A Survey on Isolated Word and Digit Recognition using Different Techniques

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ABSTRACT
Nowadays, Spoken digit recognition is one the challenging task in the field of speech recognition. Spoken digit recognition is necessary nowadays in many applications that needed number as input like telephone dialing using speech, addresses, airline reservation & automatic directory to retrieve & send information which make the system more efficient to use. Also, It proves very helpful for physically challenged people in hands & eyes free applications. Various techniques are used for isolated speech recognition like MFCC, HMM, LPC. But among all of them many researchers found that MFCC is widely used & give a more accurate result. ASR achieves a maturity level in many Indian languages. Mostly research work has been carried out. Here in this paper, Discussions of the survey is on some of that recent research work in isolated digit recognition for the Indian languages like English, Gujarati, and Hindi & also in other similar languages. Likewise, discussing different approaches, methods & comparative analysis about recent research work done in isolated digit & word recognition in various languages.

General Terms
Speech Recognition , Isolated digit recognition

Keywords
Speech Recognition, MFCC, Hidden Markov Model (HMM), LPC, Isolated word, isolated digit recognition.

1. INTRODUCTION
Speech recognition is a very common & useful way to interact with others. In today's modern world, many devices are designed & produced user friendly for the communication purpose, speaking activity & also used for many applications which make devices very reliable & more convenient to use. Speech recognition is the interface between human & machine interaction. It is a natural language which is based on human voice which help machine to recognize & understand various human languages spoken by different speakers by means of Speech recognition. It can be done by converting speech signals into a sequence of words by means of an algorithm. Speech recognition is also known as Automatic Speech Recognition (ASR) system [42], [44]. The Aim of the speech recognition area is to develop system for various languages by using various techniques by converting speech into machine readable format. Which provide more convenient & hands-free environment for users.

Speech recognition, increase technology & encourages people who are not physically & mentally comfortable to operate machines due to the lack of the knowledge & language barrier also for disabled & blind people [46]. It is very challenging task for blind people to read from the machine. Also, for the foreign students because of the pronunciations of different

speakers & grammar rules. Various issues like Noisy environment, Transducer, a different speech style which affects the speech [42], [43]. A speech recognition system developed to overcome these types of difficulties during recognition.

This paper organized in following manner, Section 1, is about Introduction part. Section 2 presents the scope & motivation of this survey paper, Section 3 is a brief definition about the speech which is also known as "Classification of Speech Recognition", Section 4 is Literature Survey about recent contribution made in isolated word & digit recognition system in different languages, Section 5 focuses on techniques used in isolated speech recognition, Section 6 is analysis & discussion, Section 7 is about Conclusion and future work.

2. SCOPE AND MOTIVATION
All This survey paper gives an overview about isolated speech recognition systems developed in different languages, using different techniques with their recent development. It also included an overview about mainly used techniques in isolated speech recognition, their experimental results & the Graphical representation about the overall work done in the isolated digit recognition system at various languages. Which may help a lot to the researchers to get the overview about the isolated digit recognition system developed in different languages around the world & the recognition rate achieved by that system helps researchers in choosing the technique that gives better improvements in the isolated digit recognition system.

From the comparative analysis part of this survey paper, it is observed that the isolated digit recognition system is implemented in English language. Little work is done in other similar languages like Gujarati, Hindi, Bengali, Tamil etc. So we conclude with the decision for isolated digit recognition, apart from those languages, requires more attention.

3. CLASSIFICATION OF SPEECH RECOGNITION
There is a large amount of variety in speech recognition. This is important to understand the differences between various types of speech utterances, the size of the vocabulary, speaker dependency. Also, its applications & issues.

3.1 Types Of Speech Recognition
3.3.1 Isolated Word
It accepts single words or single utterances at a time.

3.3.2 Connected Word
Run together minimum pause between them.

3.3.3   Continuous speech

Continuous speech recognizers allows user to speak naturally, while the computer determine the continue Recognizer with continues speech capabilities.

3.3.4   Spontaneous speech

System with spontaneous speech ability should be able to handle a variety of natural speech feature such as words being run together.

3.2 Vocabulary Size

Vocabulary size of ASR system will affect the system complexity & also the accuracy of the system because of the limitations of the size at some applications. Types of vocabulary size can be classified as,

Table 1. Vocabulary Size

Type of vocabulary	No of words contain
A Small vocabulary	10
Medium vocabulary	100
Large vocabulary	1000
Very large vocabulary	10,000

3.3 Types Of Speaker Model

3.3.1   Speaker dependent

Speaker dependent system mainly developed for a single speaker. This is easy to develop, cheaper & more accurate. It uses a unique feature of a single person's voice. An upcoming user must have to train system first, by speaking with it so that the system will analyze that how a person talks. This is not as flexible as speaker independent & speaker adaptive.

3.3.2   Speaker independent

In speaker independent, System developed for any speaker of a particular type. It will recognize speech patterns of a large group of people. This system is difficult to develop, expensive & gives less accuracy than speaker dependent system.

3.3.3   Speaker adaptive

A speaker adaptive system developed to adapt its operation to the characteristics of a new speaker. This system is flexible.

3.4 Speech Recognition Issues

There are various issues in speech recognition, which are,

3.4.1   Environment

Due to the type of noise, signal/noise ratio, working condition.

3.4.2   Transducer

Due to microphone

3.4.3   Speaker

Speaker independent/dependent, sex, age

3.4.4   Channel

Due to the band amplitude, distortion

3.4.5   Speech Style

Due to voice tone (quite, normal, shouted)

3.4.6   Vocabulary

Due to the characteristics of available data, vocabulary [42], [43], [44], [45], [46], [11], [8], [18]

3.5 Speech Recognition Applications

3.5.1   Educational purpose

For teaching students of foreign languages to pronounce vocabulary correctly

3.5.2   Medical sector

For health care

3.5.3   Military sector

For high performance fighter aircraft, battle management.

3.5.4   Telephony and other domains

For dial up connection

3.5.5   Serving the disabled

3.5.6   Home automation

3.5.7   Automobile audio systems[42], [44], [46]

4. LITERATURE SURVEY

This section of the paper highlights literature survey on recent research work has been done in isolated digit recognition in different languages as well as for isolated word recognition. Here some research & development related to isolated digit & word are discussed,

Choudhary, Chauhan, & Gupta, (2013) have implemented automatic speech recognition system for isolated & connected words of Hindi language using hidden Markova model toolkit (HTK), that is based on Hidden Markov Model (HMM), which is a statistical approach is used to develop the system for 100 distinct Hindi words (small vocabulary). MFCCC is used here for feature extraction which shows an overall system accuracy rate for isolated word is 95% & for connected words it is 90% [1].

Singhal & Dubey, (2015) have implemented automatic speech recognition for connected words using DTW/HMM for English /Hindi languages. In which author shows their work on isolated word recognizer for speaker dependent data works in both English as well as Hindi using DTW & HMM techniques, Both techniques are compared in this paper, including database for 10 speaker about 20 isolated word for both languages. which shows Overall WER (Word error rate) for English language is 13.33% using DTW & 6.67% using HMM & Overall WER for Hindi language is 13.33% using DTW & 13.33 % using HMM. From the results author concluded here that HMM model for English language gives most efficient results compared with the DTW approach with minimum WER [2].

H B Chuahan, Prof B A tanawala (2015) have compared both MFCC & LPC method under vector quantization(VQ) method at comparative study of MFCC & LPC Algorithms for Gujarati isolated word recognition in which they use database of both male & female voices where each word is repeated at 5 times by speakers   where results shows that using LPC, accuracy is above 85% , MFCC is more above 95%. So author concluded here that MFCC performs better for feature extractor [3].

Pandit & Bhatt,(2014)   have described automatic speech recognition of Gujarati digits using dynamic time warping , In which author discussed speech recognition of Gujarati isolated digit with the database of small vocabulary about 1 to 10 Gujarati digits from 10 speakers. Where MFCC is used for feature extraction & recognition of unknown speech signal is go through DTW method. Whole this process is done using

MATLAB. From Experimental results author got the accuracy about 84.44%, while with extra care during recoding they achieve an accuracy rate increased to 95.56% [4].

Chapaneri & Jayaswal, (2013) has present efficient speech recognition system for isolated digit in which they discussed speaker independent 0 to 9 English digits in which implementation is done with the IFDTW(improved feature for DTW) method with 13 Weighted MFCC coefficients for feature extraction. Also, they proposed sola based technique for reducing the complexity of recognition. Author founds sola based technique & faster implementation of IFDTW is 22 times faster than the other techniques which got 99.16% accuracy [5].

Patel & Desai, (2014) have described recognition of spoken Gujarati numerals & its conversion into electronic form, In that proposed model includes mainly three components which are, digitization , feature extraction & pattern classification. Also, they used MFCC for feature extraction it includes framing, windowing, fast Fourier transform (FFT) & also compute the Discrete Cosine Transform (DCT) to produce feature vector of spoken numeral. Model work only for Gujarati numeral which is an isolated word that is recognize by different speakers. The proposed model achieves average an accuracy rate of 78.13% [6].

Elouahabi, Atounti, & Bellouki, (2016) have described amazigh isolated word speech recognition system using hidden markov model toolkit (HTK), where amazigh language is known as Berber or Tamazight that is so vast in Africa. HTK tool that uses HMM model for to develop the system & MFCC for feature extraction. Proposed model works on both 10 digits & 33 alphabets collected from 60 both male & female speakers. The Overall accuracy of the proposed model achieves 80% [7].

Therese & Lingam, (2015) have described speaker based language independent isolated speech recognition system proposed a model in which most widely used MFCC is used for feature extraction also k means algorithm is used for specific feature extraction. Here this proposed system is not only used for recognizing the speech but also for language in which speech is uttered. Vocabulary contains digits from 1 to 10 of seven different languages. Which achieves 97.14% accuracy except digit three & seven [8].

Mishra, Biswas, & Chandra, (2010) have describes isolated Hindi digit recognition: a comparative study which works on isolated spoken Hindi digits for which proposed model has been evaluated using both HTK & MATLAB, Also used both HMM & MFCC for feature extraction & database is of 0 to 9 Hindi digits from 40 speakers, recognized here. Author observed here that the HTK works better than MATLAB in both clean & noisy environment. This achieves an overall result of 99.2% accuracy [9].

MarutiLimkara, RamaRaob & Vidya Sagvekarc, (2012) have described isolated digit recognition using MFCC & DTW, Which propose an approach to recognize isolated English words from 0 to 9 from different male & female speaker. Here recognition can be done by combining other components of proposed model which are, Endpoint detection, framing, normalization, MFCC & DTW algorithm which they used for implementation & recognize the isolated digits. Achievement of overall accuracy rate is 90.5% [10].

Revathi & Venkataramani, (2011) have described speaker independent continuous speech & isolated digit recognition using VQ & HMM ,discussed both HMM & VQ Method, they proposed a system , which uses PLP feature extraction with both combine VQ+ HMM method, Author observed here that it performs & shows better results, using VQ with PLP they achieve 86 % & 93 % accuracy with combining both VQ + HMM. PLP feature also shows results up to 99 % & 100 % for both VQ & combining VQ+HMM respectively [11].

Patil, Admuthe, & Zirmite, (2014) have described isolated digit recognition using ear microphone data using MFCC, VQ & HMM ,here proposed model implement isolated digit into three stages, which are endpoint detection & speech segmentation, another one include d feature extraction which is done by MFCC, & at last it conducted both VQ & HMM based classifier , works on isolated English digits [12].

Trivedi, (2013) have described a survey on English digit speech recognition using HMM, which focuses on isolated English digits from 0 to 9 by implementing it with the use of the HMM Model using MFCC feature extraction technique. Here the authors have also discussed some methods & approaches related to the speech recognition [13].

Saksamudre, (2015) have described comparative study of isolated word recognition system for Hindi language ,which focuses on comparative study on isolated Hindi language using MFCC & KNN as pattern classification technique. When proposed model works on 10 words, it achieves overall accuracy about 89%, while for 100 words, it achieves 62.50% so it is observed here that when vocabulary size increases performance will be decreased [14].

Nandyala, (2010) have described real time isolated word speech recognition system for human computer interaction ,In which proposed model works on speaker dependent system , which is implemented using MFCC feature extraction technique & Dynamic programming algorithm. This work is used in tourism application. System obtained 88.0% accuracy [15]. Mengdi Yuet, Ling Chen, Jie Zhang, Hong Liu, has implemented speaker age recognition based on isolated words by using SVM , Here proposed model recognize speaker's age using SVM with MFCC feature extraction technique of 4507 isolated words, which achieves 72.93% accuracy. Author also compare HMM & SVM both & based on that it is observed that SVM is more suitable [16].

Londhe, (2014) have described hybrid HMM/ANN based isolated Hindi word recognition , proposed a model which is hybrid model for hindi word recognition. HMM model is also used for implementation with KNN classifier. Proposed model works for ten digits with 5 speakers. Author concluded here that proposed hybrid model gives efficient & satisfactory result. Which got success in recognition accuracy up to 89.8% [17].

Tailor, Shah, Patel, & Graduate, (2015) have described review on speech recognition system for Indian language in which author survey on different Indian languages also discussed different techniques & expiremental results related to them. They observed some challenges related to their & found that proper noise removal techniques improve accuracy level [18].

Dhandhania, Hansen, Kandi, & Ramesh, (2012) have described a robust speaker independent speech recognizer for isolated Hindi digits in which proposed model works on 30 individual that represent 5 distinct age groups of 15 to 40 years for isolated 0 to 9 hindi digits using HMM Model with MFCC feature extraction that achieves 75 % accuracy [19].

Abushariah, Gunawan, Khalifa, & Abushariah, (2010) have described English digit speech recognition system based on HMM proposed model to implement English isolated digit from zero to nine using HMM with MATLAB. Proposed model which achieves accuracy in clean environment isolated

Karpagavalli, Rani, Deepika, & Kokila, (2012) have described isolated tamil digit speech recognition using VQ in which proposed model is based on small vocabulary isolated speaker independent tamil digits. In which tamil digit recognizer is designed & analyzed. Here in proposed system, codebook for each word in the vocabulary is done using Linde-Budo-Gray (LBG) vector quantization algorithm.Each digit is evaluated using word error rate & word recognition rate. Which achieves overall 91.8 % accuracy [50].

Darabkh, Khalifeh, Bathech, & Sabah, (2013) have described Efficient DTW based speech recognition system for isolated words of Arabic language in which proposed system is used to do many tasks. Here signal is preprocessed to reduce noise effect.signal is digitized, voice activity regions are segmented

word with multi speaker 99.5 & with speaker independent 79.5 same with Continuous Speech Recognition 92.5 , 76.67 respectively , In noisy environment isolated word with multi speaker 88 & with speaker independent 67 same with Continuous Speech Recognition 72.5 , 56.25 respectively[20].

using voice activity detection (VAD) algorithm & features are extracted from speech signals using MFCC feature extraction technique. Proposed system added delta & acceleration coefficients to improve recognition accuracy. Here each word's features is compared using DTW algorithm which achieves 98.5% accuracy [51].

Das & Parekh, (2012) have described recognition of isolated words using features based on LPC, MFCC, ZCR & STE, with neural network classifiers in which proposed system works on isolated word corresponds to English digits from 0 to 9 which is spoken by 28 speakers that is implemented using different type of feature extraction techniques like MFCC,LPC,ZCR & STE. This proposed system also uses ANN classifier. That achieves 85% accuracy level [52].

5. PREDOMINANTLY USED TECHNIQUES IN ISOLATED SPEECH RECOGNITION

Table 2. Techniques used in isolated speech recognition

Method	Property	Advantages	Procedure for Implementation
DTW	Dynamic time warping is a algorithm used for pattern matching.which provides time registration between reference pattern & test pattern	Used in many applications like speaker recognition & online signature recognition	DTW is a method that allows a computer to find an optimal match between two given sequences (e.g. Time series) with certain restrictions.
HMM	Hidden Markov Model is used to study hidden & unobserved state. It constructs a statistical model where each word is the vocabulary & to recognize each input word as the word of the vocabulary.	It provides a framework which is useful in mathematical computations	Used widely in finding pairwise alignment
LPC	10 to 16 lower sequence coefficient, Static feature extraction method	Spectral analysis is done with fixed resolution along subjective frequency scale	Linear predictive coding used for feature extraction at lower order
MFCC	Mel frequency cestrum used for find features	Provide more accurate result for feature extraction.	In this method power cestrum is computed by implementing fourier analysis.
VQ	Vector Quantization is a text independent recognition method which is divided into two parts (i) feature training (ii) feature matching where feature training referred with randomly choosing feature vector & perform training using vq algorithm.	VQ has small number of feature vector used as specifying speaker specific features.	VQ is stronger than continuous hmm

6. ANALYSIS & DISCUSSION

Table 3. Comparison of isolated digit in different languages using different techniques

Work	Author	Dataset	Algorithm / Tools & Techniques	Accuracy	Language
Isolated handwritten digits	Gattal, Abdeljalil Chibani, Youcef Djeddi, Chawki Siddiqi, Imran [34]	Handwritten English digits(0 to 9)	SVM	97.74% & 96.72 % with two proposed systems respectively	English
Isolated Digit	Abushariah, Ahmad A M Gunawan, Teddy S. Khalifa, Othman O. Abushariah, Mohammad A M[20]	English Digits From 0 To 9	HMM	Clean environment - Based on Multi speaker 99.5% Speaker independent: 79.5% Continuous digit: 92.5% In noisy environment speaker independent:72.5% & 56.25 % respectively	English
Isolated digit	Safäa ELOUAHABI ,Mohamed ATOUNTI, Mohamed BELLOUKI [7]	Amazigh isolated digit from (0 to 9) & 33 alphabets	HMM, MFCC, HTK toolkit	80 %	Amazigh (spoken in Africa)
Isolated digit	Shanthi Therese S[8]	Isolated digit from (0 to 9)of Seven different languages	MFCC, K-mean algorithm	97.14 %, except digit 3 & 7	7 different languages
Isolated digit	MarutiLimkara, RamaRaob & VidyaSagvekarc[10]	English isolated digit (0 to 9)	DTW, MFCC	90.50 %	English
Isolated digit	Chapaneri, Santosh V Jayaswal, Deepak J[5]	English digit from (0 to 9)	DTW,MFCC,WMFCC,IFDTW	99.16%	English
Isolated digit	Sabah, Reem Ainon,Raja N.[36]	Isolated digit (0 to 9)	Adaptive Neuro Fuzzy Inference System (ANFIS) Structure	85.24 %	Malay
Isolated digit	Tarun Et.Al [23]	Vocabulary Of Hindi Digits	Noise Elimination, LPC, HMM, VQ	84.27 %	Hindi
Isolated digit	Bush Et.Al [26]	Isolated Digits	VQ	96 % To 97 %	English
Isolated digit	K H Davis Et.Al[21]	Isolated Telephone Digits	MFCC	97 % To 99 %	English
Isolated digit	Ike Novita Dewi, Fahri Firdausillah And	Indonesian Isolated Digit	MFCC, HMM	50%	Indonesian

	Catur Supriyanto[47]				
Isolated digit	Sumit Kumar Ghanty, Soharab Hossain Shaikh And[48]	Bengali Numerals	MFCC, DTW WITH EUCLIDIAN DISTANCE	90%	Bengali
Isolated digit	Karpagavalli,S	Isolated Tamil Digits	MFCC, DTW, HMM	DTW- 87.8% HMM- 92%	Tamil

The above tabular representation of table 3 shows the comparative analysis of research found in isolated digit recognition in English & other similar languages using various techniques. In which, many attempts have been made by combining the techniques, that support to develop robust & Multilanguage isolated digit recognition. For recognizing isolated speech, two different feature extraction techniques MFCC & LPC played pivotal role in analysing & drawing good results. Different models are used to recognize the isolated digit, including HMM, DTW, VQ with a different toolkit namely MATLAB, HTK etc. All these techniques are compared here in table 3 among different languages. From that comparative analysis, it is observed that most of the research work in English isolated digit recognition system has been developed very far rather than other different languages.

Table 4. Comparison of isolated digit in Hindi language using different techniques

Work	Author	Dataset	Algorithm / Tools & Techniques	Accuracy	Language
Isolated Hindi Digit	Vedant Dhandhania, Jens Kofod Hansen, Shefali Jayanth Kandi, And Arvind Ramesh[19]	Hindi Digit From (0 To 9)	MFCC,HMM	75 %	Hindi
Isolated Hindi Digit	Moustafa, Akram A[37]	Hindi Digits (0 to 9)	LPC,MFCC,VQ Also Combining This Both Technique	LPC= 80.6%, MFCC =96.8%, LPC+MFCC+VQ=95.2%, LPC+MFCC=96.1%	Hindi
Isolated Hindi Digit	Mishra, A N Biswas, Astik Chandra, Mahesh[38]	Hindi (0 to 9)	MFCC,HMM,VQ,HTK,MATLAB	99.20%	Hindi
Isolated Hindi Digit	Tarun Et.Al [23]	Vocabulary Of Hindi Digits (0 to 9)	Noise Elimination, LPC, Hmm, VQ	84.27 %	Hindi

Above tabular representation of table 4 discussed separately for Hindi isolated digit recognition system about the how different types of research work has been carried out to develop Hindi language. Also, their recognition rate with different combination of techniques.

Table 5. Comparison of isolated digit in Gujarati language using different techniques

Work	Author	Dataset	Algorithm / Tools & Techniques	Accuracy	Language
Isolated Gujarati Numeral	H.B.Chauhan [3]	Gujarati Words & Digits	MFCC & LPC	LPC=85% ABOVE MFCC= 95%	Gujarati
Isolated Gujarati Digits	Purnima Pandit, Shardav Bhatt[4]	Gujarati digits(0 to 9)	MFCC, DTW, MATLAB	84% Experimental result, With extra care = achieve 95.56% accuracy	Gujarati
Isolated Gujarati Digits	Bhoomika Dave, D. S. Pipalia [40]	10Guajrati digits,20 words,	MATLAB, MFCC, HMM	70.57% Within 10 speakers It increases after implementation to 79.14%	Gujarati
Isolated Gujarati Digits	Patel, Bharat C Desai,Apurva A [6]	Spoken Gujarati numeral from (0 to 9)	MFCC, KNN Classifier, MATLAB	78.13%	Gujarati
Isolated Gujarati Digits	J Baheti M V., Kale K E Jadhav M [41]	Isolated Gujarati handwritten numeral (0 to 9)	PCA,KNN	KNN= 90% PCA=84%	Gujarati

There have been many literatures in isolated digit recognition system for the English language. Only a few attempts have been made to Gujarati language. That is discussed separately in table 5. Which represents, how different types of research work have been proposed in Gujarati language, it also shows a comparison between combinations of techniques & their recognition rates.

Table 6. Comparison of different types of work in isolated word in different languages

Work	Author	Dataset	Algorithm / Tools & Techniques	Accuracy	Language
Punjabi Isolated Word Recognition	Sharma Et.Al[31]	Isolated Punjabi Words	Survey On All Techniques Related To Isolated Word Recognition	Different Accuracies As Per Different Techniques	Punjabi
Isolated Word	Ishan[30]	Hindi Isolated Word	MFCC & HMM	97.5 % 99 %	Hindi
Isolated Word	G V Rao[29]	Isolated Word	MFCC	85 %	Indian
Isolated Word	Ms.Puspa Machhar, Mr.Dipak Agrawal[39]	Gujarati Tricky Words	HMM,MFCC,KNN CLASSIFIER,MATLAB	Good Accuracy Using Hmm Rather Than Knn Classifier	Gujarati
Isolated Word	Dua Et.Al [24]	Isolated Word	MFCC & HMM WITH JAVA & HTK TOOLKIT	94.08 % To 95.63 %	Punjabi
Isolated Word	Kaur Et.Al[32]	Isolated Word	Ste & Endpoint Detection Algorithm	Accurate Comparable	Punjabi

Isolated Word	Rabinar Et.Al V[33]	54 Isolated Word	MFCC	Better Accuracy	English
	Rabinar Et.Al[25]	Speaker Independent Isolated Words	LPC	95 %	English
Compare HMM / DTW & MFCC/LPC	Rupali S .Chavan [35]	Isolated word	GMM,HMM,MFCCC,MATLAB	For Two Words- 92 % & For Third Word – 88 %	English
	L R Rabinar Et.Al [22]	Isolated word	LPC,DTW	LPC Is Better Than DTW	English
	R Kumar [28]	500 Punjabi Isolated Word	LPC,MFCC,DTW,HMM	HMM :92% DTW :96 %	Punjabi
	S C .Saijjan[27]	Isolated Limited Word	LPC,MFCC,HMM,DTW	LPC : 91% MFCC 94%	English

Table 6 shows the comparative analysis of different types of research found especially in isolated word recognition in English & other similar languages using various techniques.

All these techniques & their results are compared in table 6 among English & other different languages.

Performance of Isolated Digit recognition in different languages using different techniques
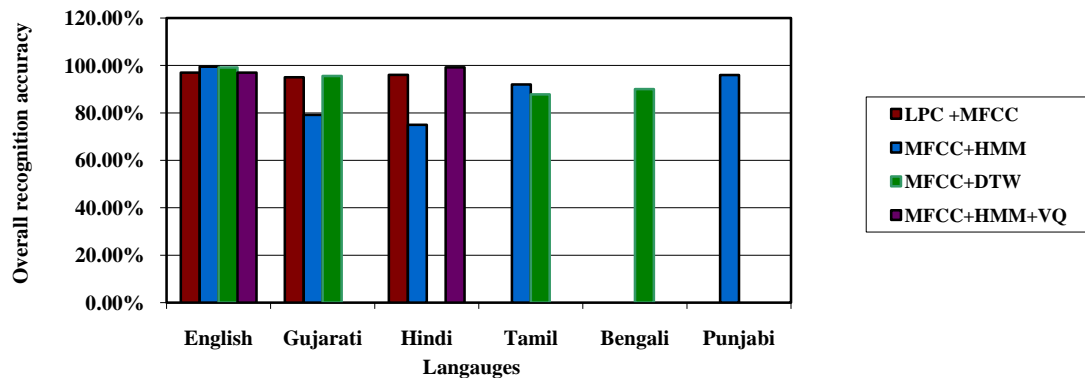

Fig. 1: Comparison of isolated digit recognition rates obtained in different languages with different techniques

The graphical representation of fig. 1 shows the overall recognition accuracy of isolated digit recognition in different languages using a combination of multiple techniques. From this figure & comparative analysis part in this section, it's observed that researchers mostly used MFCC for feature extraction. With the combination of MFCC achieve better improvement. As it shows in this figure combination of MFCC & HMM technique achieve higher recognition rate for each language.

7. CONCLUSION AND FUTURE WORK

In this survey report, comparative analysis is presented on few isolated speech recognition systems developed in different languages around the world in last few decades. Furthermore, it also includes the survey & comparative analysis of different techniques & their accuracy in various languages, where good results has been carried out by researchers which is presented in analysis & the discussion part in section 6 & thus we found that MFCC & HMM achieve higher recognition rate as compared to the other techniques at each language. Also, it's observed that the isolated digit recognition system is developed in English language. The amount of work in other

similar languages has not yet reached to a critical level. So in the future, for isolated digit recognition, apart from those languages require more attention.

8. ACKNOWLEDGMENT

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