ProximIoT: A Proximity-based Product Marketing Platform

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Abstract
The broad acceptance and deployment of smartphone and Internet of Things (IoT) technologies presents a first-class opportunity for strengthening product marketing via interaction between businesses and their in-store customers within physical stores. Knowledge and tracking of the physical proximity of customers to particular products can extend successful recommendation strategies for product marketing applied in online stores to physical stores. Thus, there is an opportunity for businesses to utilize the potential of smartphones and IoT for organizing advertising and promotion campaigns with better results compared to traditional techniques. This paper presents an IoT platform developed for proximity marketing, which collects information related to user locations in real time within the sales area and processed in correlation with historical data. The platform analyzes the aggregated data for optimal decision making by marketing departments and performs targeted interaction with consumers in real time through automated messaging. The IoT platform operation is based on Bluetooth beacon devices installed in the business sales area, combined with smartphones owned by customers. The aim of developing the ProximIoT platform is to improve the effectiveness of promotional activities put in place by businesses, as well as overall customer experience.

Keywords
Proximity Marketing, IoT, Bluetooth beacons

1. Introduction

The concept of proximity marketing put forward by the ProximIoT [1] project relies on the intuitive notion that the location and movement of customers in relation to products is an indicator of purchasing interests. PrioximIoT combines the advantages of physical (presence in the store) and digital stores (personalized information and better understanding of customer interests), thus creating a new immersive experience and an effective channel for relevant and personalized advertising and marketing information. Proximity marketing directly utilizes mobile devices to deliver advertising and marketing content; thus, marketers take advantage of the ever increasing use of smartphones by all consumers, sending them targeted notifications and personalized offers. This strengthens loyalty and active participation of consumers, increases motivation for direct in-store purchases [1], and reduces labor-intensive marketing tasks. GDPR-compliant collection and processing of consumer location data combined with inferred user behavior (e.g., interests, preferences, etc.) can lead to better targeting and personalized offers to consumers [2] as well as improved placement of products in the store, in areas that attract the most attention [3].

ProximIoT is being developed by Terracom S.A., the department of Computer Science and Engineering, University of Ioannina, and the Institute of Computer Science, FORTH. The system combines different tools and technologies with the aim to recognize consumer preferences and subsequently address targeted advertising recommendations. The system tracks and collects the location of the customer inside the sales area with the use of IoT devices [4] (Bluetooth beacons) and a specially-developed smartphone application. These location data are transferred to the Zastel IoT platform [2], which allows the easy management of IoT devices and the development of IoT applications based on cloud technologies. It constitutes a vital part of the system providing all necessary CRUD functions on the basic entities of the IoT platform and the appropriate infrastructure, services and an API to facilitate IoT applications development. Content Management System (CMS) has been developed which is where the content of recommendations is derived, by processing collected data using machine learning techniques in order to generate targeted recommendations related to a customer's interests. The development of profiling techniques offers a personalized experience to consumers based on their dynamic behavior within the

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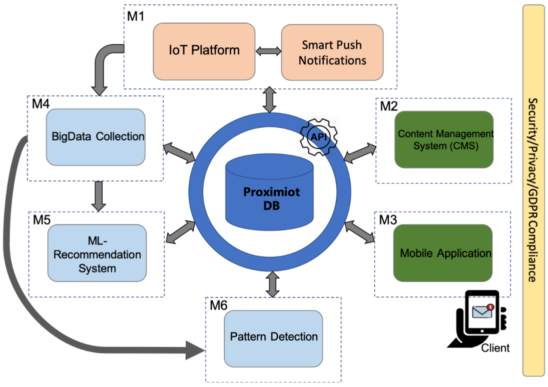

Figure 1: System Architecture

sales area. The study of the dynamic behavior and movement of customers within the store (e.g., duration of stay near specific products) through pattern recognition can successfully lead to comprehension of customers' buying power, motivation for purchases and habits, i.e., all elements that can increase business profitability.

2. System Architecture

The ProximIoT architecture is modular, consisting of six subsystems that comprise a customizable and extensible system. The structure and information flow between them is shown in Fig. 1.

A core component is the ProximIoT database (ProximiotDB) which interacts with all subsystems and mainly manages location-related data. The IoT platform and smart push notification subsystem (M1) receive data from the application that runs on the consumer's mobile device, processes and stores the data on queues, from where they are consumed by the BigData Collection component (M4). After processing, the platform forwards appropriate marketing content to the client's smartphone via push notifications. The subsystem responsible for storing and managing information regarding products, customers, offers and transactions is the CMS (M2).

The mobile application (M3) that interacts with ProximIoT realizes the bidirectional communication with the IoT platform, through which users automatically receive the corresponding information for each product based on their location within a market store, as detected by beacons. The main functions of M3 besides forwarding product information are the projection of advertising campaigns for each store, product rating, and product comparison. The BigData collection and processing subsystem (M4) consumes data messages from Zastel and accepts product and customer data from CMS and ProximiotDB. Retailers can receive real-time insights and reports with visualisation of the movement of consumers and their interest in products.

Algorithm 1: M5: product recommendation

Input: Current user (cu), Current beacon (bcn)
Output: The product to propose

$cu\_products$ = getProducts(cu, bcn);
$possible\_products = \emptyset$;
foreach $user \in topK(similarity(cu))$ **do**
    $user\_products$ = getProducts($user$, bcn);
    foreach $prod \in user\_products$ **do**
        if $prod \notin cu\_products$ **then**
            $possible\_products$ add($prod$);
            if $user$ $bought$ $prod$ **then**
                $prod.score$ += similarity($user$);
            else
                $prod.score$ -= similarity($user$);
            end
        end
    end
end
return *topScore($possible\_products$)*;

ProximIoT contains a ML and recommendations subsystem (M5) that receives data from M4, CMS and ProximiotDB modules and applies ML techniques using Spark. M5's functions include classifications of customers based on their choices and creating recommendations for purchases based on customer history and profile similarity, navigation to points or aisles of the store with products of interest or discounts, and products in their wishlist available on the mobile application.

To achieve this, M5 performs a *cosine similarity* check on the customers, based on the amount of time they spent on products, trying to find customers with similar buying interests as the current one. M5 selects the *topk* customers and locates the products they bought, that the current customer has not yet bought. M5 ranks those products with a scoring function (based on the cosine similarity) and proposes the one with the highest value to the user, as depicted in Algorithm 1.

Finally, a pattern detection component (M6) is responsible for detecting interesting event patterns using the location-based events collected by the placed beacons at runtime. Pattern detection [5] is based on Esper[3] Complex Event Processing (CEP) system. Esper considers the most recent activity of a customer in a store and then using the Event Processing Language (EPL), a SQL-based language, M6 detects event patterns of interest which, in turn, trigger specific promotional notifications sent to the customer through the smart push notification system. For instance, if the customer is detected in the area of TVs

[3]https://www.espertech.com/esper/

in a retail shop for at least 2 minutes, then a promotional message for a specific TV on sale is sent to the customer.

Overall, the information flow starts when M3 provides the location of the consumer to M1, while it also communicates with the CMS from where it receives information about a specific product, which the customer focuses on. In addition, M1 continuously sends to M4 tracked user data (location, duration of stay in beacon's range) for collection and filtering. M4 updates the recommendations (M5) and event pattern detection (M6), which in turn analyse the information and provide the customer with personalised behaviour-based suggestions, which will be displayed on smartphone (M3) via M1. M1 communicates bidirectionally with M2, M3, M4, M5 and M6 subsystems aided by the ProximIoTDB.

As already mentioned, ProximiotDB is required for the interconnection of the subsystems, through its API. ProximiotDB stores the customers' locations per session, the aggregate of recommendations that took place, and useful detected patterns. ProximiotDB and CMS (that manages clients' personal information and products' information) constitute the entire system databases. From privacy perspective, note that no sensitive user information (e.g. names, addresses, etc.) is stored in ProximiotDB; each user is represented by a unique random identifier.

3. Current Status

ProximIoT is currently in an advanced development phase with several subsystems and functions completed and others in an optimization phase. Completed subsystems include the IoT platform with the APIs and CMS which have been deployed on the cloud, ProximiotDB along with the BigData collection module, deployed at the University of Ioannina, and the mobile application with many features and smart notifications continuing to be enriched. Furthermore, the recommendation system has reached the state where it can suggest products based on the customer's current position and his similarity to the previous customers of the store (Alg. 1). A testbed has been developed at FORTH-ICS (Fig. 2) for the purpose of applying integration tests on the implemented subsystems. We use Kontakt.io's Bluetooth LE beacons, configured to use iBeacon protocol with signal range about 1 meter. The placement of beacons is made in a way to avoid signal overlaps in space when possible.

Results from the controlled experiments with the current ProximIoT prototype indicate that tracking and analyzing the location of customers with respect to promoted products over time can indeed provide useful insight as to their interests and potential purchasing plans. Furthermore, a store located in Ioannina, Greece has already installed on its premise Bluetooth beacons, and assigned on them the nearby products, so as to test ProximIoT with real customers. From that upcoming commercial pilot we are expecting further validation of our experimental results.

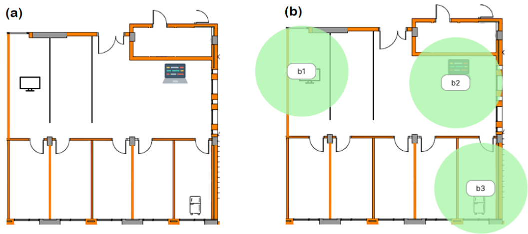

Figure 2: (a) Floor plan ; (b) Installed beacons

4. Conclusions and acknowledgments

In this report we described ProximIoT, a novel IoT-driven system for proximity marketing, aiming to drastically improve the effectiveness and automation of in-store product marketing, advertisement, and promotion campaigns.

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