Ionic and AngularJS: Frameworks for developing Interactive & location-based-museum hybrid systems

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1. Motivation and Background

Museums are rich in history and cultural content, but are heavily challenged on ways to best present them to large groups of mobile visitors irrespective of information accessed by their devices and preserving the interest of each individual. The use of interactive information systems technology in museums has been getting much attention and so many studies are being done in different directions in hopes of improving user experience and further help museums' exhibit artifacts in a more attractive way. Some of these emerging technologies at the heart of museum community are Virtual Reality (VR), Augmented Reality (AR) and Web3D as indicated by (Styliani, Fotis, Kostas & Petros, 2009; Sommerauer & Müller, 2014). Due to diverse contextual environment found in cultural institutions, there is a huge range of isolated possibilities in addressing user experience but when considering a visitors inclusive-based approach this in turn leads to most museums adopting hybrid systems.

Customary ways of developing museum systems are heavily restrictive to certain single platforms, which might not be familiar to some visitors (El-Kassas, Abdullah, Yousef, & Wahba, 2014)., and museum's owned single platform application would furthermore limit visitors from using their personal devices for that purpose, hence the consideration to design and develop a hybrid system in this study. A number of cross-platform development tools and frameworks are already widely used in both research and industry. Such tools include but not limited to Phonegap, Appcelerator, Xamarin, Codename One and Ionic ("Top 10 Cross-Platform", 2017 & Griffith, 2017). These tools and frameworks have pros and cons, but selection depends on the desired project type and requirements. Studies [ref?] show that a large segment of mobile users worldwide still possess limited emerging features that actually support augmented and interactive guide experience applications. In order to support a large number of mobile visitors, we have opted to explore cross platform mobile development, with major benefits such as those stated by El-Kassas, Abdullah, Yousef, and Wahba, (2014):

a) Development is done once, and distributed for use on different platforms.
b) Reduction of development time and hence resources plus efforts.
c) Allows code reusability and easy development, since code is written once but deployed a multiple times.

These could shorten our development time and with access to native functionality we would be able to explore those functionalities on all different platforms. This option however is only limited to platforms with Bluetooth Low Energy (BLE) compatibility. The question is how to allow other phones to mimic augmented virtual interactive experience, however for the purpose of this paper is the core aspect of the BLE-based system that we aim to achieve.

This study aims to use agile development methodology to create iterative and incremental system implementation; this study will specifically be based on extreme programming since the systems versions will be meant to enhance its quality following the users' responses or the continuous change in users' requirements ("Extreme programming- Wikipedia", 2017). An extensive field tests usability evaluation will conclude this research; we will use an approach based on (Harrison, Flood & Duce, 2013) model that considers a comprehensive set of usability attributes including cognitive load and mobility of visitors within a museum. We will use the Independence Memorial Museum (IMM) data for our test cases and the first prototype is limited to Android and iOS platforms due to their BLE compatibility.

The purpose of this paper is to demonstrate how Ionic and AngularJS can be combined to develop a hybrid museum system that could be used in museums to enhance visitors' experience and satisfaction using smart phones with different platforms to provide video, audio and text format information of an iBeacon-tagged artifact.

2. SYSTEM OVERVIEW.

This project relies on data exchange services of a Couchbase server and gateway that has two user interfaces, one as a web application based on NodeJS/AngularJS and the other as a cross-platform mobile application developed with Ionic. AngularJS is a JavaScript based framework that can be used to build modern, dynamic and complex single page web

applications. Angular extends plain HTML templates and structures, styling and behavior to the different components. Ionic is a mobile framework built on top of AngularJS and Cordova using HTML5 for markups, CSS/SASS for styling and JavaScript for additional functionalities.

Combining Ionic and Angular during development makes building web / hybrid mobile applications easy, quick and resource saving because they are both based on JavaScript and hence the developer can reuse code from either the back-end to the front-end and vice versa. In addition the latest version of Ionic comes with a set of native style and layouts for most popular mobile platforms (Pham, P., 2016). The native wrappers of Cordova incorporated in Ionic empowers it much further since one can use these wrappers to mimic the native functionalities of any given platform.

Couchbase (originally known as **Membase**), is an open-source, distributed (shared-nothing architecture) multi-model NoSQL document-oriented database server that is optimized for interactive web, desktop and mobile applications. It is designed to easily support JSON document access with low latency and high sustained throughput. This project makes use of Couchbase because it can easily scale large documents into JSON objects and it's fully compatible with JavaScript hence it will be easily be manipulated by both the web and mobile UIs. The figure below illustrates Couchbase systems architecture that is commonly adopted and to be used in this project (Smotra, 2017).
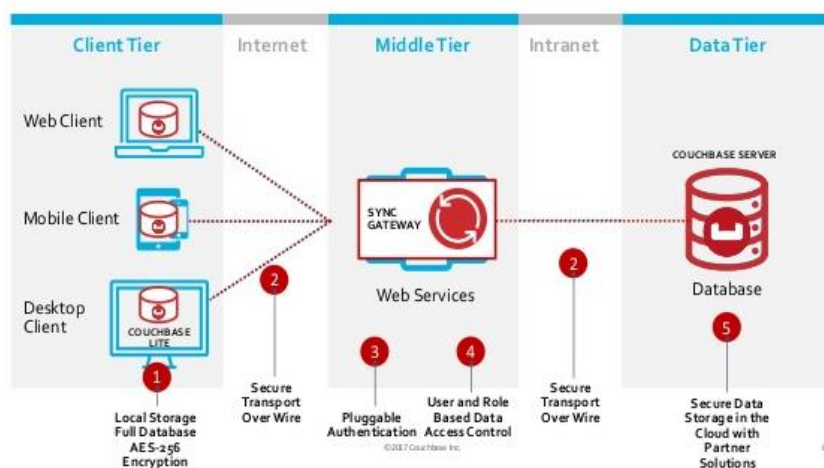
The system has two more crucial aspects to make it function properly; that is BLE-tags (iBeacons in our case) on artifacts or Points-Of-Interests (POIs) and Wi-Fi or Internet access for data

exchange between the Couchbase server and the different client applications. A User-centered design will be employ in this study to try and minimize "visitor cognitive load".

3. WHAT WILL BE DEMONSTRATED?

We will give a brief description on development, testing and deployment with Ionic and AngularJS, then demonstrate the following features of the hybrid museum application in a simulated museum setting:

a) Updating information on the server through the web applications, such as new museums and new exhibits within an existing museum

b) Changing iBeacon tags from one artefact to the next and let the mobile clients pick up the changes. The precision of the iBeacons will also be tested by varying the distances from the artifacts to the mobile phones.

c) Allow simulated visitors to update photos from their tour onto the web applications' gallery and social media.

d) Compile changes on the web and mobile applications and have them reflect in the test environments.

4. FURTHER WORK.

The implementation challenges of micro-location precision for mobile phones with or without BLE support and features phones needs to be further studied to allow majority of mobile phone users visiting the museum to mimic augmented virtual guide experience.

System usability as well as its functionalities and human ethical issues will be explored further.

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