Client Aware Opportunistic Framework of Rich Mobile Applications in Mobile Cloud Environment

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Abstract

The key objective of this proposed work is to serve the purpose of constructing an efficient information retrieval system in collaboration with Mobile Cloud Computing. The developed system promotes efficient usage of our application for real book detection using Android Operating System with the assistance of Tesseract Optical Character Recognition (OCR) Engine, where all the relevant information is stored and retrieved from the cloud server environment. This phenomenon gives rise to the new paradigm called Mobile Cloud Computing based Real Time Book Detection. The application essentially perceives the title of the book after which the texts on it is automatically detected and identified using Optical Character Recognition (OCR). The main objective of the application is to advocate the users with different necessary features of the book such as ratings, reviews, and opinions along with the associated details like relevant authors and information. The above feature recognition of book is carried out using Clustering and Apriori algorithm which identifies the related data set with various associativity rules, which employs a better platform for users to identify their needs quickly. During this implementation process, the title of the book is captured by the mobile camera, the image is transferred to cloud server platform, where the computations like recognition are done using Tesseract and associativity of the relevant feature is tabulated using the data mining algorithm where it is retained and saved in the server itself. In due course, whenever the user needs the information, it is returned with the necessary details as a separate activity on the mobile screen. This application helps the user based on the context and avoids wasting memory and power in mobile by performing the core computation in the cloud.

Keywords: Mobile Cloud Computing, Android, Optical Character Recognition (OCR), Tesseract, Apriori algorithm

1. Introduction

The growth of smartphones and its market has reached its propaganda with the evolution of tablets and different kinds of smart devices with an internet connection. Moreover we have entered an era where the smart devices and applications play a vital role in this generation. The imaginative ideas prevailed and still prevailing in this world has marked its presence in reality with the progression in the characteristic features of smartphones. Similarly, the headway of mobile applications also increased with is high availability, network access, and portability. The smartphones of this modern age can

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provide all the features what a normal personal computer can provide. Adding to all these applicative advantages, the smartphones are embedded with GPS, processor, powerful graphics card, internal storage, wireless adapters and many other inbuilt drivers, which make the life and jobs easier. Even though, the smartphones are equipped with high-end capabilities, it cannot process data-intensive applications due to its limited storage and power properties. To address this complexity, cloud computing extended it's powerful and applicative properties that made smart devices more popular in the market. Cloud Computing means the users can benefit all the services online through internet. With the available mobile application web interface, the user can access the facilities with internet access, but the computation, as well as the storage, will probably be in a cloud platform. So, whenever the user is need of the facilities, it can be downloaded from the cloud. This paradigm is named as Mobile Cloud Computing (MCC). This has alone become a buzz word for research, for now, a day. The rapid adoption of smartphones, netbooks and tablets and the way consumers interact with these devices in the consumer market is becoming the dominant form of information. These devices are becoming interestingly powerful, with more processing powers storage, and sensing capabilities and network resources as needed via Cloud computing, in which data is processed and stored remotely at large-scale compute and data centers. Thus, the emergence on internet and the advancements in mobile applications and with the boom in the cloud computing platform has led to the new market for mobile cloud applications.

The core objective of the work is to enable the mobile application to captures the title of the book as an image and that would be in turn identified by the Tesseract OCR engine. The Tesseract OCR engine is a mechanical or electronic conversion of the captured image (printed text) into (editable text) understandable [1]. OCR is the extensive field of research in artificial intelligence, pattern recognition, and computer vision. The Optical Character Recognition (OCR) recognizes the text automatically. The OCR acts similar to human which characterizes and displays the identified words. In the current situation OCR engine is widely used in all the IT and core industries, education, research and government agencies for the process of document management. With the development of trends in OCR technology, has widely spread the increased use of handwriting recognition. In addition to that barcode recognition is also used in many retail places which are the qualitative extension of OCR technology. There are many different [2] kinds of OCR namely, Desktop OCR, Server OCR, Web OCR, *etc.,* Several OCR tools are available online for processing the text, among which Tesseract is the free and open source. Tesseract OCR engine provides more accurate results in the identification of the texts. It works with different languages. Initially, the captured color image is converted into gray scale image based on the RGB values [2].

The proposed application makes use of smart phone's rear camera which detects and captures the text of the book title and it is transferred to the cloud storage. At the cloud storage, the computation takes place which processes the following important features of the book like ratings, reviews, and opinions along with the related articles and authors. This paper describes our work with the design and implementation of the book recognition on the cloud computing platform, which provides PC-Cloud-Mobile architecture. And here, we use Cloud Storage and deploy Tesseract on the cloud so that it recognizes the text of the book. Once that text has been identified, further information like ratings, reviews and opinions can be extracted and are visually presented on the phone in real time whenever needed by the user.

The Section II in the paper provides a review of the literature and Section III depicts the data mining Apriori algorithm, which classifies the captured image data set with the proposed architecture and Section IV contains the results and discussions of PC-Cloud-Mobile architecture, Section V exhibits conclusion and future works.

2. Related Work

The existing systems employ the book detection using QR code or using the presence of ISBN on the book cover. These identification methodologies are quite difficult. Moreover, the currently used Tesseract OCR is implemented on a local machine but not on a cloud platform, which uses a lot of resources and latency delay.

M. Bahrami, [3] in his paper explains about the initiation of cloud computing models and services. He also discussed the evolution of Mobile Cloud Computing and its services along with the marketers. This also highpoint the challenges and benefits of the application services elaborately. And the article also primarily focused on the cutting edge research on mobile cloud app design, along with that security and privacy issues are also put forth for better understanding. The below-mentioned paperwork explicitly describes the mobile cloud architecture, standards, challenges and it's application development which was presented by P. A. Kotwal and A. R. Singh [4].

Chirag Patel *et. al.,* [5] in their paper depicts the use of optical character recognition (OCR). The writer briefly modulates about the open OCR engine Tesseract and also transparently shows the comparative study between Tesseract and Transym OCR engines on various parameters.

P. Feng *et. al.,* [6], the presenters in this article presented a detailed study on the implementation of the multi-language card reader on the android platform. The processing involves capture of images using android mobiles and before image processing techniques are applied Tesseract OCR engine is used to identify the text on the image exactly. These applications on more commonly used in the daily stores, health care, *etc.*

In the following write-up, the authors have explored the ISBN code number recognition in android. The authors have proposed an effective algorithm for recognition of ISBN code. This verification process proves to be similar to Tesseract OCR. The authors have presented the working model which can be used in libraries to maximize the usage of e-books [7]. The main drawback is that not all books have QR codes on them. They can be used only on products which have QR codes on them QR codes can be replaced by another identifying mechanism, and then the app will cease to be useful.

There exist solutions that provide book recognition using mobile cloud architecture on the cloud. Many of them have presented a book recognition application on the cloud using mobile cloud architecture and presented an algorithm which minimizes overall response time which has some disadvantages like.

> ➢ Data security applied on whole data which can be trapped in between and decrypt the entire data.
> ➢ Data security is less.

Upon the critical survey, there is no existing model which utilizes all the three components (laptop, cloud and mobile) working with specific algorithms, applications, and initial result.

3. System Architecture

The proposed PC-cloud-mobile architecture can be divided into three subsystems:

> ➢ Initially the title of the book is captured by the smart phone's camera.

> ➢ At next step, the captured image is sent to the cloud storage, where computations such as recognition of text using Tesseract OCR engine, clustering and Apriori algorithm detection is carried out.

> ➢ During third stage, the detection of resulting features like ratings, opinions of the book are displayed on the user's smartphones screen.

For instance, the sample data set is taken as the list of cloud computing books. If the destined users want to know the ratings, reviews, and opinions on the respective book, is

given back to the user with above mentioned three stages of computation processing as depicted in Figure 1, below.
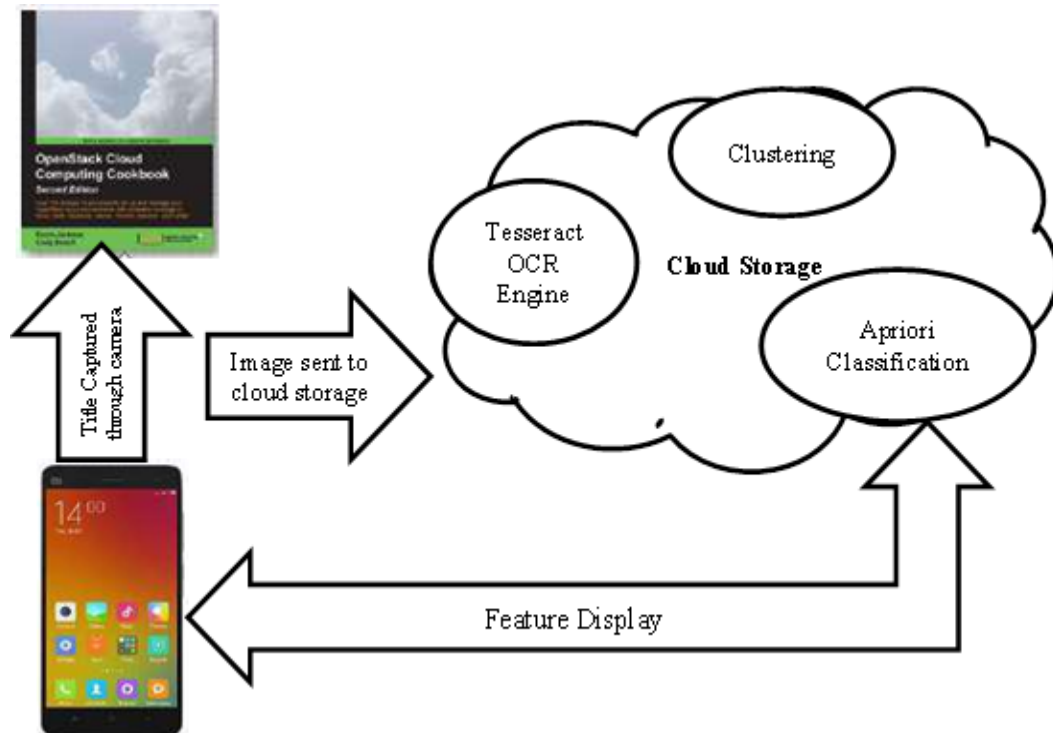

Figure 1. Proposed PC-Mobile-Cloud Architecture

3.1. Computation Process

When the image of the book is captured by the smart phone's camera, the Tesseract OCR engine is checked offline, if not present in the mobile application, it is then transferred to the cloud server for further processing.

With the transfer to a cloud server, the OCR would recognize the text on the image by undergoing the following process. The image is converted into gray scale image (binary image) and then the characters and words are outlined and the respective word is identified in next two passes.

Once the title of the book is recognized, clustering of the data takes place. For example, the data is clustered and segregated according to its domain based on the title, ISBN number, publisher, author, Edition.

After clustering of sample data set, Apriori algorithm is used to find the set of associative rules to give opinions to the users for further retrieval of information.

3.2. Clustering

Clustering may be defined as the process of segregating the similar type of data under the distinctive category. It is a process by which the related objects and dissimilar objects are organized into groups. It is considered as the most applicable unsupervised learning algorithm that structures all the unlabelled data. At this juncture, the below example is explains the clustering technique based on the given data. According to the proposal of this paper, once the title of the book is captured it is sent to the cloud server for clustering and classification. On identification of the title of the book, it is isolated as shown in the below Table 1. The table depicts the Title of the book, its respective domain, Edition, Publisher along with the rating.

Table 1. Dataset after Clustering

S. No.	Title of the book	Domain	Author	Publisher	Rating	Reviews
1	Cloud Computing – From Beginning to end	Cloud Computing	Ray J Rafaels	Create space Independent	****	Good for novices
2	Security, Privacy and Trust in Cloud Systems	Cloud Security	Editors: Surya Nepal, MukaddimPathan	Springer	*****	Good book for beginners
3	Cloud Security and Privacy	Cloud Security	Tim Mather, Subra Kumaraswamy, Shahed Latif	O' Reilly	****	Excellent book for learning security policies
4	Cloud Storage Security	Cloud Security	Aaron Wheeler	Elsevier	*****	Explains in detail in Cloud Storages
5	The Cloud Security Ecosystem Technical, Legal, Business and Management Issues	Cloud Security	Ryan Ko	Syngress	****	Showcases the overall aspects of cloud security

3.3. Apriori Association Rule Classifications

After clustering, of similar data, the next step is to mine the set of data based on the user's perception. Apriori algorithm is first class data mining algorithm to find the frequent data set mining by forming association rules.

From the above-clustered table, based on the users' interest of learning, the books can suggest to the users based on the authors and the content of the book. Based on the user's frequent list of buying, the new users can be suggested with the relevant books of interest.

The association rules can be defined as follows; For instance, let us considers the following transactions.

Step 1: Table of Transaction Items

Transaction ID	Item Nos'
T1	1,2
T2	2,4,6
T3	1,2,6
T4	2,4,5

The transaction id and items are defined below;

1- Cloud Computing – From Beginning to end
2- Security, Privacy and Trust in Cloud Systems
3- Cloud Security and Privacy
4- Cloud Storage Security
5- The Cloud Security Ecosystem Technical, Legal, Business and Management Issues

Step 2: At the end, based the analysis if the,

- If Item – 1, then Item – 2
- If Item – 2, then Item – 4, 6

- If Item – 1, then Item – 2,4
- If Item – 2, then Item – 4, 5

Step 3: At the end of clustering and classification

Once the clustering and association are found, the computation process will be over in the cloud server and the user will be returned with the following information like rating and review of the book along with the frequent mining set of data for the users' easy information retrieval.

3.4 Proposed Algorithm for Book Detection System using Mobile Cloud Architecture

The above clustering and association classification is used for retrieval of information in an easier way. The algorithm defines the proposed system architecture procedure that transfers the captured image to the server where it is converted into editable text and entered into the clustered table from where associative hypothesis is arrived at for providing easy perception and analysis to the user by providing rating and opinion about the book along with the frequent set of books bought by other customers in series.
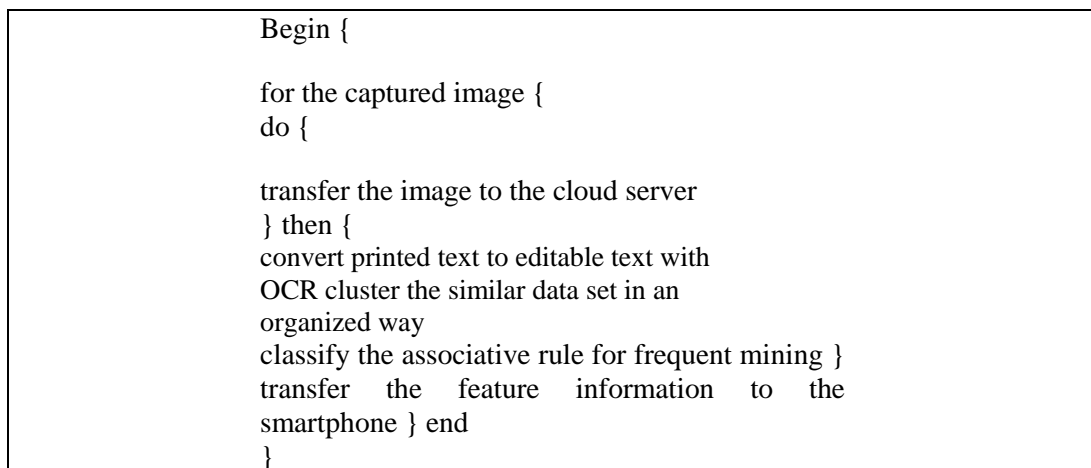
```
Begin {

for the captured image {
do {

transfer the image to the cloud server
} then {
convert printed text to editable text with
OCR cluster the similar data set in an
organized way
classify the associative rule for frequent mining }
transfer the feature information to the
smartphone } end
}
```

Figure 2. Proposed PC-Mobile-Cloud Algorithm

4. Results and Discussions

The following section shows the results and discussions on the server offloading of the image into the server.

Step 1 – Client Side

Initially at the client side, the user can upload the image from the mobile gallery which will be sent to the server.
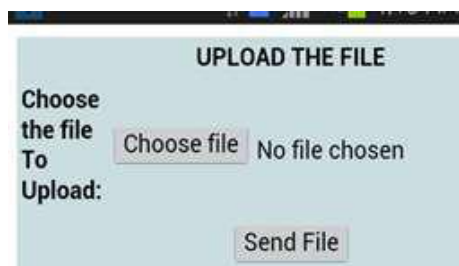

Figure 3. File Upload from Mobile to Server

Step 2 – Server Side

At the server side, the received image is given to the Tesseract OCR engine for converting the printed text into editable one.

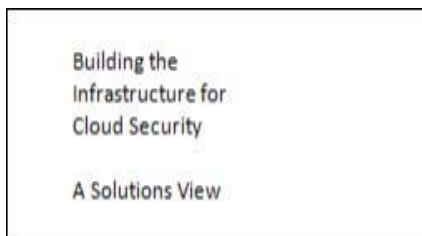**Figure 4. Tesseract OCR Engine–Captured Image (Printed Text)**

Figure 5. Tesseract OCR Engine–Converted Image (Editable Text) (DOC File)

Step 3 – Client Side

After conversion, the Book Detection System displays the user with, the name of the book, its author, rating, reviews and further suggestion for reading. The below figure 6 shows the sample detection for a book.
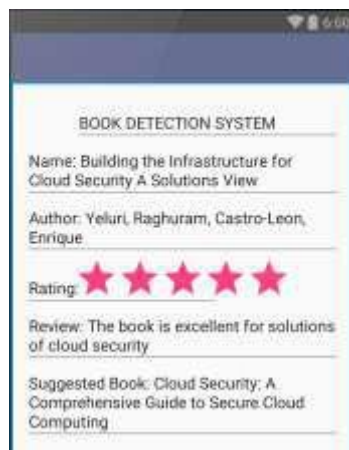

Figure 6. Book Detection with Rating, Review Suggestions

5. Conclusion and Future Work

We have deployed the OCR engine, Tesseract on cloud server which would greatly reduce the resource load on the smartphone because the computation takes place in the cloud. Implementation of the anticipated future of smartphones by interacting with the

daily used objects supports the tedious process of computation offline. We're also checking the local machines in proximity to check if Tesseract exists. This means that we can detect the text offline and the processing of the text can be done at a later stage. This concept can be applied in a variety of situations like movie posters to determine the movie's ratings and reviews and details, medicines to detect the use of the drug and how it can be diagnosed *etc.,* In future, more sophisticated synchronization algorithms which permitted cloud to cloud communication has to be extended rather than multiple communication links. And also develop 3D book recognition on mobile-laptop-cloud architecture.

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