

An Efficient and Affordable Push Strategy of Mobile Advertising for Micro Enterprises

Bagus Priambodo, Nur Ani, and Yuwan Jumaryadi

Abstract— The main feature in the location based on advertising is sending the latest ads from POI nearest the user. For this task, a mobile device should send the current location to the LBA server at intervals, and the LBA server will later deliver the latest ads closest to the user location. As a result, there was a high demand for the query and it also draining the device's performance with the ongoing operation requires high Internet bandwidth. We proposed an efficient push strategy, easy-to-use and affordable mobile advertising for micro businesses. For evaluation, we carried out experiments with up-to-date dataset of 624 micro-enterprises scattered throughout the city of Jakarta. The data consists of latitude-long coordinates, name and postcode of the micro-enterprises. Compare our proposed push strategy with other similar push strategies, the results show that our strategies use four times more efficient power consumption and lower Internet bandwidth with fewer queries to the server.

Index Terms— Mobile advertising, micro enterprises, push strategy, efficient energy.

I. INTRODUCTION

It is acknowledged that micro and medium enterprises have an important role in the development and economic growth, not only in developing countries like Indonesia but also in developed countries such as Japan, United States and European countries. Despite having a vast role in the economy of the country, micro enterprises still have many constraints [1] one of which is the difficulty of marketing. According to the central bank of the Republic of Indonesia, micro-enterprises are businesses with an annual turnover of fewer than 100 million rupiahs. Micro-enterprises are the smallest type of commercial enterprise in Indonesia and classified as MSE, but this type of business is the largest type of business in

Indonesia. Micro-enterprises can usually be found in both home-based and rural regions that are home-based or have no fixed location[2]. According to BPS (Central Bureau of Statistics), the difference between Micro Enterprises (MIEs), Small Enterprises (SMEs) and Medium Enterprises (MEs) is in the number of workers involved 1-9 workers, 10-19 workers and 20-99 workers [3]. The product of micro and medium enterprises in Indonesia is very diverse and the location is spread in urban and rural areas. Selecting an appropriate strategy with technology adoption should impact community empowerment and geographical segment expansion [4]. The effective system is needed to promote their product in their respective areas so that potential customers know the location and the latest product information automatically. Furthermore, to reach potential customers effectively, the advertising system should be easily implemented, inexpensive installation and day-to-day operations, so that each region can use this system to market their finest product around their location.

The aim of effective potential customers is smartphone users because in 2017 smartphone users in Indonesia reach approximately 173 million users [5]. The number of users of a smartphone, making advertisements on a smartphone or better known as mobile advertising into a new channel-based location advertising. This advertising channel is efficient to advertise products to smartphone users based on the location of usage [5] [6]. The proper use of LBA technology can improve e-business efficiency [7] by linking businesses with possible customers.

LBA has two delivery strategies: push and pull [5] [8]. In push strategy, the server sends ads to the subscriber automatically according to the location received from the user. While using a pull strategy, user request promotion or ads from the mobile device to the server. For an example for push strategy in Indonesia, Telkomsel utilizes a push strategy for marketing services [5]. Push strategy is a good choice because the ads delivered continuously, automatically sent according to the location of the users, but it requires a continuous query to the server to get the nearest ads from the user, so it will consume a lot of energy [9]. It requires an appropriate approach so push strategy does not consume a lot of

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smartphone energy and high internet bandwidth.

There are three technologies [7] commonly used to locate users location, by the network, by GPS [10], or by a hybrid combination between the two technologies. GPS-based usage is more accurate [6][11] but it uses more energy than network usage. There are several strategies for managing GPS usage automatically so that the GPS is turned on only at certain times or circumstances [12] [13] [14].

In order to be affordable by micro-enterprises, the use of high performance of dedicated servers is avoided. Utilization of web hosting as a server takes precedence because it does not necessitate the purchase of expensive servers with high performance. In addition, micro enterprises actors can easily update their latest products and adverts.

We propose an efficient and inexpensive push strategy, that can be easily implemented and affordable by micro-enterprises. Our proposed push strategy efficiency was tested with actual data, and compared with a push strategy search nearest POI using haversine method directly from the server.

II. PROBLEM

Mobile apps need to be capable to advertise effective micro enterprises products in their respective areas, so potential customers know the current location and product information automatically. In addition, to reach potential customers effectively, mobile advertising should be easy to use, efficient on battery and internet bandwidth usage. Server installation should be easy and affordable for micro-enterprises. Micro enterprises actors are easy to update the product and advertisement data so that each field can use this system to market their superior product in their area.

For micro-enterprises user. We considered our strategy should easy to implement, inexpensive, and battery efficient, so it will suitable and affordable by micro enterprises

To reduce battery usage in m-advertising, the usage of GPS is reduced or better avoided because continuous GPS usage will cause the power run out quickly [13] [14] [15] [16]. Utilized a dedicated server with high performance is also avoided because the expensive price is not affordable by a micro enterprise's actor. Paid cheap hosting becomes an alternative because it is cheap and does not need server maintenance costs. Therefore, continuous queries to the server should be avoided, and complicated computations are not performed on the server but are distributed to the mobile customer. High hardware specifications on a smartphone make computing process in mobile client very fast.

A lot of research has been performed in the LBS and LBA fields for finding nearest objects from users. Search POI (Point of Interest) using Euclidean distance on server [8] haversine [17], but this method not efficient for LBA push strategy, because queries should be executed continuously at all time, even if the user is in the same area, to solve continuous queries in the same area interval query are proposed, interval query still have another problem that in the same area user keeps query to the server. All we require is a POI search based on a polygon or region, queries will not be done if the user is still in the same / polygon area. There are many ways to search by

polygon, either by particular area [18] or by ZIP code [12]. Sharing if the user has still on made partition space automatically based on a query from mobile customers, using the k-NN and Voronoi diagram [19][20][21]. We need an efficient push strategy that the strategy is efficient in battery and bandwidth usage, inexpensive and easy to implement for micro-enterprises. We propose a push strategy based on ZIP code mixed with the haversine method in the mobile client

TABLE I
FINDING THE NEAREST POI STRATEGY

Strategy	Required Special Server	Complexity	Continuous query (Push Strategy)	Display POIs
Directly from Nearest POI, Calculation on Server	Not required	Simple	Query performs every interval	Nearest POIs
Based on the region of user location (dynamic region) using the Voronoi diagram	Required special server	High computation on the server	Query performs only when a user arrives at a new region / ZIP code area	Nearest POIs
Based on static region or polygon / ZIP code region	Not required	Simple	Query performs only when a user arrives at a new region / ZIP code area	All POIs in ZIP Code Area
Our propose Push Strategy Based on ZIP code combine with the Haversine method in the mobile client	Not required	Simple	Query performs only when a user arrives at a new region / ZIP code area	Nearest POIs from POIs in ZIP Code Area

III. RESEARCH METHODOLOGY

A. Algorithm

We proposed a mixed strategy including server and mobile computing strategy, using static region on server and haversine method in mobile computation. Our proposed system based on the static polygon. Users send their ZIP code based on their location. Server send based on ZIP code input.

Example:

set B = POI in region ZIP code (11620)

A is set POI query by ZIP code, $\forall \in A$ in B

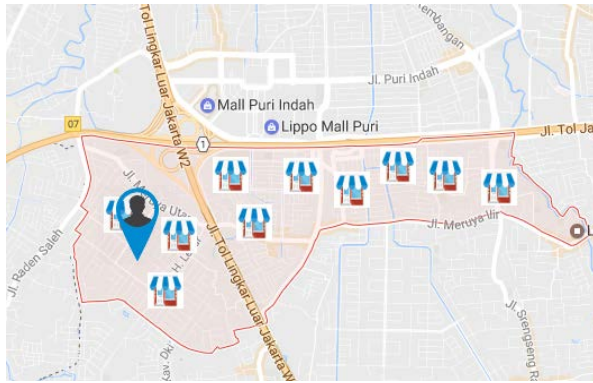


Fig. 1. Query POI based on ZIP code area

Using haversine methods we calculate nearest location between POI save in mobile database with user location
 Set display POI = POI user location – set A location



Fig. 2. Find nearest POI from the selected region in a database mobile

Algorithm:

```

interval = 0
while (true)
  interval = interval + 1
  if(interval % 100)=0)
    userLocation.lat = lat
    userLocation.lng = lng
    currentZIPCode = getCurrentZIPCode(userLocation)
    if(currentZIPCode <> oldZIPCode)
      arrayPOI[] = getPOI(currentZIPCode)
      for index = 0 to lengthPOIObject
        cPOI = arrayPOI[index]
        if(distanceHaversine(userLocation <= 1)
          displayPOI(cPOI)
        end if
      end for
      oldZIPCode = currentZIPCode
    end if
  end if

```

B. Haversine Method

To calculate the distance between user and array POI object we used Haversine Method [2].

$$\Delta lat = POI.lat2 - POI.lat1$$

$$\Delta long = POI.long2 - POI.long1$$

$$a = \sin^2(\Delta lat/2) + \cos(lat1) \cos(lat2) \sin^2(\Delta long/2)$$

$$c = 2 \arctan(\sqrt{a}, \sqrt{1-a}) \quad d = R \cdot c$$

Information:

R = radius of the earth by 6371 (km)

Δlat = amount of changes in latitude

$\Delta long$ = amount of changes in longitude

c = calculation axes intersect

d = distance (km)

1 degree = 0.0174532925 radians

Likewise, before we use in trigonometric functions the angle of the latitude and longitude should be converted from degrees to radians.

C. Mixed Push Strategy

We considered our strategy should be easy to implement, inexpensive, and battery efficient, so it will suitable and affordable by micro-enterprises.

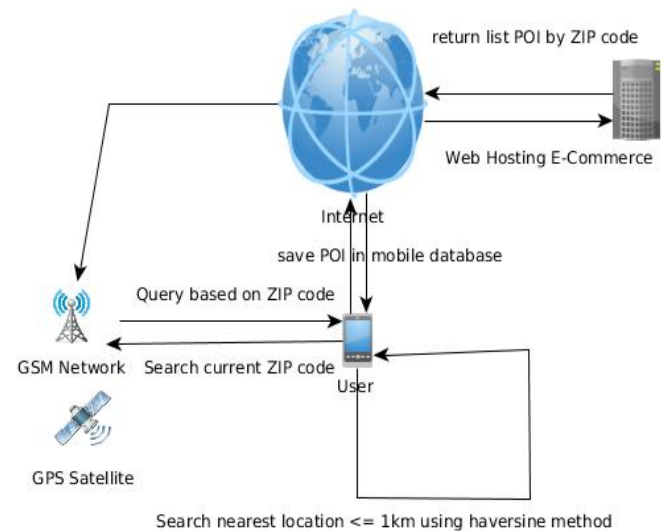


Fig. 3. Propose push strategy

Users get current ZIP code location using the internet, user query POI in ZIP code region. POI received from e-commerce database and save in mobile client database. The mobile client shows the nearest location (1 km) using haversine method from POI saved in database mobile.

D. Data preparation

We performed experiments with actual information, approximately about 624 microenterprises that scattered in the city of Jakarta. Our data consist of latitude-longitude coordinates, name and Zip Code of the microenterprise.

TABLE 2
EXAMPLES OF MICRO ENTERPRISES DATA

No	Name	Latitude	Longitude	Zip Code
1	Eko Ongan	-6.2941	106.738	11610
2	Bu Eka	-6.2751	106.743	11610
3	Jannathan	-6.2065	106.742	11610
4	Pandegelang	-6.2441	106.744	11610
5	Rere	-6.2351	106.748	11630
6	Jaya Bahari	-6.2077	106.741	11610
7	Citra Jaya	-6.19781	106.742	11620
8	Hidayah	-6.19367	106.743	11620
623	Bukit Salasiah	-6.23606	106.703	15151
624	Berlian Jaya	-6.22273	106.963	17134

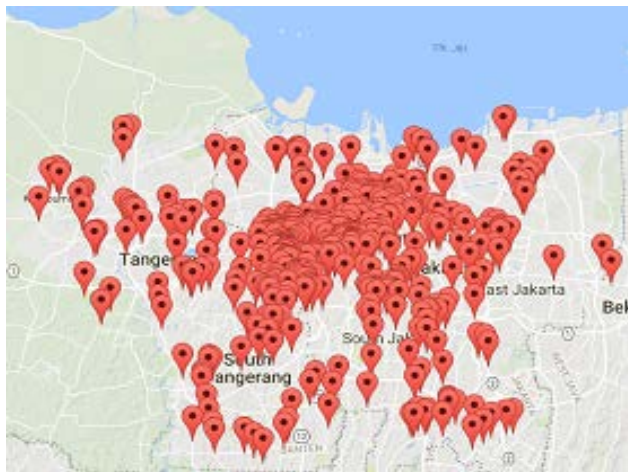


Fig. 4. Actual data of micro enterprises location in Jakarta, Indonesia

IV. EXPERIMENT

A. Experimental Setup

For the experiment, we used Linux share hosting with 500 MB capacity of the POI server database. For testing mobile client, we used LG Optimus L7 P705 Qualcomm MSM7227A Snapdragon, 1 GHz Cortex-A5, GPU Adreno 200, 512 MB RAM, 3G HSDPA, 21 Mbps, HSUPA, 5.76 Mbps. We use the old android device (2012) to ensure mobile advertising running on lower specification.

We evaluate two query strategies, first, we evaluate query strategy proposed in research methodology that is the ZIP code strategy, mixed push strategy using static region on the server and haversine method in mobile computing. Second, we evaluate push strategy using haversine method directly on the server, the user posts his current location to the server, the server then finds nearest POI using Euclidean distance and haversine method and sent array POI to the user.

Our scenario is the same for both algorithms; we run both algorithms for four minutes. Using the same start and end location, in same ZIP code / same region (ZIP code 11620). We conduct an experiment around 11620 ZIP code area.

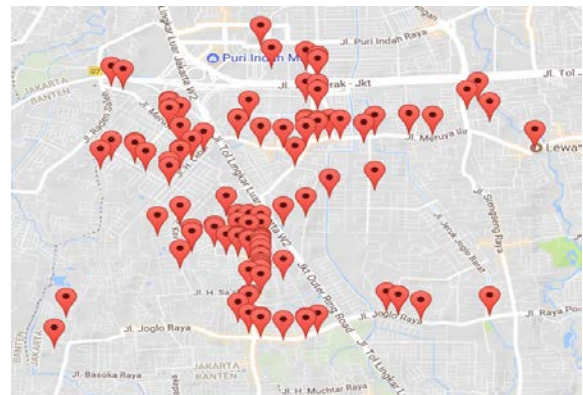


Fig. 5 Location of performing an experiment

C. Experimental Result

After four minutes, we capture the results of both algorithms. Our propose push strategy is shown in figure 6, while directly push strategy using Euclidean distance and haversine method is shown in figure 7 below:

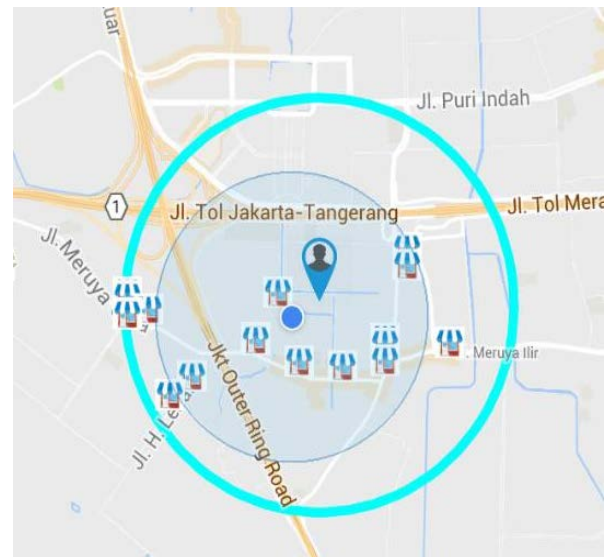


Fig. 6. First strategy query after 4 minutes

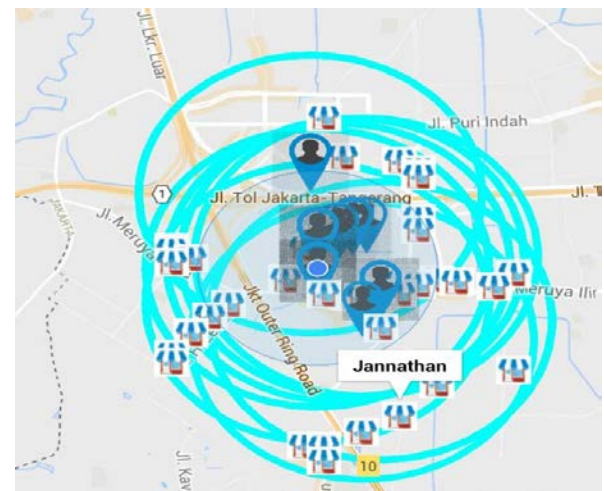


Fig. 7. Second strategy query after 4 minutes

First query strategy shows fewer POI object rather the second query. Because in first query strategy, the mobile client only shows nearest POI object in one region (ZIP code), but in second query strategy mobile client show nearest POI object in all regions or all ZIP code near the user.

The first query strategy only consumes 1 % of power energy, but the second query strategy consumes 4 % of power energy of android device. As we can see in figure 4 and figure 5. Looping with interval 100ms, mobile client request query from POI server database every 100ms. In the first push strategy, after processing the first query, because user location still in the same ZIP code area, the mobile client does not process a new query from the server for requesting a new array of POI object, rather mobile client only show the nearest POI object from the mobile database. Different with second push strategy, the query is looping every interval 100ms, the mobile client requests a new array of POI object from the server every 100ms. Because of this activity, the second strategy consumes more energy compared with the first strategy. Furthermore, the second strategy spends more bandwidth compared with the first strategy as shown in Figure 9, the second strategy spends 21 MB of internet bandwidth while the strategy that we propose only spent internet bandwidth less than 1 MB.

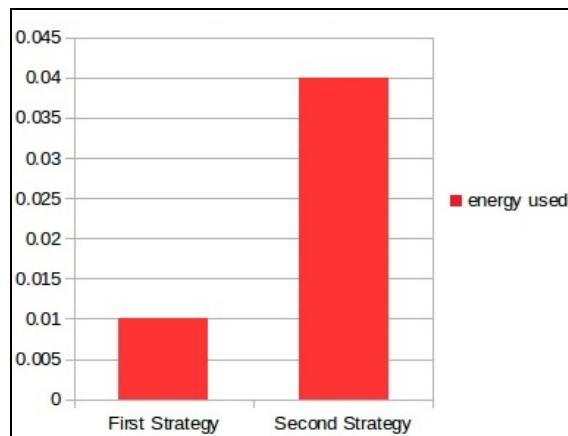


Fig. 8. Comparison of energy usage for 4 minutes

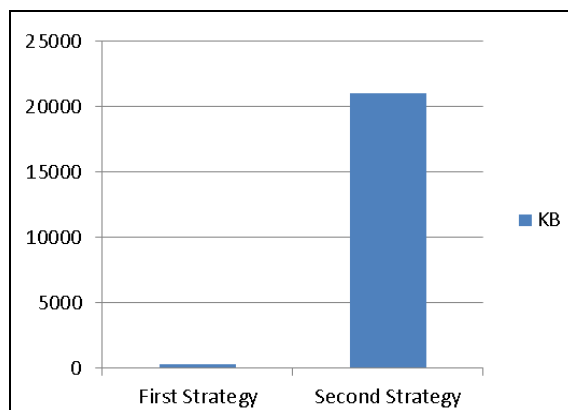


Fig. 9. Comparison of bandwidth usage for 4 minutes

V. DISCUSSION

The main aim of our experiments in this study is to investigate an efficient POI search strategy, and affordable for implementation by Microenterprises. We have chosen two strategies that are inexpensive and affordable for Microenterprises. From the experimental result, we evaluate both algorithms running in one ZIP code area (11620). The result shows our proposed method (first query strategy) use lower energy consumption, it only consumes 1 % power energy, compares with the second strategy consume 4 % energy. Because in second strategy every 100ms, will query POI object from the server and will update POI in mobile client, so it will consume more energy consumption. However, the second strategy displays more POI compared to the first strategy, this is because the second strategy looking for POI of nearby objects from various ZIP code areas. But our proposed strategy shows more efficient in usage of energy and bandwidth internet compared to the second strategy. Because our proposed strategy only request query when the user makes a motion to another ZIP code area.

VI. CONCLUSION AND FUTURE WORK

In order that mobile advertising will be used often by users, mobile advertising should be efficient in battery and internet bandwidth usage. Also, in order mobile advertising inexpensive and affordable by micro-enterprises, Utilizing high performance dedicated servers is avoided. Utilization of web hosting as a server takes main priority because it does not involve the purchase of expensive servers with high performance. Furthermore, micro enterprises actors can easily update their latest products and adverts. We evaluate two query strategies to find nearest POIs from user location that inexpensive for micro-enterprises. First, we evaluate query strategy proposed in research methodology, that is a push strategy based on ZIP code mixed with the haversine method in the mobile client for selected nearest POIs. Second, we evaluate query to find the nearest object using haversine method directly on the server, the user sends his current location to the server, the server finds nearest POI using haversine method, and sent array POI to the user. Both algorithms tested with actual data in the same ZIP code area.

For push location-based advertising strategy, our proposed strategy shows more efficient in usage of energy and bandwidth internet compared to the second strategy. Also, our proposed strategy is suitable for implemented in shared web server in the Linux hosting, so it can be implemented and affordable by micro-enterprises. In the future, we will consider the direction of user movement to display more POI near the user.

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