Mall Maps – A new approach for generating and Using indoor mapping techniques

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Abstract— **This paper presents an idea of generating indoor maps for malls in a newer and innovative way tackling different kind of situations or problems that arise due to some or other reasons when going to malls for shopping. I've tried to look at the problem in a different way and come up with a conceptual solution in the forms of maps. These maps are meant to be generated dynamically by employing different technological advancements in the field of data mining, routing and map generations. The paper discusses the problems and their possible solutions in detail.**

Keywords— **Mall Maps, Use of Indoor Mapping, Use of Association Rules in Map Generation.**

I.INTRODUCTION

With major technological advancements taking place in the field of mapping (GIS and GPS), data mining and fast routing algorithms, I've tried to conceptualize a possible solution to problems faced by individuals while going out for shopping in malls or marts. The solution is a concept of generating indoor maps by integrating above mentioned technological fields and using it in a different way. The problem here I am talking about is based on my personal experience which, coincidently, is experienced by many others as well. I present a scenario after reading which it will become clear what kind of problems I am talking about.

Consider a customer "A" who has to do some shopping for which he/she goes to mall with a list of items he/she wishes to buy. Now A is not a frequent shopper. He enters the mall and has to figure out what things are placed where. He/she simply picks up a trolley/cart and heads towards the section in front of him. A tries to categorize the items in the list which otherwise are listed in a random order. After this difficult process, A finds out a section that holds the items of a particular category. Now another problem is the section is already too crowded and it has become difficult to pass through it without waiting for other people in front. Above all this chaos, one more problem is that A doesn't have a slightest bit of idea "What the item and it's packing look like?" After passing through the crowded section A asks someone about the item and is told that it is present at beginning of the section. That means A has to go back through the crowded area but this time in opposite direction. What could be worse? Well after reaching there somehow, A finds out that the last piece of item was being picked by someone else. If only A could be notified beforehand that the item is low in stock, he/she wouldn't have to struggle this much just for one item.

Before going for shopping A had decided a budget. While shopping he/she comes across an item that is not in the list but is desired, or maybe A wants to spend on something from remaining budget. But the problem is A has no idea what his/her bill for the picked up items will amount to, unless A is manually calculating the price of every item he/she picks. This is not a practical solution.

There are many such problems faced by general population which have been categorized in the problem field. We will be going through these problems and the possible solution that I've have conceptualized in further sections.

1I. THE PROBLEM FIELD

II.I Customer's Perspective

1. *"New to Mall" or "To new Mall"*: Many a times one visits mall and is totally unaware of the placements and/or availability of the commodities one is looking for. Two possible reasons :
   - The person is new to the mall or may be he/she isn't a frequent shopper.
   - The mall is new, may be either it's a newly opened mall or the person is in different region/province and visiting a new mall.

   A very obvious solution to this is use of map. "Why and how" are discussed in later sections 2.1 and 2.2.
2. *Difficult to detect and avoid crowded sections*: Usually while shopping for groceries and other such things, one is only busy in and concentrating on finding and locating the desired items.

   The most obvious path one takes is the straight one that lies ahead where most of the items which one wants to purchase are in line of sight of the buyer.

   Now there isn't anything wrong with it and is quite a common choice one would make in normal circumstances. But the problem arises when everybody is following the same pattern and the most easily approachable section becomes most crowded. How this situation is handled by my concept of mapping is discussed in later sections

3. *Spending more than planned*: Although it's not a common thing, but it's still a case worth taking under consideration. The solution I propose also takes care of this problem as discussed in section 3.2

II.II Supplier's Perspective

4. *Getting notifications of the item's unavailability in real time:* Authorities should get immediate notification of the items that are not available on their respective racks so that new stock can be pulled out from the stock godown and replaced on the empty racks. This way customers wont have to go empty handed despite the item's availability. The solution to this is discussed in section 2.2.
5. *Offering buyer various alternatives and complementary products*: All suppliers and shopkeepers desire to achieve greater productivity and sales. The proposed system offers a way of employing data mining for newer purpose. We will see in the upcoming sections how the dynamically generated mall map helps us achieve this task.

III. MY IDEA

Considering all the above problems, I propose an idea that can be counted as a possible, plausible, tenable and efficient solution. My idea revolves around the concept of a Map App that, I believe, can solve all the above mentioned problems. The idea is to provide the customer with a map application that is generated dynamically based on the parameters provided by the customer/buyer/user at the time of entry into the mall.

Why maps?

Maps are graphical representation of the place/platform showing all the ins and outs and the possible passages to roam around and explore the place at will. Maps are understood by global population and do not require strict knowledge of any specific language to grasp the concept.

III.I How maps are beneficial in our scenario?

The kind of maps I am talking about here are generated dynamically and give a full path description to the buyer that he/she can opt to, but not restricted to follow. The maps will act as path guide to the customer in order to get all the items that he/she desires to purchase in an easy and quick manner. These maps are supposed to be generated in such a way that the path passes by every item present in buyer's purchase list.

III.II Reconsidering the above scenario

Let us reconsider our previous scenario where A enters in the mall/mart and A have no idea what things are placed where. But now let us assume that my proposed system has been implemented and is working in its finest manner. So this time A's experience will be different. A as usual grabs a trolley/cart. But this time the cart is equipped with a small touch screen device (looks like a tab) which after some procedure shows all the list of items A wanted to buy along with an estimate of extra amount A is willing to spend on shopping for some or other reasons. The procedure is simple and is discussed properly in "Details" section.

With one touch an indoor map is generated showing A's current location and the path he/she should follow to get all the items on the list. To his/her surprise A is able to locate and get all the items as he/she pass by it without putting much effort into it. Why? The moment A passes by that item while following the map, an image of that item pops up at the screen with a beep notifying me that the item is nearby. A just have to look around and he/she is able to find it with an ease. Along with it A is suggested with related accessories or other complementary item that can be bought. A finds it amusing that even though it wasn't on the list, it was an item that he/she wanted to buy. A happily puts that item into the cart. If he/she doesn't want it, A can simply neglect the notification and go on with other items.

Every time A puts an item into the cart it gets a quick scan and is marked checked against it's name in the list. That way A can keep track of what all items have been purchased. The system also recognizes the items A put into the cart that are not in the list and simply deducts it's price from his/her allotted budget showing how much more is left to spend. That way A can remain assured that he/she still is shopping within the planned budget. Another use of scanning the item being put into the cart is to maintain the count of items present on the rack. This way if a last item on the rack has been picked up and placed inside the cart, immediate notification is sent to the authorities so that they can place new stock of item on the rack. Another advantage of this would be for the customer heading towards that section for the same item. They will be notified at the real time too. They can shop for other items until the rack is refilled with the stock again.

When A is done shopping he/she can simply go back to the counter to pay for the stuff placed into the trolley. One thing A had noticed is during entire session A didn't face a crowded area and was saved from competing against other customers to get an item and go ahead.

IV. THE DETAILS

IV.I The System

The proposed system is Android based system. The reason behind making it an Android based system is it's sheer popularity[1] and it's easily available open source libraries for developing mapping applications. The system should be able to run on any android based tab or mobile phone. Initially these apps will be installed in the tablet devices embedded in the shopping trolley/cart. These carts will have special scanners attached to the edge lines of the cart in order to scan and identify any item dropped in it. This will help in identifying the items among the list and items outside the list that the customer has put into the cart. The moment an item is scanned, it is either marked checked against it's name in the list if it belongs there, or added to the list of extra items. This is very important in order to keep track of what all items the user purchased and whether he/she is going beyond his/her

shopping estimates, as the calculations are taking place at real time. Every cart is assigned with an 'id' in order to recognize and pinpoint it's location. The "id" is actually the identifier of the device attached to the cart.

The system works on a centralized GIS (GIS but for local and indoors) server system where there is one server and every other device act as a client. The server should be capable enough to process multiple requests and responses simultaneously. It should be able to perform mining algorithm executions for each list input. It should be able to determine the pattern of purchase in real time and apply different algorithms on them. It should handle congestion and manage traffic and manage map accordingly.

The mall has to be equipped with wi-fi and proximity sensors. These are required in order to identify and pinpoint the exact location of the device(cart) apart from the primary function of communicating the map information. One can achieve this task by use of Bluetooth or wi-fi fingerprinting techniques alone. But both have their disadvantages. Wi-Fi signals diffuse in space and have very large coverage and they require additional improvement technique of positioning accuracy. Bluetooth and RFID only detect an object in quite a limited range. These limitations and improvement over them are well studied and explained by Artur Baniukevic, Christian S. Jensen, Hua Lu in their paper "Hybrid Indoor Positioning with Wi-Fi and Bluetooth: Architecture and Performance"[2]. This implementation can prove helpful in the kind of indoor mapping we are discussing.

IV.II Pre-Map generation Phase

The moment a customer enters the mall/mart, he/she can submit/dictate verbally the list of items he/she intends to purchase. While doing this the bill is calculated beforehand at real time, it however is not the final bill. Even though it is subject to change depending on customer's choice of purchase, it gives an approximate idea of the amount that the buyer might be spending.

Here is a chance for the mall owners to attract customer to buy more items. For instance,

If customer A's bill will amount to let's say a sum of 4300 Rs. approx. At this time, A can be informed about and offered an ongoing discount or scheme for a purchase of more than 5000 Rs. That way A is inclined towards the offer and may decide to spend upto 5000 Rs. as it is only a little higher than what his/her original bill was amounting to. Moreover, there might be other customer's who already had decided to spend 4000 Rs. on shopping and would be willing to go an extra mile to avail an offer.

This list and the expenditure estimate is fed into the system's directory corresponding to the "id" of the cart the user is carrying. This way, the device on the user's cart receives the list and the allotted budget number from the server. One thing I would like to stress here is that the list and the budget number are not fixed and are only acting as check constraints. They are not by any means limiting or avoiding the user to go beyond the allotted budget. The choice is totally made by the customer whether to stay within the budget or not.

IV.III Map-Generation Phase

IV.III.1 Use of Association Rule

After the list and details are fed into the server and are available with the device embedded in the cart provided to the user, next comes the Map generation phase. Here comes the process of mining. We all are familiar with the "Association Rule" obtained as a result of data mining. I'll give a brief description of it for those who are unaware of it. Discovering association rule is one of the primary reasons behind exhaustive data mining procedures. It helps us find association between two items in such a way that one item implies other. This is widely used in sales analysis and finding purchase patterns. In other words, as suggested by Rakesh Agrawal and Ramkrishnan Srikant in their paper "Fast Algorithms for mining association rules" [3], the problem of discovering all association rules can be decomposed into two sub problems [4]:

- *Find all sets of items (item sets) that have transaction support above minimum support. The support for an item set is the number of transactions that contain the item set. Item sets with minimum support are called large item sets, and all others small item sets.*
- *Use the large item sets to generate the desired rules.*

These association rules help place associated items close to each other so that the buyer when going for one of the item gets inclined towards buying the other product as well. For instance, if it is observed that most of the customers who buy "butter" buy "bread" as well, then the "bread" and "butter" will be placed next to each other. This kind of mining requires fast algorithms to learn and mine the rules. Such two fast algorithms : Apriori and AprioriTid are presented by by Rakesh Agrawal and Ramkrishnan Srikant in their paper "Fast Algorithms for mining association rules" [3].

How are Association Rules related to our mapping system? I have tried to look at the utilization of association rules with a different perspective. Usually, with the help of association rule the items are placed in proximity to each other. But this becomes very difficult as it is not always possible to place all related things near to each other. However, it is possible to take the customer to all the items associated to each other. The map that is generated takes into consideration the association rule discovered by the server and designs the path in such a way that it leads the customer to all the items related to the items in the list in a row without even making him realize it. Recall the reconsideration of scenario discussed in section 2.2, where the item not in the list but associated to the item in the list pops up at the screen of interface. This happened due to above mentioned operations.

IV.III.II Avoiding congested path

The proposed system generates maps in such a way that the path with congested section are avoided, i.e. when the server detects an increase in the no. of carts in a particular section it

changes and generated a new path in such a way that the user still gets the desired items but in different order. The map directs the buyer to a different section of commodities where there is less congestion of customers and the items in the list are present in that section. The customer is directed back to the previously crowded section once the congestion clears up. This way, the buyers don't have to face the crowded section and still be able to buy all the desired items with ease.

This can be achieved by either of the two means: applying Routing algorithms for congestion detection, avoidance and control, OR using traffic avoidance techniques used in GPS systems.

Use of GPS features in controlling traffic have been studied and researched well by many. GPS-based traffic control preemption system[5], congestion control & collision avoidance algorithmin intelligent transportation systems[6], use of clustering algorithm in GPS to detect hot-spots[7] etc are few of them. I, however prefer adopting routing algorithms for congestion control over use of GPS because of the fact that GPS is designed to cover global area and its algorithms used for traffic control may not be fully compatible with indoor mapping. Use of Routing Algorithms in network on other hand seems to be more feasible solution as the algorithms work on different access points and are easily implemented. Routing algorithms for congestion control, or the GPS traffic management algorithms, nevertheless are not the subject of research of this paper. So either of them can work. Our objective is to achieve a non congested path by any means.

IV.III.III Leading to higher productivity area

The proposed system can generate a path that would lead a customer to an area with high probability of sales, i.e. it is most probable that the buyer would be interested in buying the items present in those areas but not in list. We are not talking about Association rules or related items, but a separate section dedicated for heavy discounts and sales of random items based on user's age and gender. This way the maps can help improve the profitability and sales.

V. RELATED WORKS

I've proposed a new way of using indoor mapping systems in shopping malls to enhance the experience of both customer and supplier by integrating it with some important features of Data mining. The map generation isn't based just on the indoor architecture. It is totally based on the most desirable and appropriate path obtained after careful analysis of the association rules discovered in data mining and varies from customer to customer. I haven't been able to find any work related exactly to my idea. However, different works on generating indoor maps have already been performed and brought into actions.

Various organizations and individual have contributed in the development of indoor mapping system, two of them being Google and Microsoft.

While in Google's indoor maps[7], indoor floor plans are seamlessly integrated into Google Maps for desktop and Android and are automatically enabled when the user zooms in, and fade away when the map is zoomed out, it is not what we are actually looking for as our maps are generated with the help of local GIS server present in the mall itself.

Microsoft's research named "Walkie-Markie: Indoor Pathway Mapping Made Easy"[8] works in somewhat desired way. It is just an Indoor Pathway mapping system and can be used with our proposed system when integrated with local GIS system.

J Candy in his paper "A mobile indoor location-based gis application"[9] describes a GIS research project which built a GIS web server that delivers map and linked database information to indoor wireless devices, such as mobile phone or Personal digital assistant (PDAs). Location-based applications use the current location of the wireless device when available.

Jo Agila Bitsch Link, Paul Smith, Nicolai Viol, and Klaus Wehrle in their paper "FootPath: Accurate Map-based Indoor Navigation Using Smartphones"[10] has presented a self-contained, map-based indoor navigation system using only the accelerometer and the compass readily available in modern smartphones.

VI. CONCLUSION AND FURTHER WORK

The proposed system represents a possibility of using indoor mapping in a different and productive way. It's result and functionalities may vary from place to place due to differences in implementation, size of the population, architecture of the place, algorithms, efficiency of association rules discovered during mining and other factors.

Much work lies ahead in terms of detailed feasibility study and success rate of such systems. A practical implementation of a working model of the proposed system needs to be studied. Further implementations include use of personal android enabled cell phones instead of embedded tabs to install a fully functional system within in order to minimize the installation cost.

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