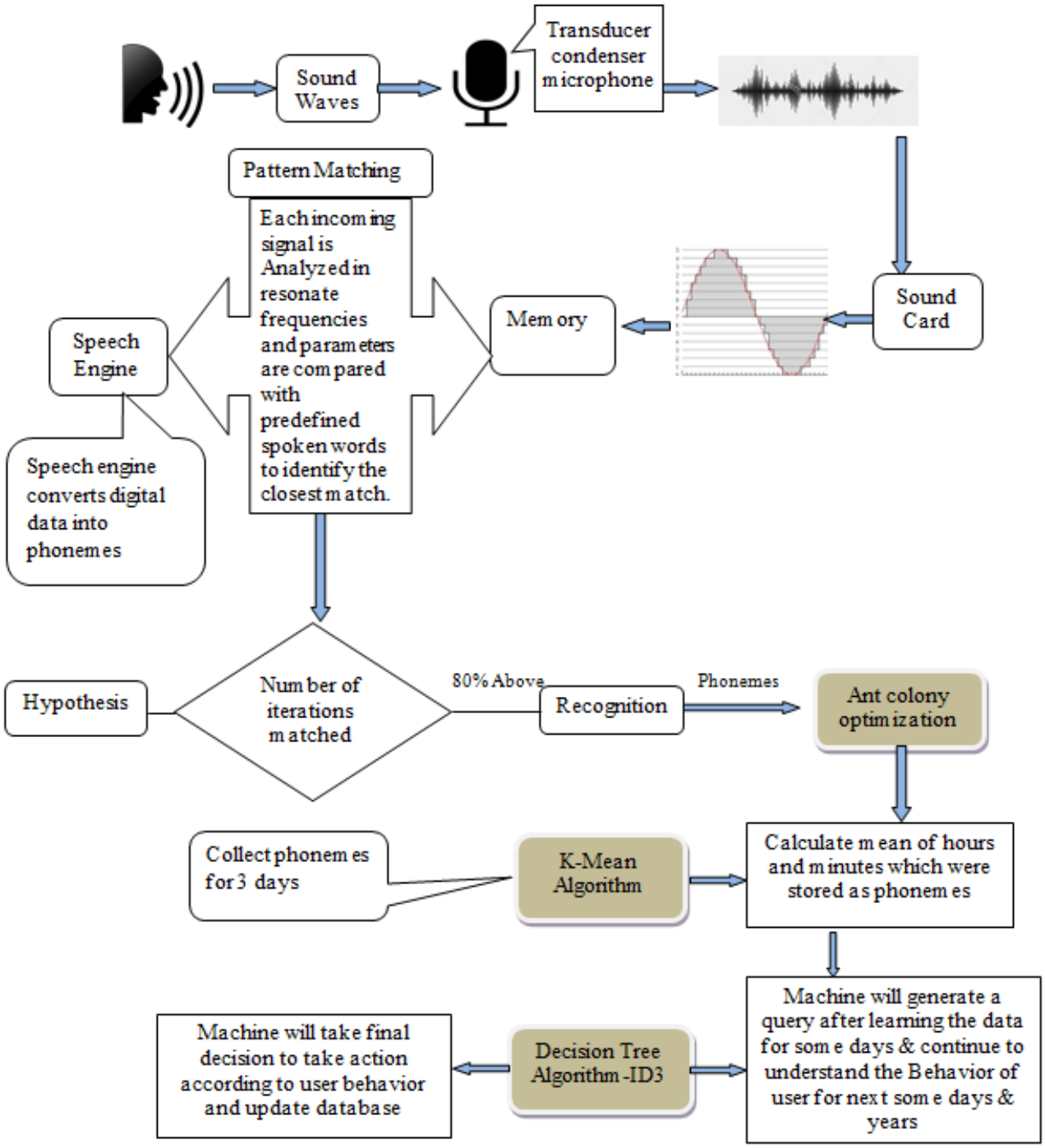
Fig(1.2) Snapshot of Proteus

3.5.3 Virtual serial communication:
Virtual serial port driver 6.9 is used to provide connection at both end. An Arduino board is simulated at one side to accept input & a system is used at another side in which visual basic language is used to provide code in speech recognition.

3.5.4 Visual Basic:
To implement the working of IDCS VB6 programming language used which provide tools to connect with speech engine & helps to create an interactive interface.

3.5.5 SAPI:
Speech API is an application program interface which allows developers to build programs to manage text-to-speech and speech recognition capabilities. Interfaces can be provided with programming languages like C, C++ and Visual Basic. Microsoft Speech SDK SAPI 5.1 is used in this research.

3.5 Flow of program:



Fig(1.3) flow of program

IV. SIMULATION RESULTS:

When we gave input to the system, it responses according to the instructions it has provided and stores the relative information in the database. Here is the snapshot of the database. If user tell to switch on the fan the system stores the relative information such as temperature, time in hours & minutes in the database. Ant colony counter starts counting & wait for sufficient database. Then after K-mean works & the counter of decision tree algorithm starts to help machine to produce final decision.

Table 4.1:Database of switch on fan

Date_on	Time_on	HH_on	MM_on	Tempreture_on	K-mean_on	AntColony_counter_on	DecisionTree_counter_on
03/07/17	18:11	18	11	32.2		1	
04/07/17	18:16	18	16	32.2		1	
05/07/17	18:14	18	14	33.5	Mean=14	1	
06/07/17	18:14	18	14	32.5			1
07/07/17	18:15	18	15	32.8			1
08/07/17	18:14	18	14	32.1			1
09/07/17	18:14	18	14	32.2			0

A voice command is provided to the system to switch on the fan. After completing the initialization procedure (connection establishment, open database, read temperature sensor value) it switched on the fan. This process shows output through the simulator which is used and connected with virtual serial communication. After this, system stores information in terms of date, time in hours & minutes, temperature value and output of algorithms ant colony, K-mean & decision tree. (showed in table).
In the last column of decision tree, entropy is calculated using value of some days through the formula:
Entropy $S= \Sigma - p(I)\log_2 p(I)$
It is the formula of ID3 algorithm which calculates entropy value to classify the data.
Here output is 0, which indicates that data is perfectly classified and system will take final decision to switch on fan daily on this particular time.
In the same way this process is working to switch off the fan. The database is as follows:

Table 4.1:Database of switch off fan

Date_off	Time_off	HH_off	MM_off	Tempreture_off	K-mean_off	AntColony_counter_off	DecisionTree_counter_off
14/07/17	16:41	16	41	32.5		1	
15/07/17	16:14	16	14	32.7		1	
16/07/17	16:40	16	40	33.8	Mean=18	1	
17/07/17	16:18	16	18	32.2			1
18/07/17	16:18	16	18	32.2			1
19/07/17	16:18	16	18	32.9			1
20/07/17	16:28	16	28	33.1			0

This process is applicable for other hardware devices which are used in home and can be automate well with learning of machine

V. CONCLUSION AND FUTURE WORK

In above experiment Interactive device control system (IDCS) is implemented which resulting higher accuracy for learning human behaviour. After analysing the behaviour of user in multiple days' intelligent machine calculated mean value & generated a artificially positive response by their algorithm for response system. User query is again analysed for next some days. With getting response from user & the value of calculated entropy machine takes final decision with the permission of user & update itself to react. In this experiment machine has provided with small dataset (multiple days) to learn. To check the efficiency & flexibility of the machine, it can extend its database for multiple years.

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