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Mobile Intelligent Web Pre-fetching Scheme for Cloud Computing Services in Industrial Revolution 4.0

Nur Syahela Hussien[1], Abdulaziz Aborujilah[2], Sarina Sulaiman[3]
[1,2]*Malaysian Institute of Information Technology, University Kuala Lumpur, 1016 Jalan Sultan Ismail, 50200 Kuala Lumpur, Malaysia.*
syahela@unikl.edu.my, abdulazizsaleh@unikl.edu.my
[3]*School of Computing, Faculty of Engineering, Universiti Teknologi Malaysia 81310 UTM Johor Bahru Johor Malaysia*
sarina@utm.edu.my

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Abstract

Currently the Mobile Cloud Computing (MCC) rapidly development and being important as the amount of consumers retrieving information continues to grow over time. Every day when customers request the information, large data storage must serve large volume data operations. Therefore, to fix the inadequate information storage encountered by some suppliers, intelligent techniques are need. In addition, the worldwide industry has altered in many areas in recent years owing to excellent technological advances. The Industry 4.0 concept has developed in this modern period and afterward has been embraced and examined by both; scholarly and professionals in numerous other progressed nations. Hence, an enhancement Mobile Intelligent Web Pre-fetching Scheme was proposed to offer a management of cloud data storage for users to readily access the information with quickness wherever to prevent the amount of response time during user access the information. This paper examines the challenges of Cloud Computing (CC) innovation in industry 4.0. The intelligent web pre-fetching technique is utilize to upgrade the execution of Cloud Computing (CC) when taking care of information get to by clients. An improvement of the MCC scheme is propose to bolster information administration to provide proficient and viable execution of MCC services for industry 4.0.

Keywords*: Mobile Cloud Computing, industry 4.0, intelligent method, Web Pre-fetching*

1. INTRODUCTION

The technology of Cloud Computing (CC) is the perfect information storage resource for industrial 4.0 and CC interconnectivity proliferation and study enables businesses in all sectors to adapt to today's quickly evolving technology.CC was a way for companies with the Artificial Intelligence (AI) and automation was more commonly incorporated into sector to alter quickly with the times without losing

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information. CC has infinite storage capacities, hence the more data it acquires, the higher the need for better organisation to make it accessible and actionable. Returns were seen quicker and more commonly with that, some principles may come to identify smart manufacturing systems for the introduction and growth of Industry 4.0. They are capability for real-time operation, which is the acquisition and conversion of data in an instant, enabling real-time solutions. It also suggests the presence of a virtual copy of the smart factories. Enabling remote surveillance and process tracking through site-wide scattered sensors.

In addition, cloud 4.0 is a resolution that extents various physical areas of the globe, allowing customers to deploy capabilities worldwide, optimizing reach without compromising efficiency. In addition to deploying and optimizing cross-regional cloud applications, Cloud 4.0 is also able to meet the compliance, governance and regulatory demands of different industries. The present CC service has constraints and difficulties, including the latency that still exists during customer access to the CC. Therefore, performance management of CC services is slowing down. In dealing with this problem, the improvement system called the Mobile Intelligent Web Pre-fetching Cloud Storage (MOBICS) scheme was suggested in this studies.

2. CHALLENGES IN CLOUD COMPUTING INDUSTRY 4.0

Industry 4.0, as the inclusion of the Internet of Things (IoT), CC, sophisticated information processing as well as other technological developments into the core of production and production systems. Industry 4.0 uses CC to take procedures that both individuals and machines usually manage internally and transfer them into the cloud where they can be managed from anywhere in the globe. With developments being made in all these fields of digital technology, Industry 4.0 integration should be somewhat smoother than the current truth. A main challenge here is to enable all this new equipment to be registered and connected to the software needed for seamless integration.

In particular, there is a lack of presently handy tools, which would enable for extra simplified integration of hardware into the software program environment that covers unique manufacturers as well as extraordinary technologies. Open-source software solutions can assist to overcome this obstacle, but there is also an obstacle in many instances due to an absence of standardization in the industry and an absence of understanding about what is accessible.

Organizations often pursue a particular path or switch to a current provider with a control philosophy that they have used historically, resulting in being "locked in" in a manner that can restrict their access or mentality to alternative alternatives in the Industry 4.0 environment.

3. PROPOSE CLOUD COMPUTING SCHEME

The proposed MOBICS aims to make it possible for mobile users to access various Cloud Storage Services (CSS) anytime and anywhere. Industry 4.0 is an abstract and complicated word that consists of many parts when examining our society carefully and the present digital trends. Some of the components that contributing digital technologies including mmobile devices, IoT platforms, big data analytics and advanced algorithms and CC. To access their information file even more quickly on big data using MOBICS as it predicts the information demanded by potential consumers using pre-fetching method. In addition, MOBICS recommends that information be stored in CSS based on accessibility and most regular access.

Figure 1depict the proposed scheme of MOBICS, which consisting of two schemes. Based on the scheme 1 as shown in Figure 1, the data was extracted from three types of log data comprising the UTM blog, IrCache and Proxy Cloud Storage. Then, data was pre-processed by removal of irrelevant information from the present data set. Pre-processing is important before applying classification on the extracted data. The data was analysed based on five different Machine Learning (ML), which are J48, RT, NB, RS and RDT. One of the research objectives is to determine the ML technique, which has provided the highest accuracy of prediction. The accuracy of prediction is gain by calculate the number of corrected data divided by total data and multiple with 100 as shown in Eq. (1).

$$\text{Accuracy} = \frac{\text{Number of correct data}}{\text{Total data}} \text{x} \quad 100\%. \quad (1)$$

The dotted line as in Figure 1 illustrated that MOBICS provides four ways of pre-fetching, the first is pre-fetch for the most visited cloud storage that allows user to access or store data based on the most frequently accessed. The second is pre-fetch based on the status of ranking for the cloud storage available. MOBICS recommends the suitable cloud storage service with bigger size available for users to store data. The third pre-fetch is by pre-fetching the cloud storage service available and the most frequent data accessed on each of CSS. The fourth is users can access their information folder more quickly use the proposed MOBICS as it forecasts the information required by upcoming use based on the rules of the decision tree (J48). The outcome comes out in a list by displaying the greatest likelihood of user accessing information in the future.

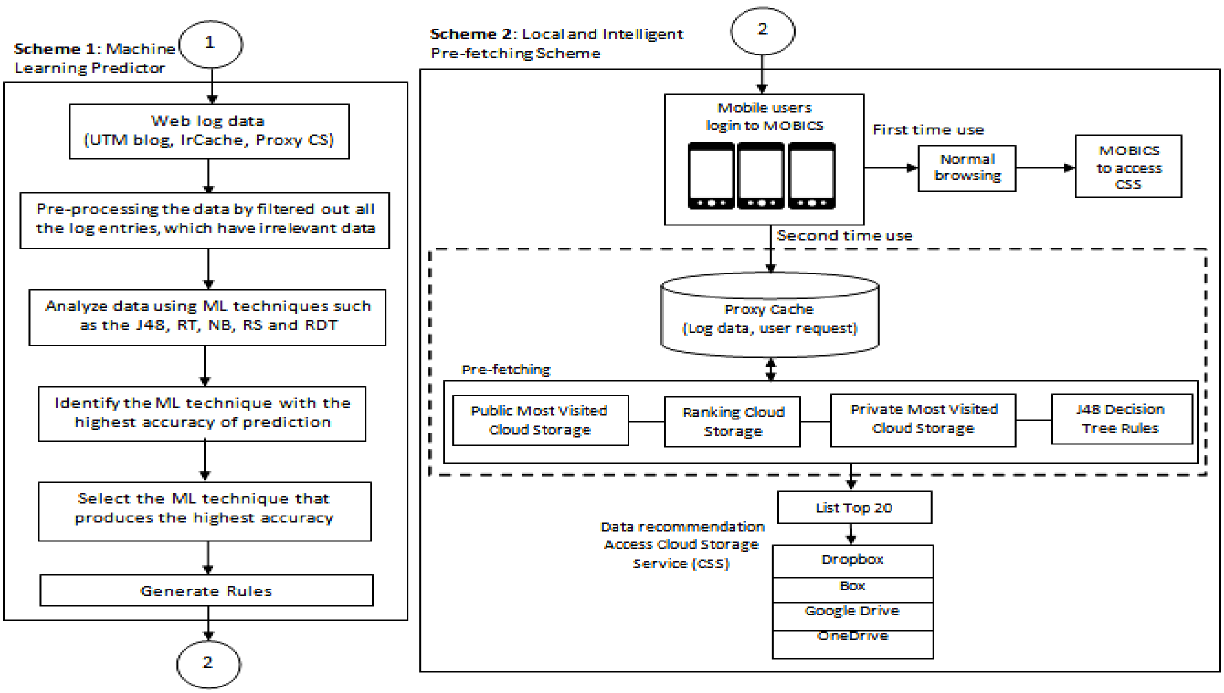

Figure 1. Proposed Scheme of MOBICS

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The equations for the four ways of pre-fetching are depicted in Eq. (2) until Eq. (5):

Public most visited cloud storage, $P = t_i+1$ (2)

Ranking cloud storage, $R = Sort_{max}(t_i+1)$ (3)

Private Most visited cloud storage, $Pr= Cloud .Sort_{max}(t_i+1)$ (4)

J48 DT rules, $J48 = J48(), S_i>1,94$ && $h_{i>}2$ (5)

The result is more accurate compared to the result based on pre-fetching only as the first way of pre-fetching. This is difference from previous work, which is the previous work, only provide pre-fetching method to predict on future request by users. However, in the proposed scheme, the pre-fetching provide four ways to pre-fetch the data to provide accurate data request from user based on different requirement. The most common CSS are Dropbox, Box, OneDrive and Google Drive. Those CSS are in the top 10 ranking famous CSS usage. Top 10 is used because the amount is appropriate to for measurement and it is commonly used by other research (Wang and Chen, 2014). Based on the scheme, a user accesses CSS by the pre-fetching technique that decreases the loading time through the speeding of access time. The J48 of decision tree result is used to make it easier for the user to directly access the most regularly viewed page, therefore it increase the speed of access time. J48 algorithm predicts Web objects more accurately based on generated rules of the process. The scheme use the database that doings as storage data by gathering the previous pre-fetch data and keeping it in database. When the data was request by user, MOBICS fetched the data based on database to quickness the access time. The scheme was proposed and implemented in real MOBICS application. The MOBICS system has proved that the scheme enhances the local pre-fetching MOBICS.

4. ANALYSIS MOBICS SCHEME PERFORMANCE

To measure the scalability of MOBICS scheme an experiment was collected based on respondents on the questionnaires. Only 15 users were selected from 69 respondents to test the scalability of MOBICS. Latency per page ratio used as benchmark in this experimental result. The equation of latency per web page ratio is the ratio of the latency that pre-fetching achieves to the latency with no pre-fetching. The latency per web page is calculate by using evaluating the time between the browser initiation of an HTML page GET and the browser reception of the remaining byte of the ultimate embedded picture or object for that page.This metric represents the benefit perceived by the user, which will be better if it is low as its value (Domènech *et al*., 2007).

Table 1 depicts the latency per page ratio that was calculated to evaluate the latency on MCS. The results show the latency was even lower at high data level. The latency page ratio at data level 5 was 0.45 which was the smallest compared with latency per page ratio at data level 1 which was 0.74. Therefore, using pre-fetching was effective in handling a big data management commonly for multiple MCS. Figure 2 illustrates clearly the reduction latency of MOBICS among 15 respondents. From the graph,it can be seen clearly that the latency per page ratio was still low even at high data level (data level 5). It can be concluded that using MOBICS reduced the latency on MCS.

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Table 1: Latency per page ratio on different data levels for 15 respondents

	Latency per page ratio				
	Data 1	**Data 2**	**Data 3**	**Data 4**	**Dat a 5**
1	0.41	0.67	0.81	0.81	0.45
2	0.62	0.70	0.65	0.88	0.43
3	0.94	0.60	0.60	0.81	0.46
4	0.50	0.50	0.65	0.74	0.42
5	1.00	0.73	0.74	0.72	0.41
6	0.63	0.65	0.50	0.73	0.43
7	0.53	0.48	0.32	0.63	0.47
8	1.36	0.63	0.48	0.68	0.44
9	0.76	0.72	0.50	0.70	0.50
10	1.00	0.59	0.68	0.82	0.47
11	0.89	0.86	0.56	0.71	0.45
12	0.65	0.62	0.45	0.62	0.46
13	0.73	0.52	0.42	0.64	0.43
14	0.67	0.81	0.54	0.63	0.47
15	0.46	0.64	0.63	0.60	0.50
Average	**0.74**	**0.65**	**0.57**	**0.71**	**0.45**

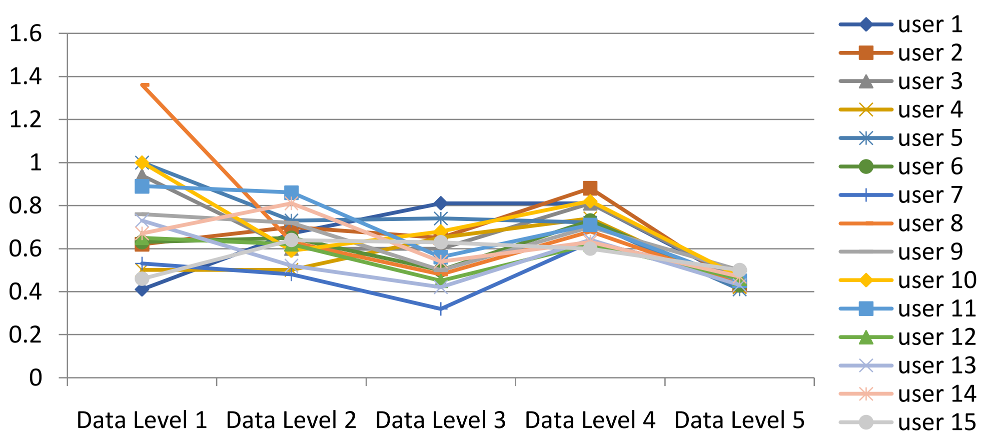

Figure 2: Latency per page ratio on different data levels

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To assess the heterogeneity, the statistical testing was implementing as a step to be conscious of the Hawthorne effect (HE) in order to recognize the dependencies of these outcomes for MOBICS. The statistical test that used to analyse are Chi-square statistic (Chi^2) and I^2 statistic (Ryan, 2014). In addition, statistical test was apply to see either these two pairs of qualitative variables are dependent on each other.

Table 2 demonstrates the impacts of heterogeneity of the Hawthorne impact with binary results in the respondents ' profile context; whether or not it impacts MOBICS response ranking. Questionnaire in part A are used to define whether the Hawthorne effect biased MOBICS outcomes. Based on the consequence, the outcomes of the questionnaire were not affect by sex and ethnicity as this questionnaire assessed the scheme rather than the customers.

While the age of respondent majority is a student. So normally the student known how to use the application. Therefore, they were less prone to the Hawthorne effect since users effectively got used to it.Same goes to the education level. All the characteristics on profile background show that the value of $P > 0.05$ means that gender, race, age and education level did not affect the ranking of MOBICS feedback. Furthermore, the results of I^2 were below than 40%, which might not be significant on the status's ranking of MOBICS feedback. It can be concluded based on the part A that there was less Hawthorne effect occurred because the majority of result get effectively to use it and not for the reason was being observed.

Table 2. The Effect of Heterogeneity in Respondents' Profile Background on the Hawthorne Effect with Binary Outcomes

	Q	*df*	P	I^2 (%)
Gender	2.273	2	0.330	12.01
Race	2.948	2	0.078	32.15
Age	2.360	2	0.573	15.27
Education Level	2.925	2	0.368	31.62

Table 3 demonstrates the binary outcome of the Hawthorne impacts on participants when determining the MCS history of use. Based on the outcome, the frequency of web use and the time spent did not influence the MOBICS feedback ranking because the statistical outcome was less than 40%. It can be concluded, however, that there may have been less Hawthorne effect. Thus, these findings indicate suggested MOBICS decreased the effect of Hawthorne by reducing the outcome of the bias.

Table 3. The Effect of Heterogeneity in Respondents' MCS Usage Background on the Hawthorne Effect with Binary Outcomes

	Q	*df*	P	I^2 (%)
Frequency of the Internet Usage	2.948	2	0.078	32.15
Time Spend	2.947	2	0.168	32.14

5. CONCLUSION

CC provide unlimited storage capabilities. Consequently, the more information that is attained, the greater the need for appropriate organization in order to

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make that information reachable and actionable. With that, returns will be seen quicker and more often. Hence, in this research have proposed the enhancement of mobile CC scheme. Based on the research, to generate the decision tree rules, the J48 is selected and was integrated into MOBICS system in scheme 2 to analyse the local and global pre-fetching on MCS environment. MOBICS pre-fetch the data based on ML rules. The rules influence the result of data prediction either to pre-fetch or not to pre-fetch to data to be store in MOBICS application. Based on the result generated by ML rules, user able to access the data directly with faster by reduces the latency. Furthermore, ML rules intelligently manage the data in MOBICS. User easy to store the data easier based on the bigger size of free storage available and the most CS user always access. In addition, the analysis test proved the latency be reduced based on proposed scheme even at high data level and for the statistical test verified that the background of respondents did not affect the respondents' ranking feedback on MOBICS application, hence MOBICS responsiveness from Hawthorne Effect. This paper is important in studying the CC based on industry 4.0 on future work. On future work, will cover on the effectiveness evaluation on MCC in industry 4.0.

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