Employing Green Mobile Cloud Computing to Reduce Mobile Phone Storage and CPU Consumption

Laura Hussein Ali[a] **,Dr. Karim Q. Hussein**[b]

[a]Computer Sciences Department,Iraqi Commission for Computer and Informatics Informatics Institute for Postgraduate Studies, Baghdad , Iraq.laura.hussein978@gmail.com, ms201930539@iips.icci.edu.iq

[b]Assist. Prof. /Computer Science Dept./Faculty of Science/ Mustansiryha University / Baghdad, Iraq . Karimzzm@yahoo.com , karim.q.h@uomustansiriyha.edu.iq

Abstract: The rapid development of modern technology produces large amounts of data that need large storage capacities and high processing, such as video, high-resolution images and other types of data. Previously, mobile devices were simple and had limited capabilities, but nowadays many mobile devices have appeared that have many advantages and capabilities, but at the same time these devices need some support from certain tools, and one of the most prominent of these tools or technologies is cloud computing. Green computing can be achieved through virtualization technology and server integration, proper load balancing between resources, storage power management, CPU power consumption management, power management of network resources, especially in mobile devices, etc... In this paper, we perform compression processes of the data (image, video, text) inside the cloud and then sent it to the mobile phone, and the results showed the speed in data transfer and speed in data processing while saving a lot of battery power and memory storage capacity.

Keywords: Mobile, Green Cloud, Data Compression, Offloading

1. Introduction

Nowadays, mobile devices can support video formats with insufficient resolution. Thus, encoding technology is needed to convert videos to a specific format (such as mp4) that is suitable for playback on mobile devices, along with lowering the resolution to match the screen size of various mobile devices. However, this transcoding process needs extensive computations that can consume the battery life of mobile devices. Therefore, mobile devices are increasingly demanding a new computing model for consuming video content. Due to the flexibility of cloud computing to its resource allocation, it provides a natural way to accomplish transcoding tasks, bridging the hiatus among online videos and mobile devices. Alternatively of transcoding a video locally, mobile users can upload the video to the cloud for conversion via base stations or WiFi access points, which is referred to as account offload. By offloading the account to the cloud, significant power consumption can be saved on resource forced mobile devices, allowing mobile devices to run rich media applications(Zhang, Wen, and Chen 2014).

2. Related Works

The authors presented a portable cloud system in energy saving in offload for TaaS in the system. The goal is to decrease power waste for encode operation on mobile phone and service engines in the cloud while obtaining small latency. For the mobile phone, researchers were prepared to formulate an offload policy as a delay obliged optimization obstacle. Operation area in which the

running mode, so mobile implementation or cloud implementation, is the greatest energy efficient for a mobile phone. An online algorithm has been introduced for transmitting transcoding jobs to cloud service engines, which can decrease power waste while gaining queue balance. The proposed algorithm betters a group of algorithms, with a smaller average power loss time and queue length(Zhang, Wen, and Chen 2014).

This research concentrates on power improvement in network simulations for mobile phone. A review of power consumption on mobile phone highlighted processor and communication hardware usage as the main interest, but other reasons such as user characteristics and storage usage need be viewed, as MCC is a key portion in this. It has been explained that energy optimization is desirable to some area through the use of SDN based improvements. The requirement for network emulators to contain a broad scope of devices was further highlighted by a short offering of the MCC. Since this technology is so broadly applied, simulators focused on mobile phone assess any condition of networks from a larger point of representation for their complicated cooperation(Benkhelifa et al. 2016).

The researchers proposed a new network device called (Femto-let) for the 5G mobile network to produce connection and calculate offload services concurrently at lowering power and latency. The characteristics of two different devices, a femtocell base station and a cloudlet are merged into a single network device called (Femto-let) to present femtocell services besides with little power and latency cloud environment. The structure and moulding principle of the proposed (Femto-let) device is explained with the power waste and latency model. Numerical analyzes explain that by using (Femto-let) alternately of femtocell plus and cloudlet, energy consumption could be decreased by nearly 17% and 11%, respectively. Numerical analyzes also prove that the proposed (Femto-let) device can decrease latency by nearly 20% and 13% of femtocell plus and cloudlet structure(Mukherjee and De 2016).

3. Green Cloud Computing

Green computing is the environment friend of using computers and their resources. In more general words, it is also described as the subject of the design, manufacture or engineering, using computer devices in a way that reduces their impact on the environment. Many IT producers are continually advancing in producing energy efficient computing devices, which does not consume the resources of the systems. Green computing is also identified as green information technology. The goal of green computing is to reach economic utility and enhance the way computing devices are employed(Harjani and Gopalan 2013).

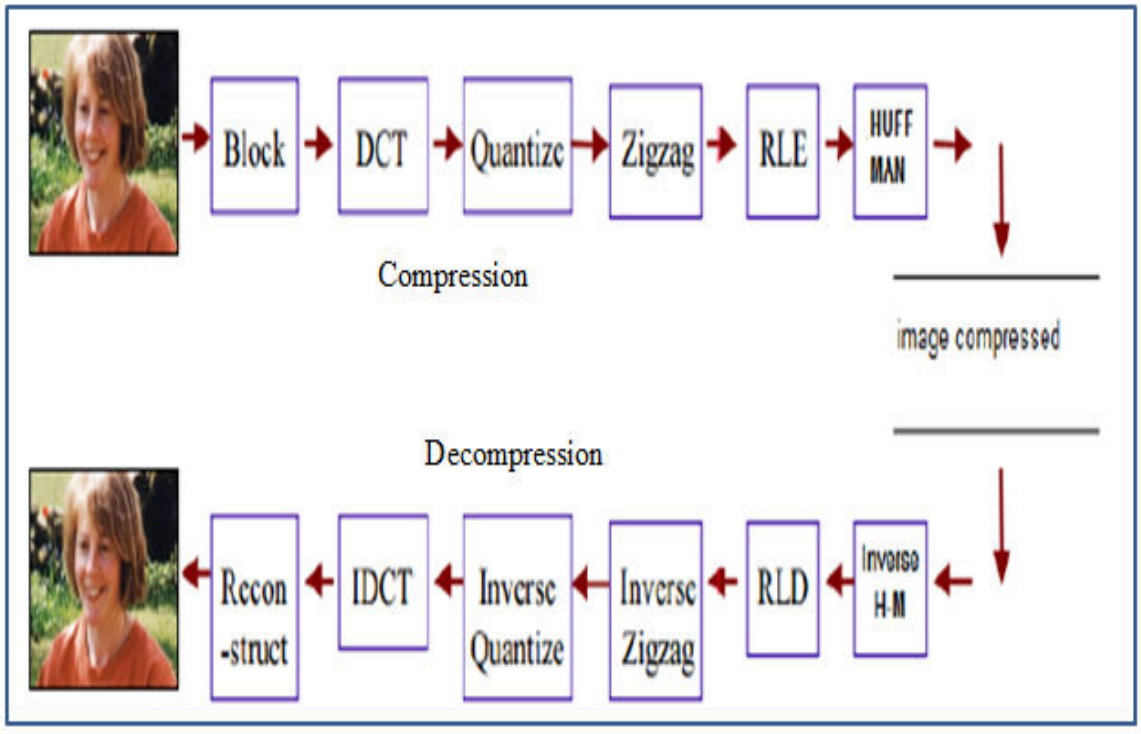
4. Insomnia Application

Insomnia is a free, platform desktop application that communicates with and creates HTTP based APIs. Insomnia merges an easy to use interface with advanced functions such as authentication assistants, code creation, and environment variables. Insomnia is available on Mac, Windows, and Linux and can be downloaded from the website. A famous Insomnia HTTP client can be generated to send requests. Insomniac can assign requests for any API. Most APIs need client credentials for the account and an interface (registration data and account creation). To start with the Insomnia application. The new workspace created, and then a new folder is created. Replace the public request URL with the URL of the work(Cipijali n.d.; The API Design Platform and API Client - Insomnia n.d.).

5. **SQLite Database**
   SQLite is an open source software library that executes a light-weight Structured Query Language (SQL) database engine for embedded use and it is suitable for Android system. SQLite light-weight design doesn't need a separate server and this provides for fast use of saved data by reading and writing quickly to the disk file(Bhosale, Patil, and Patil 2015).
6. **Image Compression**

The Joint Photographic Experts Group (JEGP) was developed and planted the first universal image compression measure. The picking operation was chosen based on an experience evaluation of image quality. Three working collections of information were created to polish them and a second, stricter selection process exhibited that the most useful in the 8x8 DCT provided the most suitable image quality. Image compression addresses the issue of decreasing the quantity of data wanted to describe a digital image. The goal is to produce a compressed format of an image, thus decreasing the requirements for image storage or transmission. Image compression techniques decrease the number of bits needed to represent an image by the benefit of this redundancy. A reverse process called decompression is implemented to the compressed data to reach the original image. The goal of compression is to decrease the number of bits as much as possible while keeping the resolution and visual quality of the reconstructed image as close as possible to the original image. Image compression systems consist of two distinct structural blocks: an encoder and a decoder(Jaffar Iqbal Barbhuiya, Laskar, and Hemachandran 2014).

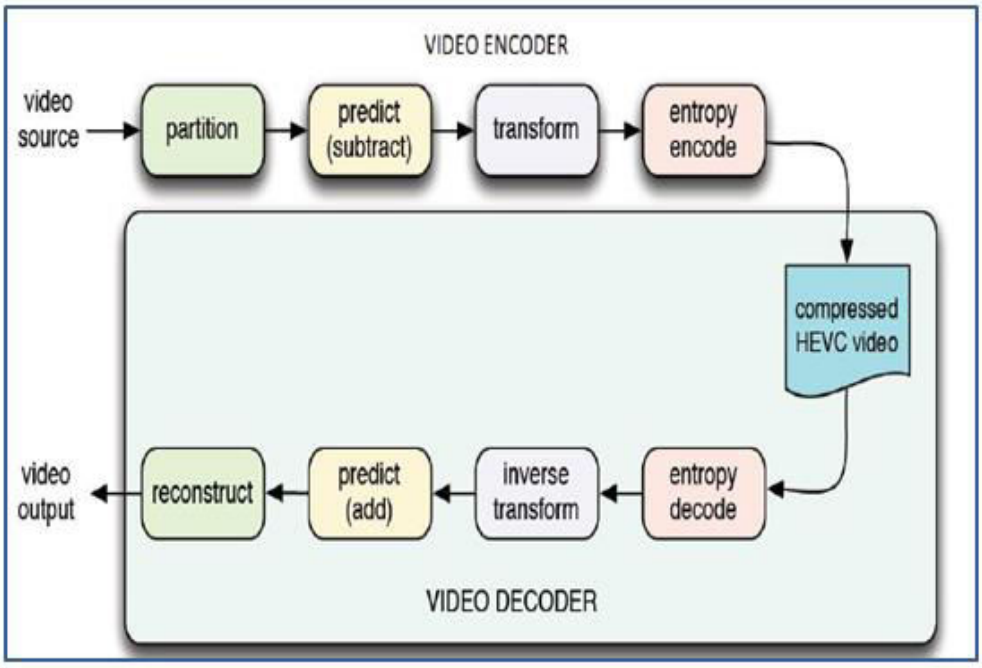
Figure.1 JPEG Image Compression and Decompression Algorithm.



7. Video Compression

HEVC also called (H.265) is one of the video coding standards of the ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group. The main goal of HEVC standardization purposes is to enable notably enhanced compression performance comparative to current standards in the range of 50% bitrate reduction for video quality(Sullivan et al. 2012).

Figuer.2 shows block diagram of H.265 encoder and decoder.



8. Android Platform

The Android system was released and developed by Google, it is still developing until now. The Android platform is one of the Linux systems and it is open source, it is supported with Java, where it is possible to create multiple kinds of applications using Android. Google refers to the Android system as a software stack for mobile device, and this software stack consists of the operating system (the system responsible for everything), middleware (system specific software), and applications(Engineering 2019).

9. Prototype Implementation

The main purpose of this paper is to build a model realize the concept of green cloud computing and capable of reducing the burden on the mobile phone in terms of data processing in the cloud and reducing the drainage of battery consumption and memory size. We divide the system in to four phases as follow:

Phase 1 : Input Data to the Server

As a first step, the Insomnia application was used to enter data into the system by uploading it from inside the computer, and from this data are images of archaeological locations inside Iraq, in addition to video clips that review the archaeological sites. When uploading an image within the

application from the file tab, this image is given a specific name, and its section is determined according to civilization, such as, Babylonian or Sumerian. There is also an option in which the data can be specified as green or not green, and the goal is to obtain the difference between the data sizes in case they are green or not green.

Phase 2 : Data Processing

This phase shows the processing step that is compressing the data to reduce the size of the memory consumed in addition to reducing the battery drain, as the data processing step consumes the battery power, as well as the large size of the data, needs large storage space, and for these reasons, the images were compressed using Joint Photographic Experts Group (JPEG), After being entered by the insomnia application, it is sent to the remote cloud server, where the insomnia application is linked to the server through spring boot. In the case of the video, the High Efficiency Video Coding (HEVC) also known as H265 method was used to compress the size of the video, where the video is uploaded to the insomnia application, and the application, in turn, sends the video to the cloud server, where the video is compressed, and then it is returned to the insomnia application.

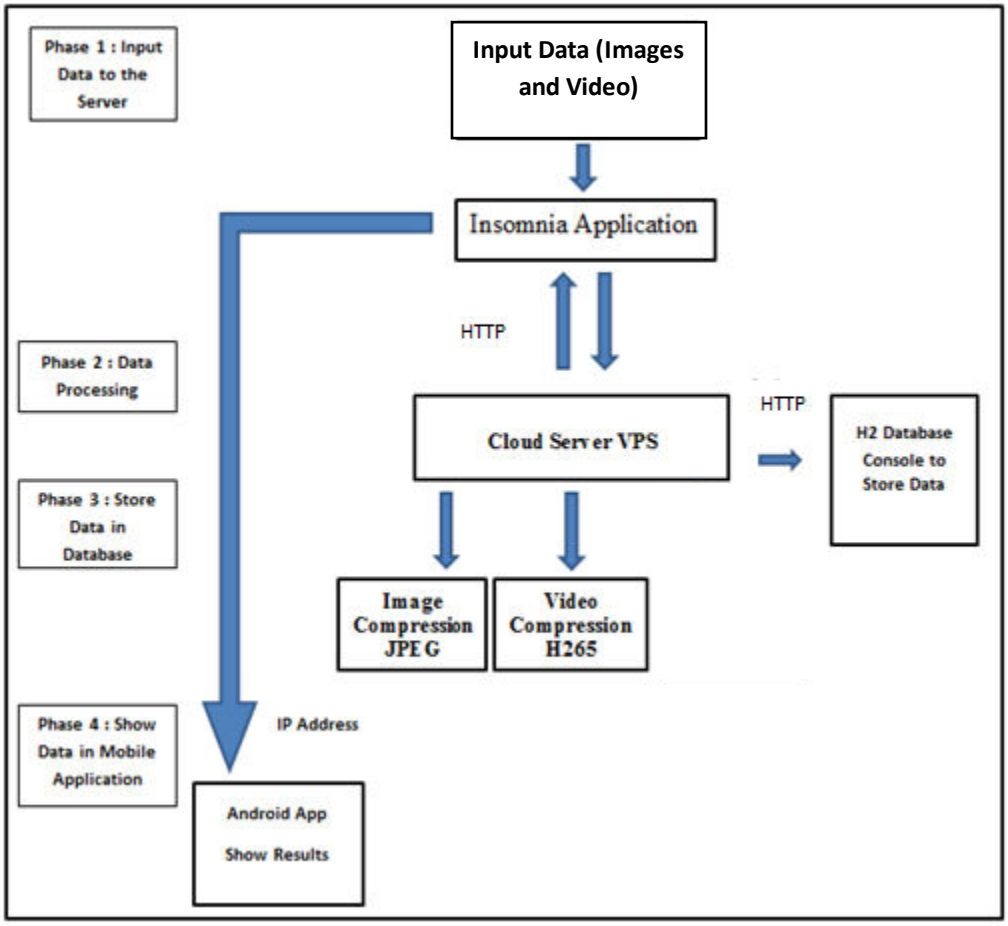
Phase 3 : Store Data in Database

After the process of compressing the data inside the cloud server, the data is stored in a relational database, which is the H2 database, where this database contains eight fields it is as follows ID, ENTRY_TYPE, IS_GREEN, NAME, PATH, SIZE_AFTER, SIZE_BEFORE, UUID. The database was connected to the cloud server using spring boot, and the purpose of the database is to store data after it is compressed into the cloud server and keep a copy of the data.

Phase 4 : Show Data in Mobile Application

The last step of the system is to display all of the images and video the mobile application, after the data has been compressed, it is sent to the phone via the IP address of the cloud server located inside the application. The images are reviewed in a special interface for pictures, as is the case for the video, as the application contains a set of interfaces, and each interface is concerned with a specific civilization.

Figure.3 shows general architecture of the proposed system.



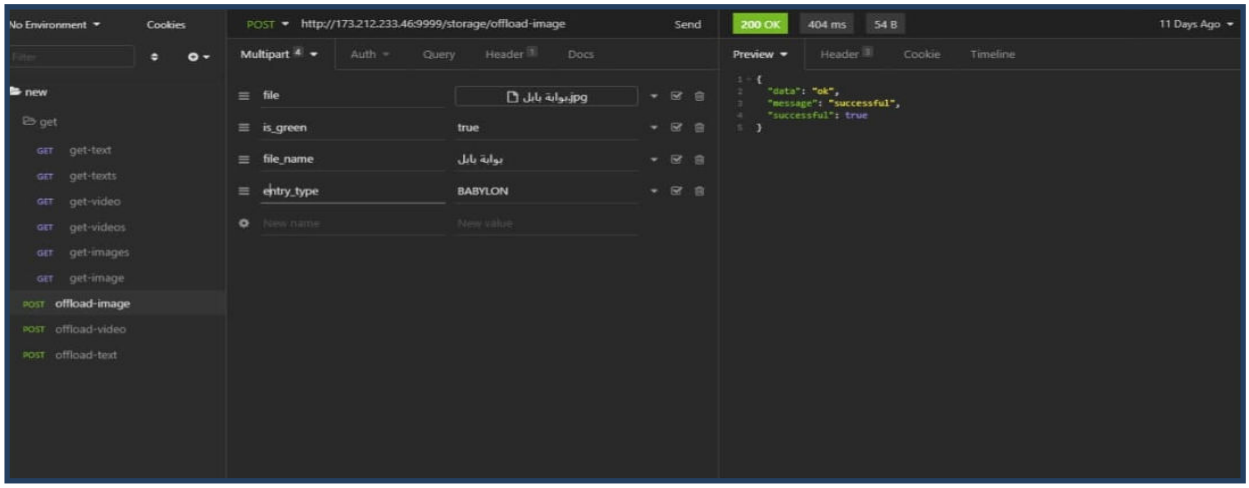
10. Results and Discussion

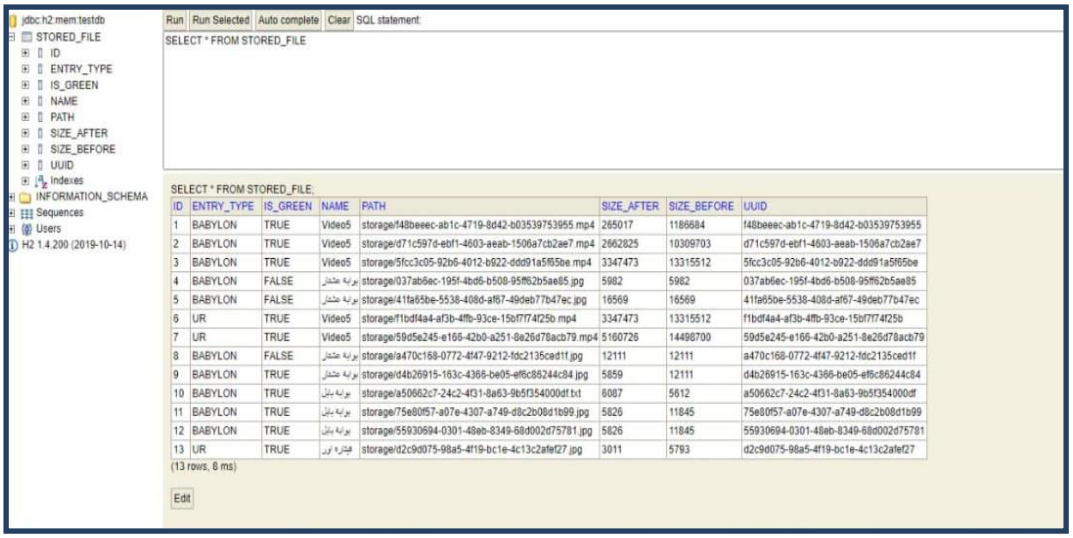
In this section, the results of the proposed system will be presented and discussed, The concept of green mobile cloud computing will be implemented by sending data to the cloud server for data processing such as image compression using JPEG and video compression using H265, where the data is entered through the Insomnia application and is processed by the cloud server and then sent to the application in a mobile phone. The offloading process is accomplished by making complex processing operations outside the application, which helps to reduce CPU and memory consumption in the phone.

Filling data fields through which data such as images and video are entered, there are four fields for data, namely:

- The file, through which a file is attached from inside the computer.
- Is green, if the choice is true, the data will be compressed and stored in the database, but if the choice is false, the data will not be compressed and stored directly in the database.
- Filename, the names of the entered data are written, such as the name of the image.
- The entry type, in this field, is determined to which civilization the data belongs, such as, Babylon.

Figure.4 shows Insomnia application and data entry.





This table contains eight fields as follows:

- The ID field: It is for numbering only.
- Entry type field: It indicates which civilization the data belongs to.
- Is green field: It determines whether the data is compressed or not. If the choice is true, then this means that the data is compressed, but if the choice is false, then this means that the data is not compressed.
- Name field: contains the names of the entered data.
- Path field: it contains the data path and determines whether it is image, or video, according to the extension.
- The size after field: determines the size of the data after compression.
- The size before field: determines the size of the data before compression.

- UUID field: This field is a random variable of data, and it is used in the case of sending specific data.

After the data is processed inside the cloud server, the data is sent to the application in the mobile phone via the IP address of the cloud server, which is located inside the application to display the results.
Figure.6 Android Application Interfaces.

Table.1. shows the difference between the sizes in bytes of a group of images before and after the compression process. As it appeared, the average compression ratio was approximately 54.44. This means obtaining a good compression ratio while maintaining the image quality. Taking into account the resolution of the image, this means that the compression ratio changes if the image resolution varies.

Table.1. The difference between image size in bytes before and after compression

Image Name	Size Before	Size After	Difference	Compression Ratio
اسد بابل	5982	3531	2451	59.02 %
بوابة عشتار	16569	8524	8045	51.44 %
زقورة اور الاقدم بالتاريخ	9259	4871	4388	52.6 %
اور	6984	3823	3161	54.73 %

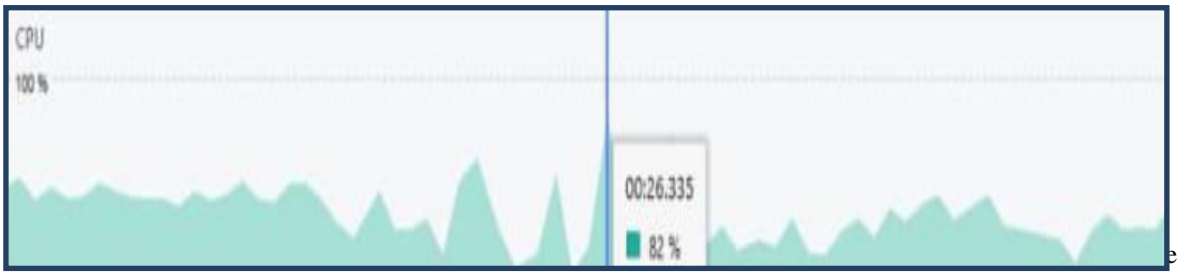
Table 2 shows the difference between the sizes in bytes of a group of videos before and after the compression process. As it appeared, the average compression ratio was approximately 40.43. This means obtaining a good compression ratio while maintaining the video quality. Taking into account the resolution of the video, this means that the compression ratio changes if the video resolution varies.

Table.2. The difference between video size in bytes before and after compression

Video Name	Size Before	Size After	Difference	Compression Ratio
دهاليز بابل	1186684	265017	921667	22.33 %
لماذا سميت بابل	1909798	482404	1427394	25.25 %
تقرير عن زقورة اور في محافظة ذي قار	370897	273364	97533	73.7 %

Android Studio provides the ability to measure the use of resources, by implementing the application using a profile, where it is possible to read the percentage of CPU consumption at every click of a button or perform specific processing within the application.

Figure.7 shows the percentage of CPU consumption when an image is sent by the cloud server and the image is received by the application.



application, the percentage was rose to 82% only. After that, the percentage decreased because there was no other processing process. This means that the CPU consumption time is very little compared to the applications in which the data processing operations occur inside the application.

11. Conclusion

In this paper, the proposed system has been built to achieve the goal of mobile green cloud computing, whereby data volume is reduced, the processor's burden is reduced and reduces memory usage. The android platform provides a set of tools that can enable the application to present a system capable of using the system resources well. The Android operating system works in low cost devices with open source projects. The application is compatible with different types of android devices that support the Android system. A virtual private server was used to offload processing operations outside the application. SQLite database was used to store the compressed data. Achieve the goal of mobile green cloud computing by compressing data such as image compression with JPEG and video compression with H.265. In addition to the speed of data transmission over the network and the economy in the use of the mobile phone battery, this is done because the processing is carried out inside the cloud.

12. Future Work

In future work, we suggest improving the compression ratio by using modern algorithms and methods and reducing the energy consumption in the cloud and expanding in a green cloud computing concept.

Acknowledgment

The Authors would like to express their acknowledgment to the Computer Science Department / Iraqi Commission for Computer and Informatics Informatics Institute for Postgraduate Studies for the encouragement and support to perform the current research and hoping to carry out more next related researches**.**

References

Benkhelifa, Elhadj et al. 2016. "Energy Optimisation for Mobile Device Power Consumption: A Survey and a Unified View of Modelling for a Comprehensive Network Simulation." *Mobile Networks and Applications* 21(4): 575–88. http://dx.doi.org/10.1007/s11036-016-0756-y.

Bhosale, S T, Tejaswini Patil, and Pooja Patil. 2015. "SQLite: Light Database System." *International Journal of Computer Science and Mobile Computing* 44(4): 882–85.

Cipijali, Yevelugira. *Insomnia Rest Client*.

Engineering, Innovative. 2019. "Survey on Android Application." 5(12): 816–21.

Harjani, Monica B, and Samir M Gopalan. 2013. "Comparative Study between Green Cloud Computing and Mobile Cloud Computing." 3(3): 1–4.

Jaffar Iqbal Barbhuiya, A. H.M., Tahera Akhtar Laskar, and K. Hemachandran. 2014. "An Approach for Color Image Compression of JPEG and PNG Images Using DCT and DWT." *Proceedings - 2014 6th International Conference on Computational Intelligence and Communication Networks, CICN 2014*: 129–33.

Mukherjee, Anwesha, and Debashis De. 2016. "Femtolet: A Novel Fifth Generation Network Device for Green Mobile Cloud Computing." *Simulation Modelling Practice and Theory* 62: 68–87.

Sullivan, Gary J., Jens Rainer Ohm, Woo Jin Han, and Thomas Wiegand. 2012. "Overview of the High Efficiency Video Coding (HEVC) Standard." *IEEE Transactions on Circuits and Systems for Video Technology* 22(12): 1649–68.

"The API Design Platform and API Client - Insomnia." https://insomnia.rest/ (May 17, 2021).

Zhang, Weiwen, Yonggang Wen, and Hsiao Hwa Chen. 2014. "Toward Transcoding as a Service: Energy-Efficient Offloading Policy for Green Mobile Cloud." *IEEE Network* 28(6): 67–73.