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mySmartCart: a smart shopping list for day-to-day supplies

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ABSTRACT

Shopping of day-to-day items and keeping track of the shopping list can be a tedious and a time-consuming procedure, especially if it has to be done frequently. mySmartCart is a mobile application design proposed to transform the traditional way of writing a shopping list to a digitalized smart list which implements voice recognition and handwriting recognition for processing the natural language input of the user. The system design comprises four modules: i) input- which takes voice and handwritten list image input from the user; ii) processing- natural language processing of input data and converted to digital shopping list; iii) classification-list items classified into respective categories using machine learning algorithms; iv) output - searching on e-commerce applications and adding to shopping cart. The design proposed utilizes natural languages to communicate with the user thus enhancing their shopping experience. Google cloud speech recognition and Tesseract optical character recognition (OCR) for natural language processing have been utilized in the prototype along with support vector machine classifier for categorization.

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1. INTRODUCTION

Shopping for day-to-day supplies is an important aspect of one's life, and is a rather time consuming and tedious process. The traditional way of shopping involves handwritten shopping lists and making mental notes [1], [2], which are ineffective and result in time and money loss. The adoption of technology in human lives has enabled online mode of shopping resulting in its wide usage irrespective of the industry domain. Domestic requirements have been met through several web and mobile based applications for grocery shopping along with the traditional offline mode. There is always a consistent need in improving the solution for betterment of people's constant grocery shopping demand. Applications consisting of text and speech recognition are smart solutions that are trending in the current technological era.

Semantic meaning associated with the speech is predominantly influenced by the manner of speaking, articulation, modulation, elocution and pronunciation by the speaker. Virtual speakers use synthesizers based on geographical perspective. Smart applications based on audio input use voice and speech recognition algorithms for better user experience and service. Although the terms voice recognition and speech recognition are often used interchangeably, voice recognition is primarily concerned with determining a speaker's identity rather than the content of their speech [3], whereas speech recognition is the process of converting the sound of words or phrases spoken by humans into electrical signals with meaning attached to it [4]. Individual users having different handwriting hence having unique strokes in various languages is a challenge for automation tasks. Optical character recognition (OCR) involves detecting the

text from embedded images, text documents and converting them to digital text [5]. Several handwriting text recognition techniques have been proposed for camera based whiteboard writing detection [6], document image text detection [7], and digitization of handwritten notes.

In this work, a system design prototype which is a mobile application called mySmartCart is presented. The goal of the design is to enable users to create a shopping list using voice commands and/or by uploading the image of a handwritten shopping list, displaying options from various e-commerce websites from which users can select and add the items to their respective e-carts. The design implements voice recognition and OCR algorithms for processing natural languages and a machine learning algorithm for classifying the list items. In section 2 of this paper, we analyze existing works on smart shopping, applications of voice and handwriting recognition, and classification algorithms that can be implemented in our system. The proposed system methodology is explained in section 3 of the paper. The results of our analysis are presented in section 4 followed by conclusion.

2. RELATED WORKS

In this section, state-of-the-art conventional approaches adopted for voice recognition, OCR and classification algorithms are discussed and compared. The advantages and disadvantages of various existing application programming interfaces (API) for natural language processing involving voice and OCR are identified. Multiple machine learning classification algorithms that can be used to classify the shopping list items are also discussed in this section to identify their efficacy in segregation of chosen products.

2.1. Voice recognition

Voice recognition technology allows computers to recognise and translate spoken words into text, with the primary benefit of searchability. Automatic speech recognition (ASR) or speech to text (STT) are other coined terms for the same thing. Supervised training-based solutions are incorporated with voice samples to aid the physically challenged, augmented reality applications, smart shopping to provide an ease of use for all stake as shown in Table 1.

Table 1. Literature survey on voice recognition APIs

Sl No.	Technology	Advantages	Disadvantages
1	Google STT API [8]–[14]	Enables voice input for queries Speech is converted in real time	Result quality is not good. Speaker identification algorithm does not exist
2	Watson speech to text (STT) [15]–[17]	Organized transcripts Corpus-based Text to Speech (TTS)	Very few languages are supported. Memory required is more due to storage of whole phrases.
3	Speech-To-Text (STT) based on Mel-frequency cepstral coefficients [18]–[20]	Supports multiple languages. SNR is less, which leads to better accuracy.	Training database is self-generated. Generating databases for multiple languages is time consuming Difficult to implement new languages
4	Mozilla's Deep Speech [21]–[23]	Embedded engine Higher accuracy Open source	Poor performance High memory consumption

2.2. Optical character recognition

Digitization of documents comprising text, images, videos is achieved with the help of OCR algorithms for text extraction. Recognizing text elements in a document can be used in various fields like shopping, handwriting recognition, and medical field. Multiple languages can also be recognised using the OCR approach as depicted in Table 2.

2.3. Classification algorithm

Supervised approach is used to identify the category of new observations based on training data. These algorithms learn from the data they're given and trained. It empowers artificial intelligence to the machine and facilitates smart applications. Table 3 indicates the popular classification algorithm adopted for classifying the texts.

Table 2. Optical character recognition (OCR) APIs and their usage

Sl No.	Technology	Advantages	Disadvantages
1	Optical Character Recognition Tesseract OCR [24], [25]	High accuracy Free Data security	Doesn't work well with partial occlusion, warped perspective, or a complicated background.
2	Recurrent Neural Network (RNN) [26]–[28]	Disseminate data over longer distances Provides strong preparation features	Vanishing gradients Learning large data series is challenging
3	Convolutional neural network (CNN) [29]	Increase text identification performance in whiteboard and handwritten note scenario Can be used to train any handwritten language Has good accuracy	Overfitting model Explosive gradients Class imbalance
4	Bidirectional associative memory (BAM) [30]	Completes the heteroassociation challenge by achieving a steady state in a repeating pattern	Recognising difficult patterns is a challenge.
5	Raspberry Pi [31], [32]	The Raspberry Pi is the project's major implementation goal since it acts as a bridge between the camera, sensors, and image processing results, as well as giving functions to change peripheral equipment. (Keyboard and USB)	Even though the mistake rate is modest, it oneeds to be reduced.
6	OpenCV [33]	Free of cost Supports multiple languages	Lower accuracy and battery performance needs to be improved
7	Directed Acyclic Graph Convolutional Neural Network (DAG-CNN) [34]	Handling of the hand-crafted features problem is done. 93% accuracy achieved.	Overfitting model

Table 3. Literature survey on classification algorithm

Sl No.	Technology	Advantages	Disadvantages
1	Discriminative patches, Support Vector Machine (SVM) [35]	Feature extraction takes an average of 27 seconds	While classifying, patch detectors consume the most amount of time
2	Naive Bayes [36]–[38]	Very good learning speed. It is the fastest.	Least amount of accuracy obtained when compared to others
3	k-nearest neighbors (KNN) [37]–[39]	Least learning period, good performance	Highest computational cost, worst tolerance with parity problem
4	SVM [36]–[40]	Highest accuracy, good classification speed, noise tolerant, performance with missing values and non-relevant features	Learning duration is long, worst classification prediction, performance degrades with large datasets

3. PROPOSED SMARTCART METHODOLOGY

mySmartCart is a mobile application idea developed to ease the online shopping experience of a user. The project design prototype implements six modules as shown in Figure 1. The proposed system architectural design comprises various stages like input through user interface, processing followed by pre-processing user input, digital list comprising user shopping cart items, classifier to transform digital list to a smart list followed by search to a suitable e-commerce application displayed to the user.

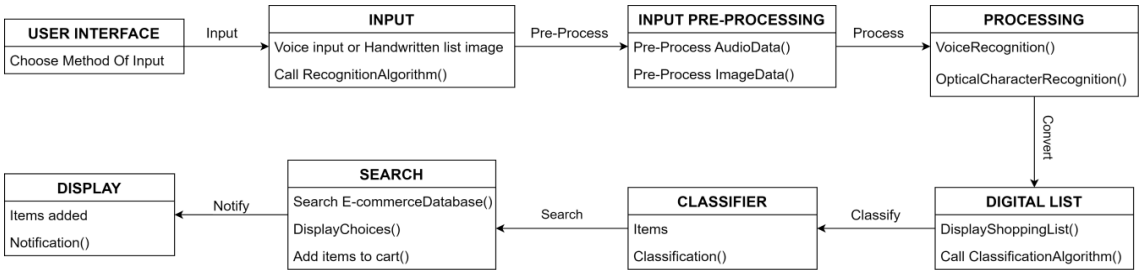

Figure 1. Proposed architecture of mySmartCart

3.1. Input given to the application

The prototype takes in an input shopping list from the user in 2 ways-with voice input or handwritten text that will be uploaded by clicking a picture of the shopping list. This input is sent to the pre-

processing module to improve accuracy of voice recognition and OCR. Voice input is fed through a microphone and the handwritten text or digital list is captured with any camera and uploaded to the application.

3.2. Input pre-processing

Audio input of the shopping list is recorded from the user and converted into spectrograms from which meaningful features are extracted. We then pre-process the data which entails comma separated values (CSV) data loading, label-encoding, feature-scaling, and data segmentation into training and test sets. Pre-processing of image data for OCR includes scaling of image, correcting the skewness of image, binarization and noise removal. The pre-processed data is fed to the processing module.

3.3. Processing of voice/text data

Once pre-processed data is available it is fed to the voice recognition/OCR algorithm to process the input and to identify the items for the digital shopping list. Voice is the most common means of communication. Natural language processing is performed to analyze and find the best fitting word that suits the audio. Some examples of voice recognition APIs are Google Speech API, IBM Watson API, Amazon Speech to Text API, Rev.AI, Siri API. The electronic translation of typed, handwritten, or printed text images into machine-encoded text is known as OCR. Artificial neural networks such as convolutional neural network (CNN), recurrent neural network (RNN), convolutional recurrent neural network (CRNN) and Tesseract OCR, are used for text recognition. Performance analysis of these methods are discussed in section 4.

3.4. Digital list

The items in the shopping list are generated after their identification using the natural language processing module. The list thus obtained is confirmed with the user to facilitate product classification. It enables the creation of a smart shopping list by enriching user experience. The digital list is then fed to the classifier for segregation that enables for smart recommendation of e-commerce sites.

3.5. Classifier

Supervised machine learning technique is adopted to classify the items on the shopping list as grocery or non-grocery items. Machine learning algorithms such as support vector machine classifier, Naive Bayes Classifier, random forest classifier is used for classifying the items in the shopping list. Traditional support vector machine and logistic regression are the two most popular techniques in machine learning for predictive analysis [37].

3.6. Search

Once a digital list is converted to a smart list after classification, the items in the smart list are searched through web scraping in e-commerce applications. ex: Amazon and SnapDeal for non-grocery items; Grofers and BigBasket for grocery items. The product details obtained from the e-commerce sites along with the prices are stored and sent to the display for user shopping choice. The user need not surf multiple websites for information about any product but can get the desired filtered result at one place to make a decision.

3.7. Display

The results of search made for the items in the smart list are made available to the user for review. The user can choose the e-commerce site based on the feedback and price details. Users can remove any item from the smart list if not interested to buy based on search results. Once the items are moved to the cart in the respective e-commerce site they can proceed with the purchase in a normal fashion.

4. RESULTS AND DISCUSSIONS

The findings of our investigation are discussed in this section. The comparison of available Voice Recognition APIs is shown in Table 4. Rev.AI has the highest accuracy, however it only supports 26 languages. Google Speech API has an accuracy rate of 84 percent and is open source.

The comparison results of different handwritten text recognition methods are shown in Table 5. Tesseract OCR, a Google open-source engine has highest recognition accuracy of above 92% and leads in usage due to its free availability. Convolutional recurrent neural network (CRNN), a deep learning model with an accuracy of 88%, comes in second. The comparison of various machine learning classification techniques used for binary text categorization is shown in Table 6. The Naive Bayes and support vector machine algorithms have the highest percentage of correctly identified data. Based on the results obtained,

we adopt the support vector machine due its high efficiency rate in text classification and is suitable for short text classification.

Table 4. Comparative analysis of popular Speech recognition APIs

API	Accuracy	Languages Supported	Price
Google Speech API	84%	125+	$0.036/minute
Amazon STT	73%	30	$0.024/minute
Azure STT	78%	100+	Free and Paid($1/hour)
Rev.AI	86%	26	$0.035/minute
IBM Watson API	77%	13	Free and paid $0.01/minute
Google Cloud API	79%	80	Free and paid $0.024/minute

Table 5. Efficiency comparison of various OCR algorithms

Name of algorithm	Accuracy	Language supported
Tesseract OCR	70.2%-92.9%	100+
OCR with Recurrent Neural Network (RNN)	87	Can train any language
OCR with Convolution Neural Network (CNN)	75	Can train any language
OCR with Convolutional Recurrent Neural Network (CRNN)	88	80+

Table 6. Comparison between various text classification algorithms

Classifier	Time (sec)	Correctly classified (%)	Incorrectly classified (%)	MAE
SVM	0.09	77	23	0.226
Naïve Bayes	0.03	76	24	0.284
Decision table	0.23	72	28	0.341
Random Forest	0.55	74	26	0.26

5. CONCLUSION

In this work, a comparative study of various natural language processing algorithms was carried out to determine the efficacy of them to utilize them in generating smart shopping lists. Among the speech recognition systems, the PLP based approach used by Google is found to be effective. OCR using the LSTM module by Tesseract engine utilizes line finding algorithms enhancing the identification of handwritten text. Classification of the text based on its semantics for smart shopping is found to be best with support vector machine classifiers. It performs better in terms of time complexity and accurate error measure.

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