NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY
[IJIERT] ISSN: 2394-3696 Website: ijiert.org
VOLUME 11, ISSUE 02, February -2024

IOT ENABLED SMART ADVERTISEMENTS RECOMMENDER FOR SHOPPING MARTS

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Article History: *Received on: 11/12/2023*
Accepted on: 16/02/2024

DOI: https://doi.org/10.26662/ijiert.v11i2.pp75-87

Abstract

Product advertisement is very crucial in a successful business for several reasons, Advertisement helps increase the visibility of a product. With so many products available in the market, effective advertisement ensures that your product stands out and reaches a wider audience. Advertising a product is also a way to build and reinforce brand awareness. Consistent advertisement helps in creating a strong brand image in the minds of consumers, also the consumers will remember and choose their products when making a purchase. Continuous and strategic product advertisement is essential for the long-term success of a business. It helps in maintaining visibility, adapting to market changes, and staying relevant in the eyes of consumers. Product advertisement can indeed present various challenges, and addressing these challenges effectively is crucial for a successful marketing campaign that is **1)** Small company budgets can restrict the range and effectiveness of products advertisement activities **2)** Evolving consumer preferences and behaviours can make it difficult to predict how to effectively reach your audience **3)** If your brand is not well-known, getting attention for your product can be a hurdle **4)** Not fully understanding your target audience can lead to ineffective advertisement strategies. However, the Internet of Things (IoT) plays a significant role in product advertisement and overcome the above listed issues by providing innovative ways to enhance customer engagement, streamline marketing efforts, and gather valuable data for targeted campaigns. This Research investigate the real-time product advertisements using IoT devices and allowing different companies businesses to monitor the advertisement campaigns instantly and remotely for targeted products over different marts and different city locations. We achieved successful results on each remote location as well as targeted mart using ESP-8266 WiFi deployed on each product shelf. In this architecture the overall communication held over the http protocol using RestFul API and Arduino.

Introduction

With fastest innovations in network technologies, many existing technologies are applied on to the IoT scenarios, as well as recommendation technology to become a good application [13]. IoT provide us the object to object communication to enable Smart Objects to receive and exchange of data without human

involvement [16]. In IoT domain perspective the recommendation system implementations are still required that is food recommendations, personalized shopping, health monitoring, animal monitoring, smart homes and sports event recommendations [14] therefore the recommendation technology become an important part of the IoT (Internet of Things) services by which the user can get the information anywhere, anytime [13]. In future aspects more applications based on IoT become introduced by connecting many other smart objects all together therefore best application for users then the recommendation system is the right solution [22]. The existing recommendation system application cannot meet the user desired recommendations with the high accuracy and fulfil all requirements in the IoT environments [13] therefore in the context of the IoT the recommender system supports different type of scenarios based on recommendation of sensor, services, applications and IoT workflows [14] and there is a need of IoT application developers to give some attention on reliability, reducing downtime, robustness, stability, consistency between the application components [24]. The internet of things (IoT) has a lot of attraction for both industry and academia because it is widely used in various application such as the intelligent transportation, smart shopping and many other areas [25]. The IoT plays a vital role in the various other fields having no exceptions that utilized recommender system get the optimized results after analysing data coming from devices to IoT users as well as behaviours [26]. IoT is a key technology in which manufacturers provide a mobile application with the other physical devices or objects to enhance the user experiences for better services. Now a days IoT support many smart devices using different framework, and other devices utilized remotely where we have individual interventions [26]. From IoT perspective, it become increasingly demandable in future because it will be used as hub between all other objects or devices over the internet for real time communication [23].

From past studies we have explored that we have different technologies such as near field communication (NFC), vehicular-to-vehicular communication (V2V), radio frequency identification (RFID) as well as machine-to-machine (M2M) depends on the experimental basis [26]. The evolution of Information Technology caused a new concept called “Internet of Things” (IOT) wherein some devices meet user needs in the form of online manner. Servers that are provided by some companies control each of these devices and users select IOT objects based on their requirements [26].

In Internet of Things (IoT), selling smart physical objects together with a compatible mobile app becomes an upcoming trend. The app allows to control or monitor the physical object and its sensors in an easy, and user-friendly way. The IOT consists of various tiny and smart gadgets with fluctuating working frameworks, CPU, memory, and additionally, these devices can be utilized remotely in the field where individuals’ intervention or design is unbelievable. In this regard, by proliferation of IOT gadgets and services, choosing appropriate services based on user’s requirements for assessing users regarding choosing suitable IOT services based on their daily needs by recommender. Internet is going to developed rapidly, new advertisements architectures and models emerge as we can see the google is one of the most prominent example which provides the related advertisements as user searches for product and services the user also found the advertisements relevant to the previous products which enhance the success to achieve the highest selling products [4]. IoT (Internet of Things) gives us the deeper concept for the network devices and what are the techniques to sense and collect data from the real world, and it also tells us the rules and mechanism to share that data over the internet where it will be processed for different purposes to get the better understanding and use of data. Since IoT enables gadgets to be controlled remotely over the web, in this manner it made chances to legitimately associate and coordinate the physical world to the PC based frameworks utilizing sensors and web. The interconnection of these numerous implanted gadgets will bring about robotization in almost all fields and furthermore empowering propelled applications

Literature Review

The Internet of Things, or IoT, is a network of interconnected devices, mainly embedded systems, which exchange data with each other or servers to monitor, analyse, or perform various tasks. These devices can range from everyday objects such as household appliances, vehicles, and wearable devices to industrial machinery and infrastructure components. They communicate and interact with each other, as well as with centralized systems or platforms, to perform automation, monitoring, and control processes. The history of the Internet of Things (IoT) can be traced back to the 1980s when researchers at Carnegie Mellon University connected a soft drink vending machine to the internet, enabling it to report its inventory and parameters. This experiment marked the beginning of the concept of interconnected devices or IoT. Since then, there have been significant developments in the field of IoT, and today, just about every device or home appliance has an IoT version available in the market. The latest development in the field of IoT has focused on enhancing the security of the communication protocol through which data is transferred between IoT devices and over the internet, making IoT more robust and reliable than its earlier iterations. In these days Internet of Things going to be considered as a tool for promotion of products and services, as well as it is also provide a mechanism to communicate with the consumers and sense and collecting other promotion based data for marketing purposes, its opportunities are endless and there is no bounding and any scholar and current marketing trends is considering IoT as greater marketing future [1]. Nowadays IoT is main research area in enabling machine advertising; it has several attention-grabbing opportunities and challenges. Internet of Things also plays a vital role in the web advertising that is based on the device compatibilities and the high performance device connectivity and their scalability as well as the strong customer personalization's which will grow any other business therefore the advertising that will attract any customer to buy which can also change the customer buying behaviour [10]. IoT gadget is a bit of equipment with a sensor that transmits information starting with one spot then onto the next over the Internet the kinds of IoT gadgets incorporate remote sensors, programming, actuators, and PC gadgets. They can be imbedded into cell phones, modern gear, natural sensors, therapeutic gadgets, and that's just the beginning. Associated IoT gadgets, which pass on use and other information, can possibly give bits of knowledge that lead organizations to cost decreases, proficiency gains, and new business openings. Right now many IoT based devices which can be used for the IoT based advertisements from the past revolutions in smart advertisements we can advertise our products to the consumers in a smart way using Raspberry pi by getting the advertisements data which is already saved onto the cloud by giving credentials to the customers [2]. We need to design efficient advertising strategies for shoppers and companies earn the maximum revenue, but this is not an easy task to find those efficient ways because many factors make it difficult to achieved and another difficult task is that user will purchase a product which is unknown [4].

Enabling computational advertising in the IoT world is an under-investigated research area; nonetheless, it possibly includes many interesting opportunities and challenges, IoT high connectivity and scalability will allow advertising to be performed in a really dynamic environment as new smart devices are constantly joining or leaving the IoT network. Finally, different from the traditional web browser-based advertising where a limited number of user interactions occur during the day, IoT advertising might count on users interacting with the IoT environment almost 24 hours a day [5]. The possible key challenges in the implementation of IoT advertising is the IoT architecture, which has several challenges that need to be addressed. IoT device heterogeneity will add an extra burden to the IoT advertisement, IoT can be configured in several different network topologies, which require the use of different network metrics to characterize the IoT traffic, Different levels of data obtained from the user will create user-based digital

signatures which needs to be handles and should be standardized, IoT device cooperation is not possible, the delivery of the advertisement content to the user will be exclusively defined by the device capacity, Integrating IoT into the traditional advertising model poses security challenges for customers, advertisers, and publishers. Some of the security challenges that need to be overcome [5]. IoT system will be the best choice for real time monitoring to reduce the traffic congestion as well to control the traffic flow with the parking availabilities, parking reservations and other payment procedures.

Related Work

The importance of IoT cannot be denied because it provides solutions to a wide range of problems. IoT devices are transforming the delivery and management of healthcare services by enabling remote patient monitoring, remote treatments, and predictive maintenance of medical equipment. IoT sensors in agriculture enable precision farming methods that maximize agricultural productivity. In addition, smart city projects use IoT technology to monitor traffic, street lights, train or bus stations, all of which contribute to the development of sustainable urban development. The demand for Internet of Things (IoT) solutions is growing across all industries, increasing efficiency and creativity in our interconnected world. For interactive real time smart advertisements our experiments based on the ESP-8266 with Arduino connected with the Web-API and this Web-API will setup the real time advertisements on the devices / software applications on real time basis.

Approach:

Company will setup Advertisement remotely using API and that advertisement will be displayed on targeted location, mart and product shelf accordingly.

Sample Request Parameters:

ProductCode=55341085688837 (Olpers 0.25 g)
LocationCode=KHIMC (Malir Cantt)
MartCode=NSM (Naheed Super Market)

Note: If **Product Code** will be empty then all products will be included similarly if **Location Code** will be empty then we will consider all location on a City and the same rule is for **Mart Code** if it is empty then we will consider all Marts of a city.

Web-API URL:

http://xxxxxxxxxx/ShowAdvertisements/ProductAdvertise?ProductCode=55341085688837&LocationCode=%20KHIMC&MartCode=%20NSM

Companies and interact with the Cloud from remote locations anywhere and anytime and then generate the Advertisements and Offers onto the Cloud there is no location dependencies. We need to design a complete infrastructure for the IoT Based Advertisement and Offers should be displayed in the Shopping Mart on real time basis for each product. We will save these real time communications on the cloud for further interaction of the mobile applications to generate the recommendations. The cost of this infrastructure will be the one-time cost and then only maintenance will be required, and Companies can do unlimited promotions using this IoT Smart Advertisement Solution

Smart Advertisement Infrastructure

The Smart Advertisement Infrastructure consists of a WiFi Module that connects to the WiFi router and then sends fetches the data from the Web-API via HTTP GET Request. In this Smart Advertisement infrastructure the Web API being implemented on Microsoft technology ASP.Net Web API tool and then hosted that Web-API onto the dedicated shared server. Now ESP-8266 chip of each product shelf connected to the centralized application via Web-API and the Web-API already synchronized by the IoT Advertisements available for each location, mart or product.

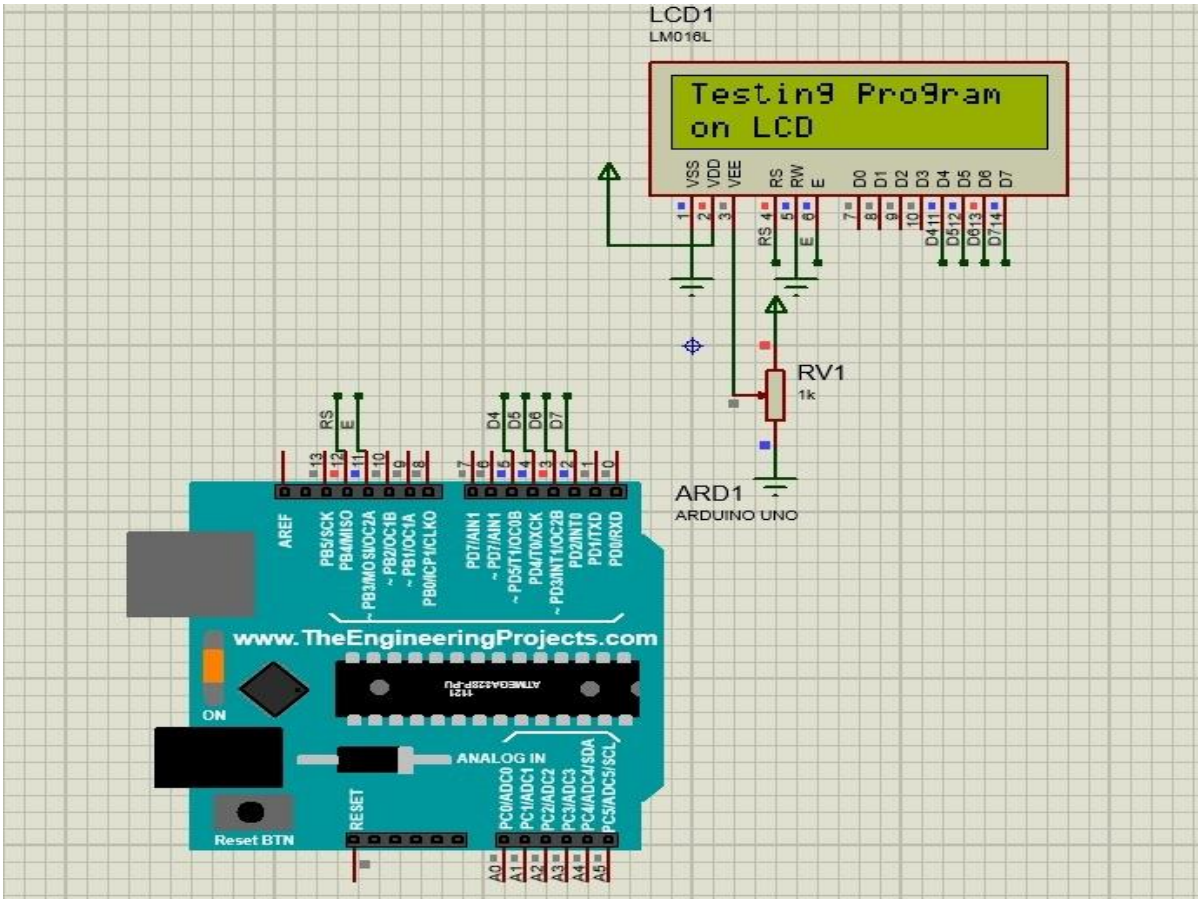

Figure 1: Simulation Circuit Diagram Using 16 X 2 LCD Arduino UNO

When the API is opened, the API gives the data in form of a JSON format which is processed by the Microcontroller to fetch its contents. The data is then sent over to the LCD / LED Screen that is connected to the System. The LCD used is a 16x2 Character LCD, and the controller used is an ESP-8266 SoC. In **Figure-1** this simulation we have tested the circuit using 16 by 2 LCD and an Arduino UNO, on Proteus. The library that is used is Liquid Crystal library. The Vss pin is connected to Ground, VDD pin is connected to 5V supply, VEE is connected to a potentiometer for adjusting pixel intensity of LCD. RS Pin is connected to Pin 12 of Arduino, R/W is connected to Gnd, Enable to Pin 11, D4 pin to pin 5, D5 pin to pin 4, D6 pin to pin 3, D8 pin to pin 2 of Arduino. The code is written on Arduino IDE, the hex file is then transferred to Proteus for Simulation.

In **Figure-2** circuit is shown in the diagram and the Same LCD code is used for ESP-8266 module, but in a slightly updated way. The previous code has hardcoded value of String that is displaying on LCD, but here the value of String that is displayed in LCD is fetched from Web API using an HTTP GET Request. The

data is then passed to ESP-8266, the simulation however is not possible is Proteus because there is no simulation package available for ESP-8266 module.

Internal Architecture of Smart Advertisement

The overall mechanism works on the shared database server, ESP-8266 WiFi Module and physical Product shelf information.

Conceptual Workflows: The Product Companies first logged-in into the system and system will verify the company account then the company administrator can select the Product Category, Aisle and Sku as the initial information to generate a (UPC) Unique Product Code. Now Companies able to setup the Location of the Mart in Karachi City against each unique Product Code and then setup the Mart Locations accordingly. After this Companies can generate the desired Advertisements and Offers against physical mart locations, specific mart or for specific Product Code.

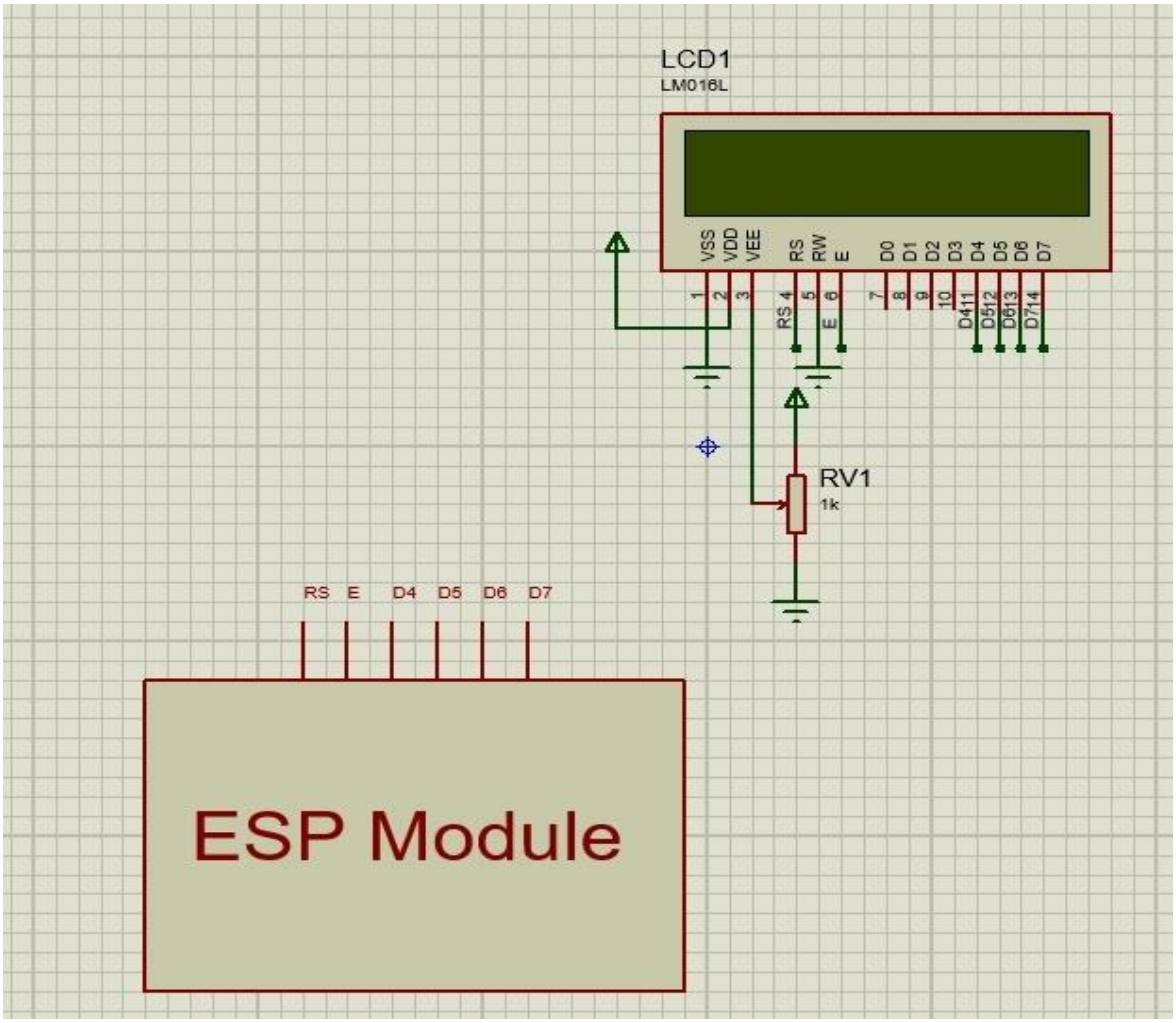

Figure 2: Circuit Diagram showing LCD with ESP Module using Proteus

Smart Advertisement Recommender System

It is also possible that any product selected in the to-do list has no satisfactory past data or it is a new product then we need to generate the recommendations on the basis of the products promotions and offerings announced by the Companies by using the IoT Smart Advertisement Component. This feature will

show the real time promotions and advertisements on the shelves in to the grocery mart. The product companies first purchase the promotion account onto the cloud server and then login into the mobile based application with that company account. Every company has a single account onto the cloud and can generate the multiple promotions thought out the city across the world. Company promotion can vary from location-to-location, mart-to-mart and product-to-product. Company can also active and inactive any promotion as needed among all marts. The first step will be the Company Registration process right now we have a simple user authentication module in this mobile application but in future we can introduced the QR Customer verification Code for mobile devices.

In **Figure-3** we can see that the generated Advertisements will be pull by the ESP-8266 WiFi Module on each Shelf against a unique product code on real time basis. Companies can on/off Advertisements at any level by handling a flag on Cloud base information. We can see that ESP8266 will fetch the information from Cloud Server through Web API. The Web API already define different URL pattern to communicate with the IoT SMART Advertisement Web API which will works on the different cases and these cases varies from Location to Location and Mart to Mart with the Product to Product. In **Figure-3** we can see that Smart Advertisement Component will use a separate database named as SIoTA and we need to synchronize the Grocery Mart Dataset with the SIoTA Database as needed to apply the appropriate Advertisement and Offers. We implemented a Web API which is the responsible to communicate or synchronize with the Real time Advertisement Component. This Web-API can provide the service to the third party software and other mobile devices and software applications.

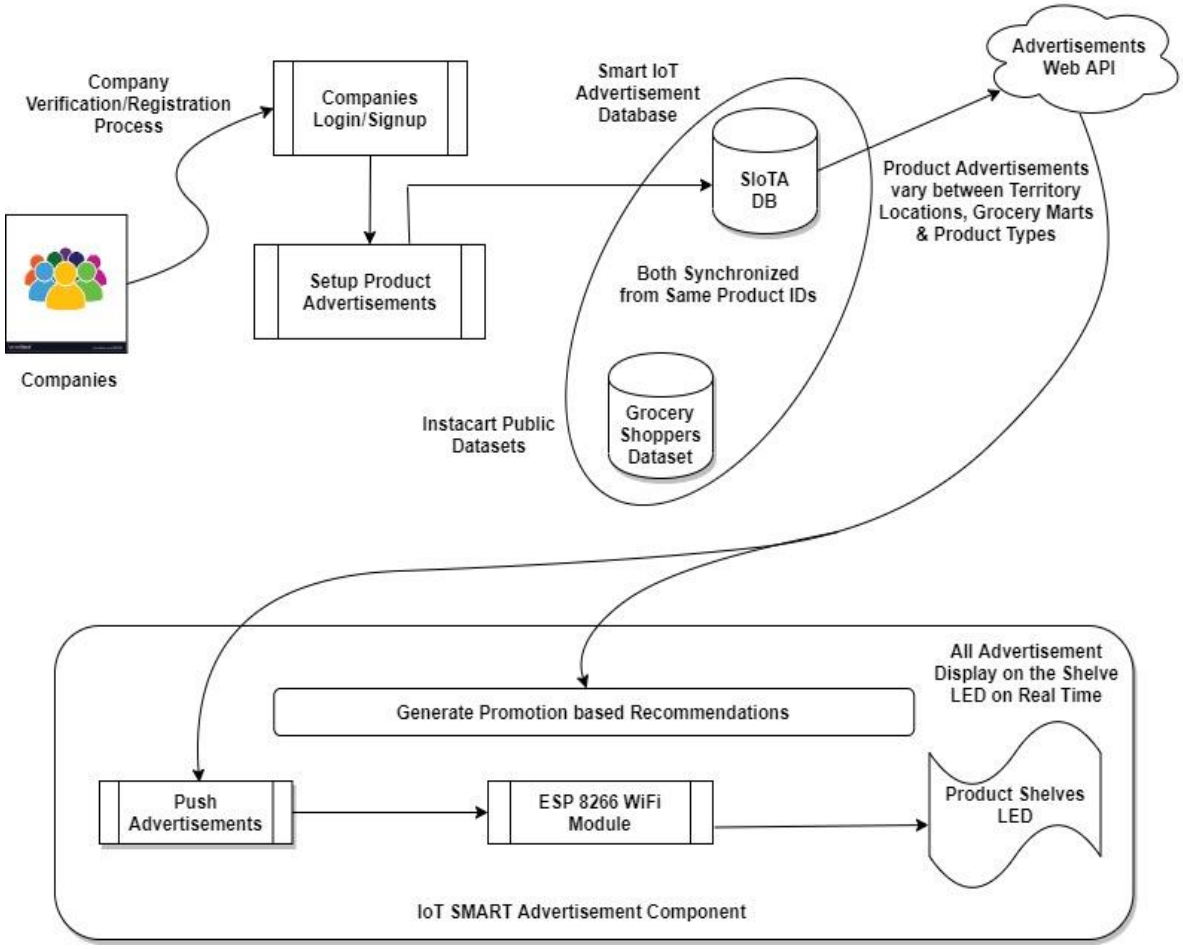

Figure 3: Figure captions should be centred and placed below the figure.

Smart Advertisement Opportunities

For smart advertisement the companies can promote their products in the following possible ways within the city. The following **Table1** describe the advertisement opportunities between P = Products, L = Locations (territories) and M = Marts whereas the cross ✗ is showing here the real time advertisement is for any product, any mart as well as any location within the city whereas ✓ is for a specific Product, Location or Mart Code.

Table 1. Smart Advertisement expected outcomes

P = Product Code **L** = Location Code **M** = Mart Code

Test	P	L	M	Smart Recommender Expected Outcomes
1	✗	✗	✗	[{"Advertisement1":"Buy 3 Get 1 Free Offer"}]
2	✗	✗	✓	[{"Advertisement1":"Buy One Get One Free"}]
3	✗	✓	✗	[{"Advertisement1":"20% Discount Offer"}]
4	✗	✓	✓	[{"Advertisement1":"Buy One Get One Free"}, {"Advertisement1":"20% Discount Offer"}, {"Advertisement1":"Buy 2 Get 1 Free Offer"}, {"Advertisement1":"Buy 3 Get 1 Free Offer"}]
5	✓	✗	✗	[{"Advertisement1":"20% Discount Offer"}, {"Advertisement1":"Buy 3 Get 1 Free Offer"}]
6	✓	✗	✓	[{"Advertisement1":"20% Discount Offer"}]
7	✓	✓	✗	[{"Advertisement1":"Buy 2 Get 1 Free Offer"}]
8	✓	✓	✓	[{"Advertisement1":"Buy One Get One Free"}, {"Advertisement1":"20% Discount Offer"}]

IoT Enabled Recommender System

Our proposed methodology is to implement an admin panel and setup desired advertisement promotions for each product in our application database through Web API. Administrators can also configured the different Products, Locations and Marts in application database so that the real time IoT advertisements can be handled remotely using ESP8266.

Company Account Setup: In application Admin will configure company and every company assgined a unique company code. Also these companies will be configured another account for IoT based remote advertisements.

Product Details: In **Figure-4** we can see that we have mobile application interface product details can be inersted after finalizing the company setup, product category, product types and product skus. We can see that we have unique key named as the Product Code and all advertisements and other itegrtions with the Web API will be handled by this product code and every sku have a unique product code.

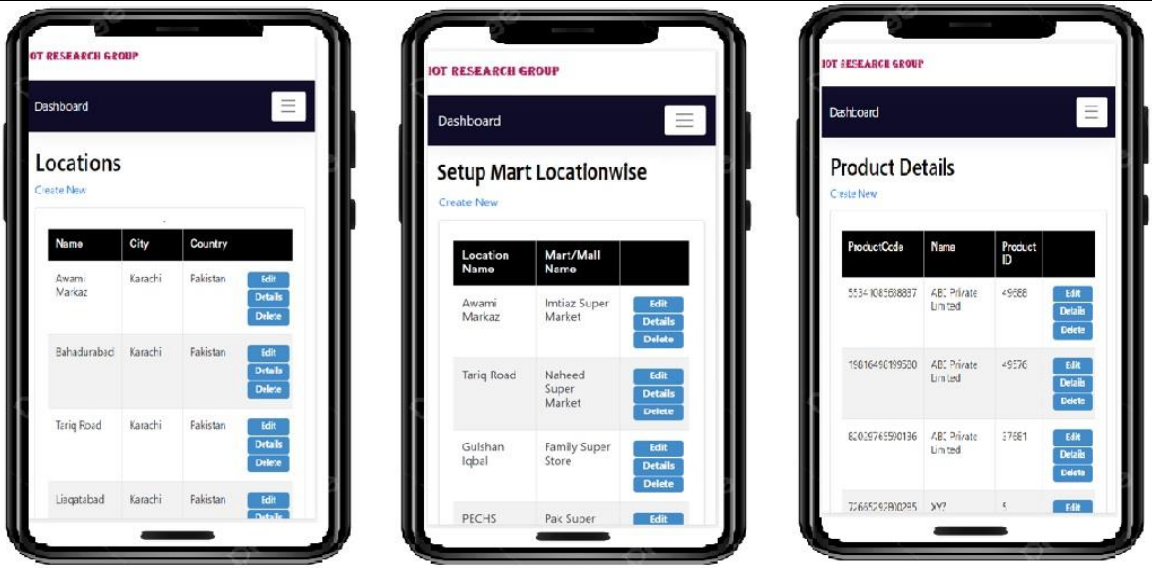

Figure 4: Mobile Application to Setup Locations, Marts and Products

Location Setup: In this mobile application interface as shown in **Figure-4** we will assign different locations of the grocery stores. We can see every location is defined under the specific city as well as the country. Every unique location can have more than one grocery marts and we can set advertisement grocery mart wise.

Mart Setup: In this mobile interface in **Figure-4** we will setup the Grocery mart for example we have inserted some sample grocery marts Imtiaz Super Market, Naheed Super Market as well as some other grocery marts.

Advertisement Setup: In **Figure-5** we will setup the Advertisements after finalizing the Shopping mart location, Shopping mart name as well as product details and we can setup advertisements in different ways by which companies can increase the revenue by increasing the company sales.

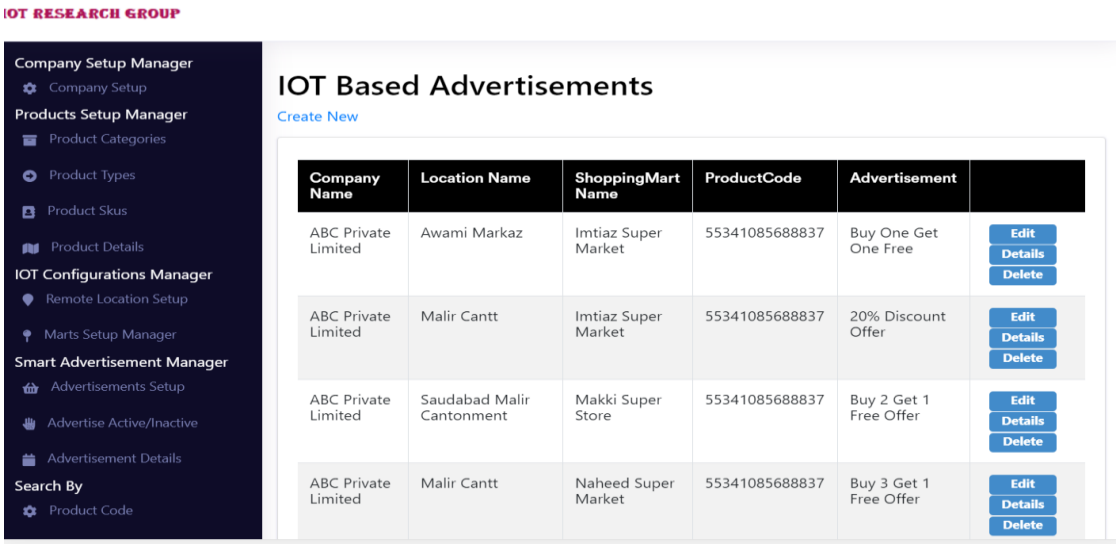

Figure 5: Admin Panel to Setup SMART Advertisements Messages

- If a shopping mall has different outlets within a city on different locations, then same product in different oulets can setup with different advertisements of the same product code for different outlets advertisement that will be displayed onto the remote locations on real time by the Advertisement companies.

- If a location is same and we have different Grocery shopping marts then we can setup different advertisements of the same product code for same location with different mart outlets that will be displayed onto the remote locations on real time by the Advertisement companies.

- If the remote mart location is unique as well as the grocery shopping mart is unique then we can easily setup the advertisements offers of the same product code for specifically in that shopping mart only to increase a sale of that product as well as to increase the overall sale of that grocery shopping mart.

Smart Advertisement Recommender System Output

In this experiment all IoT devices ESP8266 connected to the physical shelfs of different locations (areas), marts and products and each ESP-8266 connected to the data available in the implemented application interface through the Web API. Another interesting thing is that this experiment is not using the IoT Configured Server here and all IoT communications was held on the basis of http requests by introducing a simple shared web hosting server with a cheapest solution Architecture for real time IoT Smart Advertisements.

Test Case 1: P = All L=All M=All	**Test Case 2: P = All L= All M=IMS**
	
This IoT experiment is for SMART Advertisements for all products, for all shopping malls, for all locations in the City Karachi, Pakistan	This IoT experiment is for SMART Advertisements for all products, for a shopping mall Imtiaz Super Market in all locations in the City Karachi, Pakistan.
Test Case 3: P = All L=ML M= All	**Test Case 4: P = All L=ML M=IMS**
	
This IoT experiment is for SMART Advertisements for all products, for all shopping malls of a specific location **Malir** in the City Karachi, Pakistan.	This IoT experiment is for SMART Advertisements for all products, for a shopping mall **Imtiaz Super Market** in specific location Malir Karachi, Pakistan.

Test Case 5: P = Olper's L= All M= All	**Test Case 6: P = Olper's L= All M=IMS**
	
This IoT experiment is for SMART Advertisements for a product **Olpers milk**, for all shopping malls, for all locations in the City Karachi, Pakistan.	This IoT experiment is for SMART Advertisements for a product **Olpers milk**, for a shopping mall **Imtiaz Super Market**, for all locations in Karachi, Pakistan.
Test Case 7: P = Olper's L=ML M= All	**Test Case 8: P = Olper's L=ML M=ISM**
	
This IoT experiment is for SMART Advertisements for a product **Olpers milk**, for a shopping mall **Imtiaz Super Market**, for all locations in Karachi, Pakistan	This IoT experiment is for SMART Advertisements for a product **Olpers milk**, for a shopping mall **Imtiaz Super Market**, for a location **Malir** in Karachi, Pakistan

Figure 7: Experimental Results on LCDs for Real time SMART Advertisements using P=Product code, L=Location Code and M=Mart Code

Conclusions

In this experiments we can setup the advertisements on three levels it can be location-to-location means same grocery mart outlets can display different offers and advertisements according to the product situations, another is mart-to-mart means if two or more that two marts on the same location then company can setup advertisement and offers on the basis of the mart stock situations and another is product-to-product which means Advertisements and products can vary from product to product within a grocery mart. After above advertisement opportunities we concluded that all marts, locations have been successfully well equipped with the IoT based SMART Advertisements to generate the real time advertisements but there is need to maintain the proper IoT communication standards over the http requests, data privacy as well as data security. The Future directions about this thesis is that we can replace the ESP-8266 IoT device with the iBeacons (Bluetooth Technology) or any other technology to get the faster communication between the IoT devices. Maybe we can design the solution onto the native application to target the specific devices to generate the greater reliability. Another factor should be considered as future direction that is to implement personalized advertisements on the basis of past user experiences so that customers can prioritise the desirable products promotion first and then the other remaining all products advertisements

Acknowledgement

The authors of this paper would like to thanks to **Centre of Electronic Research and Development (CERD) Pakistan** (http://www.cerdpakistan.com/) for the use of Research Lab and IoT equipment's.

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