

# **Utilising Augmented Reality to create a Brand Interaction Application on Mobile Devices**

by

**Eamon Wong, B.Sc.**

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EAMON WONG

*University of Dublin, Trinity College*

*December 2011*

# Utilising Augmented Reality to create a Brand Interaction Application on Mobile Devices

Eamon Wong, M.Sc.

University of Dublin, Trinity College, 2011

Supervisor: Dr. Gerard Lacey

Advertising through the use of Augmented Reality (AR) has gained tremendous momentum in recent years. The availability of powerful, camera equipped smart phones and tablets with wireless internet connectivity have made mobile AR applications more viable than ever. As a result, brand owners and advertising companies have been actively looking for new ways to entice a wider audience to interact with their brands using AR.

This research project presents a mobile AR application built from the Junaio AR platform that allows a user with an iPhone, iPad2 or an Android device to interact with a brand's advertising campaign in various ways using AR. Interviews with several of Ireland's top advertising and marketing professionals were carried out to get an insight into how AR is viewed in the advertising industry and also to discover the voice of the customer; their key expectations and preferences regarding an AR Application. Marker based AR and various methods of interaction are analysed through the use of rapid prototyping. The final application shows how marker-less AR can be used to entice brand interaction while providing additional information about the brand, retailer locations and discounts. The application also allows the user to share their experience on Facebook. Finally feedback from an advertising and marketing professional as well as a user survey is used to evaluate the application.

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# Chapter 1

## Introduction

### 1.1 Introduction

Advertising through the use of Augmented Reality (AR) has gained tremendous momentum in recent years. The availability of powerful, camera equipped smart phones and tablets with wireless internet connectivity have rekindled everyone's excitement in AR, a technology that has been around for over two decades. Modern smartphones can use AR to show a view of the real world blended with graphics, multimedia and various other forms of computer generated data (see Figure 1.1). As a result of this, brand owners and advertising companies around the world have been actively looking for new ways to entice a wider audience to interact with their brands using AR.

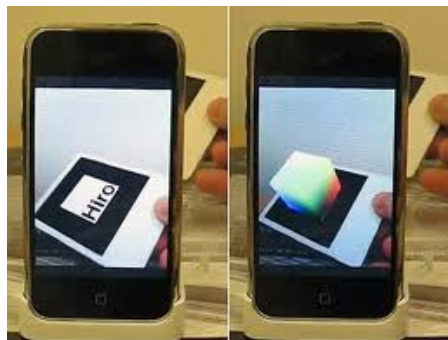


Figure 1.1: iPhone camera view before and after augmentation

*Source: technabob [1]*

The goal of augmented reality is to add information and meaning to a real object or place. Unlike virtual reality, augmented reality does not create a simulation of reality. Instead, it takes a real object or space as the foundation and incorporates technologies that add contextual data to deepen a person's understanding of the subject.

*The Educause Learning Initiative [2].*

For a long time, one of the only places you could find AR outside of research labs was in the Heads-up Display (HUD) of an aircraft (see Figure 1.2). These HUD's were a breakthrough in Human Computer Interaction (HCI) because they allowed a pilot to read vital information being produced by the aircraft's computer more quickly and without having to look down at various instruments.



Figure 1.2: The HUD of an aircraft

AR has come a long way since then. Today it's possible to enjoy a rich and interactive AR experience almost anywhere provided you have a smartphone or a tablet computer. AR applications use contextual information received by the mobile device to blur the barrier between the real world and the digital one. Vision through the device's camera and location based information from its GPS and compass services are most popularly used in mobile AR to gain context from the real world. Vision based AR relies on detecting a marker or image and tracking it. Virtual objects are then displayed to the user in locations relative to the image being tracked. In location based AR points of interest (POIs) are given real world coordinates and their locations are displayed to the user relative to their own location and direction. Advertisers and brand owners around the world have begun

to exploit both of these types of AR by enabling more interaction with their existing products (see Figure 1.3) and by adding POIs for their shops, restaurants...etc. so they can be seen and located by users of the AR applications (see Figure 1.4).



Figure 1.3: Tracking image based AR

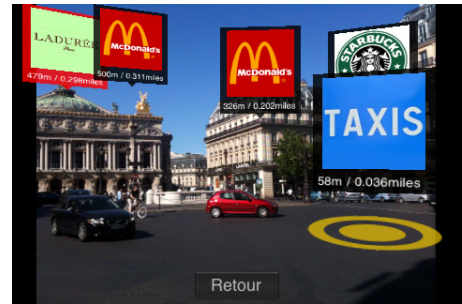


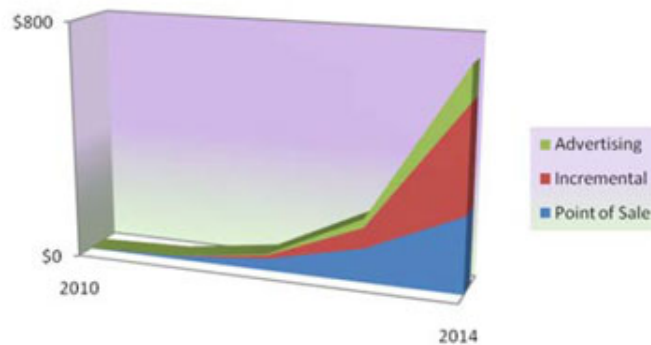
Figure 1.4: Location based AR

Mobile AR applications present a great opportunity for advertisers and brand owners to not only boost awareness of their products but also to open up a dialog with their customers and leave them a lasting impression. Many companies around the world have gotten involved with AR for advertising and had great success and some of these cases will be introduced in the next chapter. Despite its numerous benefits, AR has not taken off in the Irish advertising scene. Apart from one example found in a campaign this summer [3], no other examples of AR and its use on mobile devices in particular have been found. Why is there a lack of AR in the Irish advertising scene? What needs to change so more brand owners will get involved with this technology? These are some of the questions investigated in this research. This project will describe the ins and outs of creating an AR application as part of an Irish advertising campaign and then showcase the benefits that such an application can bring to a brand.

## 1.2 Motivation and Aims

The fascinating potential of AR as a relatively new technology, the increasingly large smartphone market in Ireland and the lack of AR in Ireland's advertising scene are all motivations of this research project.

Figure 1: Total Mobile Augmented Reality Market (\$m) Split by 3 Revenue Streams 2010-2014



Source: Juniper Research

Figure 1.5: A forecast of the AR market revenue in 2014 by Juniper Research

Since the arrival of smartphones mobile AR has been an area of great excitement because it allows the technology to be experienced by a greater audience. Predictions are already being made of how successful the mobile AR market can be (see Figure 1.5) and the forecast looks very promising. In 2011, the Irish smartphone market is stronger than ever and there are more and more new smartphone users every day. A recent study [4] shows that up to 50% of the Irish mobiles have smartphone features, 94% have cameras and 87% have an internet connection. This is very motivating news for the creation of mobile AR applications. To add to this, the smartphones available this year are more powerful than ever. With devices such as the iPhone4 [5] a number of new Android [6] devices and even tablet computers like the iPad2 [7] there are no shortages in devices that are capable of providing a rich and interactive experience using AR while on the go.

One last motivation for this research is that AR ties in with the study of Ubiquitous Computing (UbiComp). AR applications need to learn about the user's environment in order to create some context before any augmentation can take place. Context aware computing has always been a very important area of UbiComp. Another long researched area of UbiComp is HCI. AR opens new doors to how people can interact with computers and objects in the real world. The understanding of these interactions and how to use

them most effectively will push UbiComp and HCI forward into a new era. In the future if AR becomes as popular as predicted, you will not have to inform people that they can retrieve additional content or information by pointing their mobile device at a brand logo or an advertisement, they will just expect it to be there. When that time comes, AR will truly be ubiquitous.

The main goals of this research are:

- Investigate why there is a lack of AR use in Ireland, find out what needs to change in order for it to be an advertising medium of choice and discover what is really wanted by Irish advertisers when it comes to using AR as part of an advertising campaign.
- Create an effective concept and design for an AR advertising application based on the results of the investigation.
- Implement an AR advertising application for use on a mobile device that fulfils the requirements gathered during the research.
- Use the feedback of a marketing professional to evaluate the finished application.
- Perform a user impact survey to find out how people feel about the application.

### 1.3 Document Structure

The remainder of this document is structured as follows.

- *Chapter 2* describes the state of the art of the use of AR with mobile devices, commercial and popular uses of AR, the technologies involved with AR and advertising techniques that are used on mobile devices.
- *Chapter 3* covers the background on technologies used in this project. This includes an introduction to the iOS operating system, developing on the iPad2 and junaio, the AR platform chosen for use in this project.

- *Chapter 4* presents the user-centred design process that was undertaken for this project, research interviews with marketing specialists and the design of the AR application.
- *Chapter 5* gives an in-depth look at the implementation of both the Marker-based prototype and the final application AR Car Park.
- *Chapter 6* shows the two evaluation methods used during this project; Professional feedback from a marketing professional and a user impact survey.
- Finally, *Chapter 7* describes the conclusion of this project and also identifies some future work.

# Chapter 2

## State Of The Art

Brand owners are always searching for new methods to increase brand interaction. The arrival of powerful smartphones with cameras and internet access has unlocked many possibilities for brand oriented user interaction. This chapter describes the state of the art of applications involving AR on mobile devices, commercial and popular uses of AR, AR technologies and related advertising techniques used on mobile devices.

### 2.1 Augmented Reality on Mobile Devices

We will start the review by describing some academic examples of AR on mobile devices.

Early research in the area of camera-based user interaction describes PhoneGuide [8]. PhoneGuide is a mobile phone application, for use in a museum, which allows a user to find out more information about an object on display by simply taking a picture of it using the phone's built in camera. PhoneGuide performs its image processing tasks directly on the phone instead of sending the image to a server for remote processing. This sets it apart from other similar applications of its time because mobile phones were generally considered to lack the computational power to perform reliable object recognition. The object matching techniques used in PhoneGuide such as comparing the objects colour and intensity relations are only suitable for use in areas with constant lighting conditions.

This means that the recognition rate would drop dramatically if used in an outdoor situation. The recognition rate also decreases as the number of objects to be recognised increases. Bruns et al. have been working on PhoneGuide over the past five years and have documented their improvements and modifications. Some of these improvements include adding context awareness through the use of Bluetooth emitters and adding a continuous recognition mode in [9]. They focus on making a self-improving, adaptive sensor network system that dynamically improves recognition rate in [10] and finally, in [11] they improve object recognition by allowing the user to record a near-far video of the object, detect key features using SIFT [12] and then perform matching with a preloaded feature database.

The publications on PhoneGuide describe four different implementations of a mobile museum guide application. They successfully show that a regular mobile phone can be transformed into an interactive museum guide and make a visit to the museum a more enjoyable experience. The easy-to-use object recognition and rich multimedia information displayed for each object encourages the visitors to interact and to learn more about an exhibition than a traditional audio guide or information booklet.

Nassar et al. [13] present a system that is also for use at a museum or an exhibition. Their system aims to turn a user's smartphone into a "magic lens"; a device that allows the user to view hidden objects and information in the real world. An augmented reality iPhone application is described that allows users to access dynamic information about exhibition objects and also to share their own comments or reviews. In an augmented reality application keeping track of where the device is and what it is pointed at is vital for displaying relevant information to the user. Nassar et al. [13] explore the possible tracking techniques available in order to determine which one would be best suited for their application. Location based tracking techniques such as GPS and Radio Frequency Identification (RFID) tags were considered but deemed unsuitable for their application. GPS provides insufficient accuracy in an indoor setting and other known techniques require an expensive infrastructure to be set up before a location can be determined. Their

augmented reality system is based on a client-server architecture. Each object in the exhibition is allocated a unique ID marker which is detected by the application when the user points the iPhone at it. The ID number is decoded from the marker and then sent to the system's server via Wi-Fi. The server then replies with the correct object information that is associated with the given ID. Finally a semi-transparent information screen is displayed for the user allowing them to rate, review or discover additional information about the object in question as long as their phone is pointed at the marker.

In general the performance of the application was good and the use of 2D Barcodes to act as augmented reality markers was quite effective. The recognition accuracy was only limited by the quality of the iPhone's built in camera and it could accurately recognize a medium sized marker from a distance of two metres.

Takacs et al. [14] describe a mobile AR system for use outdoors. Their system matches camera phone images against a database of geo-tagged images using a robust image retrieval algorithm. They suggest that their system could be used as a tour guide application for pedestrians where the tourist simply points their smartphone at a building or a landmark and then the application displays a viewfinder with graphics and hyperlinks that can give the user more information about what they are pointing at. The main focus of this research is on achieving robust image matching on a database full of buildings and landmarks all of which can be observed from different angles and under different lighting conditions. They use GPS locations to narrow down the number of possible matches for a given image and then use the SURF algorithm [15] to extract features which are then clustered and pruned until only the key features remain. These features and location data are sent to a server to find a match and a response is sent back to the user's phone. This system is quite impressive because it successfully deals with changing environmental and lighting conditions; a topic that most research ignores or assumes is constant.

Hagbi et al. [16] present a different approach for transmitting virtual models in AR. In their system a 2D representation of the model is embedded in the printed tracking image itself. They use image processing techniques to interpret the image and then extract a

virtual model which is then used in the augmentation. The advantages of their system is that their tracking images are both human and machine readable and also their AR device does not require a database of models or an internet connection because the model information is extracted from the image itself. One of the working examples described in their paper is of a ski resort map that includes some popular ski routes. The map is enclosed in a thick black border and is used as a tracking image. The top right corner of the image is dedicated to embedded model information, which is an elevation map. The augmented image that results is a 3D map that shows the height of the various mountains and their various ski routes.

While the In-Place AR that is described in this paper is a novel approach, the 3D models that can be generated from this method are quite limited in their shape and texture as they can only use information that is embedded in the image itself.

In [17], Karlsson et al. propose an AR system that enhances a user's visit to a zoo. Their system can be broken down into two main parts; an animal tracking system that relies on a Wireless Sensor Network (WSN) comprised of cameras and RFID technology and a mobile AR application that provides information about individual animals. Using the WSN their system finds the geographical location of each animal at the zoo. This information is used in the mobile application to overlay the location of different animals on the camera view in the form of a POI. The user can then use their mobile device like a compass that points towards different animals. This application also allows the user to select an animal's POI to discover more information about it. The system described by Karlsson et al. is still a work in progress but its results to date are already quite impressive. This is a good example of enticing user interaction through the use of AR.

Belimpasakis et al. [18] present a system for enabling the rapid creation of content for use in mobile AR. Their system aims to allow the average user or small business to geo-register content such as banner ads and then share that content with others to be enjoyed in an AR experience without requiring much technical expertise. Their system is based on a client-server model, where their clients run an AR browser and communicates

with the server. They have developed a web application that allows the user to upload an image, typically a banner ad, and select a location and facing direction on an interactive map. The idea is that small business can put AR ads outside their stores to attract the attention of those using the AR browser on their mobile device. Their system seems quite useful and it would definitely make it easier for users without a technical background to create very basic AR content. If the leading AR browsers today had such an easy to use interface then a lot more users would be attracted to their service.

## **2.2 Augmented Reality in Advertising**

In 2008 commercial examples of AR being used in advertising began to appear. Soon after, the arrival of smartphones with easy access to thousands of applications encouraged more and more brand owners to get involved with AR. This section shows some of the most interesting and successful uses of AR in advertising.

In 2009, the LEGO Digital Box [19] was created. The Digital Box is a kiosk that is comprised of a camera and a large screen that displays the camera feed. Customers can hold LEGO boxes up to the Digital Box and watch a detailed 3D animation of the product from any angle through the use of AR. The Digital Box was extremely successful and by 2010 it was available in 62 LEGO stores worldwide. The Digital Box is impressive because it has to recognise the cover of hundreds of different boxes and then display the correct 3D animation in real time. It also provides very useful information to the customer; a 3D view of what the finished product looks like. This encourages the customer to find the product that truly appeals to them. The Digital Box is considered to be the most successful AR application worldwide.

Also in 2009, General Electric launched a website [20] promoting Smart Grid technology and it allows the users to experience interactive AR in their own home. The website provides instructions that inform the user to print out a special AR marker and then hold it in front of their webcam. Their camera stream is shown on screen and once the marker

is recognised a 3D model of Smart Grid windmills is displayed in its place. The user can view the model from all angles and interact with it by blowing into their microphone. This causes the blades on the windmill to rotate faster. This is a good example of AR advertising that can be enjoyed in the comfort of the user's home. It increases awareness of the Smart Grid technology in a fun and interactive way. News of this campaign spread virally and many videos of its use can be found on YouTube [21].

In 2010, Ben & Jerry's Moo Vision [22] was released on the iPhone app store. The application allowed users to point their iPhone at selected Ben & Jerry's ice-cream carton lids and experience a 3D world which could be viewed from different angles. Moo vision was an add-on to Ben & Jerry's original iPhone app and the successful detection of a lid unlocks an extra feature in the main app. This gives the customers an incentive to unlock all the features by scanning all of the different lids. With this campaign Ben and Jerry's was the first major consumer brand to feature 2D marker-less tracking in their iPhone application.

Around this time mobile AR platforms were becoming more established and viable for the use of advertising. Many mobile AR campaigns began to spring up all around the world either through the use of these AR Platforms or a self-made application. It wasn't until earlier this summer however when the first major, mobile AR based advertising campaign was launched in Ireland. The Mazda [23] AR campaign "Defy Conventions" [3] began on the 3rd of May by advertising in a free daily newspaper, Metro Herald [24], informing its readers that something exciting would be arriving a week later. In the meantime the readers were encourage to familiarise themselves with the AR platform junaio [25]. A week later a Mazda edition of Metro Herald was released, full of Mazda adverts. Using the junaio app the users could find the Mazda AR icon in the camera's view and an interactive, 3D AR microsite was displayed to them. This AR microsite, which was a world first, allowed the users to find out more information about Mazda, watch videos and enter in a competition to win a new car. This interesting campaign will hopefully encourage more Irish brand owners to explore the many innovative uses of AR

as an advertising medium.

## 2.3 AR Technology

This section includes a review the most interesting mobile AR platforms and a comparison of the two tracking methods commonly used in AR.

### 2.3.1 AR Platforms

As AR gets more popular, more and more AR platforms appear in the market for mobile phones. In this section we introduce four of the most interesting AR platforms that are available to download today. They are Layar [26], popcode [27], Qualcomm AR [28] and junaio [25].

The Layar [26] platform is available for both Android and iOS devices. It is downloadable in the form of an AR browser application. It allows users to see what is around them by using the device's GPS and compass and displaying real time digital information (called layers) on top of reality. Users can search through and display one of almost 3000 layers making it the most popular AR browser in the market. Originally Layar was purely a location based AR platform so it was not considered for the development of our AR application. In August 2011 Layar Vision was launched which boasts marker-less interactive AR but unfortunately by this time an AR platform had already been chosen and development was already in progress. Due to the project's time frame, Layar Vision was not investigated in detail.

Popcode [27] is a marker-less AR application that is available for both Android and iOS devices. It allows the user to overlay content such as 3D models over any image provided it has enough texture. The popcode logo, which is found where additional content can be discovered, has a special function. It points the application to external resources to download and then acts like a trigger for the augmentation to begin. Popcode has an impressive array of demos that shows the application at work; the most impressive being

a 3D interactive game where the player must burst 3D balloons by moving their phone in different angles towards the tracking image. Popcode definitely has potential for use in the area of advertising, but unfortunately there are currently some issues involving testing on iOS devices that make it unsuitable for our research.

Qualcomm AR (QCAR) [28] provides a software development kit (SDK) for free to anyone who registers on their site. The QCAR SDK supports both Android (2.1 or newer) and iOS (4 and 5) devices. With the SDK you can create a white label, marker-less AR application from scratch using the devices native languages and the QCAR libraries. QCAR also provides an extension for the powerful game development tool Unity 3 [29], which can really speed up and improve the development of an interactive AR application. The features of QCAR are the most impressive of all the AR platforms. It has the ability to track and overlay interactive content on multiple images at the same time, it allows for most customisation because applications are built from scratch and it also provides an online image tracker manager that allows a user to upload images to be converted to tracking images for use in their applications. The tracker manager even provides a rating for each uploaded image indicating how successful it can be tracked.

There are however some downsides to the QCAR SDK. An application made for Android systems will only be usable on Android systems and the same applies for applications made for iOS devices. The QCAR SDK requires a lot longer learning period than other AR platforms. And finally, the iOS version of the SDK was only released in beta form this summer (July 2011) and there are some known bugs that effect the development of AR apps on the iPad2. Due to these issues QCAR was not used for this project.

The last AR platform that we will introduce is junaio [25]. Junaio is available to download on both Android and iOS devices. It works in a similar fashion to Layar but instead of searching for a layar to overlay on reality in junaio you tune into a channel. There are two types of channels available on junaio; the location based channel and the GLUE channel. Location based channels work the same way as a layar does in Layar but junaio adds more interactive features and allows 3D models to be placed at POIs instead

of just location tags. GLUE channels use marker-less tracking to enrich flyers, packaging or anything else with dynamic, 3D components in real time. The junaio GLUE channel provides exactly what we needed for an AR advertising application so we decided to use the junaio AR platform in our project. Junaio is discussed in detail in section 3.2.

Features	Layar	Popcode	QCAR	Junaio
<b>iOS support</b>	YES	Limited	Beta	YES
<b>Android support</b>	YES	YES	YES	YES
<b>Image Tracking</b>	Limited	YES	YES	YES
<b>Location based POIs</b>	YES	NO	NO	YES
<b>White label app</b>	\$/month	NO	YES	€10000
<b>Documentation</b>	YES	Limited	YES	YES
<b>API</b>	YES	Limited	YES	Limited
<b>Tutorials</b>	YES	NO	Limited	YES
<b>Channel Builder</b>	NO	N/A	N/A	YES

Table 2.1: Mobile AR Platform Comparison

### 2.3.2 Marker-based vs. Markerless AR

This section will introduce both marker-based and marker-less tracking methods of AR and will outline some of the pros and cons of both.

Marker-based tracking is where machine readable symbols are used as tags that inform the machine what it's looking at. This method of does not require expensive sensors or devices with high processing power to achieve. Three types of markers are described in [13]; Template Markers (-Fig. 2.1a), Topological markers (-Fig. 2.1b) and 2D Barcodes (-Fig. 2.1c).

Template markers are made up of a square with a black or white border that contains some symbol(s). Template markers have the benefit of being both human and machine readable but the downside is that each marker must first be designed and then trained into the system before they can be used. It takes time to design each individual marker so they are best used when a smaller number of unique matches are required. Topological

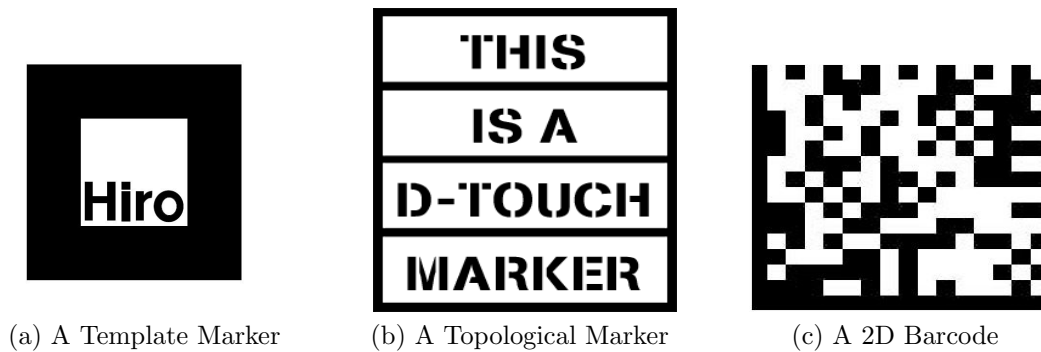


Figure 2.1: Different types of Markers

markers are markers that are recognized based on the relationship between their light and dark regions, not based on their shape. They can be created to convey meaning to people as well as machines but also suffer from the same issues as Template markers. They require a lot of initial effort before they can be used. 2D Barcodes are readable only by machines but they do not require image matching to be understood. A 2D barcode marker can be selected from a fixed set of patterns so the user does not need to design or train them before they are used. An ID marker is a type of 2D Barcode that encodes a single number.

Although using marker based tracking provides good results, their use also has limitations, some of which are mentioned by Nassar et al. [13]. Markers and other 2D barcodes are not visually attractive and as a result their use can be intrusive in an exhibition environment. For the system to work correctly a separate marker would have to be placed next to each object on display. In a circumstance where an object is quite large, several markers may be required so they can be accessed by visitors observing different sections of it. An exhibition coordinator may not want to have their display area cluttered with markers, especially if the exhibition is following a certain theme. The use of markers does not work as well when used on a 3D object like a sculpture. This is due to the fact that the marker is only tracked when it is in view; if the user moves around the object the augmentation will be lost.

Marker-less tracking relies on computer vision algorithms to extract and recognize fea-

tures from the devices camera feed, i.e. the application infers its location based solely on what information it receives from its camera. This is seen as the ideal tracking technique because potentially any image could be used to trigger an augmentation on an AR application, be it an attractive human-readable design, a brand logo or art piece. Marker-less tracking is not without its downsides. It has only started to become popular for use on mobile devices recently because of the advancements of mobile technology. The computer vision algorithms required for marker-less tracking demand high processing powers and their complexities increase as the number of objects to recognize grows. This means that a system that relies on marker-less tracking does not scale easily and as a result AR platforms that allow the use of this type of tracking limit the number of objects that can be tracked at a given time.

## **2.4 Advertising Techniques on Mobile Devices**

In [30], Chehimi et al. introduce a system that allows interactive, 3D adverts to be viewed on camera equipped mobile phones. Their 3D adverts are contained within a marker based tracking design that allows the system to be deployed without requiring an additional network infrastructure. They focus on developing client side of the system which is a mobile application for the Symbian OS platform. The application can locate and read special coloured tags and then overlay 3D content on top of the captured camera frames. Essentially their coloured tags are encoded with a message that points the application to a model location which is then downloaded and superimposed on the position of the tag on screen. They suggest that the model displayed should represent the product or brand that is being advertised thus enabling better awareness. Another possible use for their system mentioned was to create guiding avatars using tags inside a shopping centre. These tags can display newly updated offers and promotions and would reduce the need to reprint ads every time there is a new offer. This research is a good example that highlights the potential of AR in the advertising field.

One other interesting research paper in the area of advertising using mobile devices is [31]. They introduce concept of pervasive symbiotic advertising, where large LCD displays connect to the mobile phone of a passer-by ad display targeted ads based on that users likes and dislikes. The main idea is that the targeted ads are shown on public displays without intruding on the user's personal display. This type of advertising can capture the user's attention even when their mobile phone is in their pocket and is not actively being used. A prototype of this system has been developed that allows the user to store their likes and dislikes on their mobile device which can then be accessed wirelessly by their main system that displays relevant products on an LCD screen as the user gets in range.

Pervasive symbiotic advertising definitely has great potential to improve both the mobile and public advertising sectors, but there is still a lot of work to be done before it can be truly realised on a larger scale. Personally I don't see why somebody would agree to share some of their private data with advertising screens unless there were some incentives involved. Perhaps a free phone.

# Chapter 3

## Background

This chapter describes the technologies used in this project.

### 3.1 The iPad2 and iOS

The iPad 2 [7] is a tablet computer developed by Apple. It is the second generation of iPad and it boasts an array of hardware improvements from its predecessor. The device itself is 33% thinner and 15% lighter than the original iPad, weighing only 600g and it is equipped with a 1GHz dual-core Apple A5 processor which makes it nine times faster. This portability and processing power makes the iPad 2 a great choice for AR applications. The iPad 2 also has a battery life of up to 10 hours and a front and back facing camera. The back camera which would be used for AR, can record 720p HD quality video at up to 30 frames per second. This is more than enough for marker-less tracking. The iPad 2 also has all the standard inputs and outputs that you would expect to find on a tablet computer such as speakers and a microphone. This will allow for more interactive AR experiences through the use of sound and recording. Other features include a three-axis gyro, an accelerometer, an ambient light sensor, a digital compass and assisted GPS. With these features location based AR is possible. The most exciting aspect of using a tablet computer for this research is the screen size. The iPad 2's screen is 9.7 inches and has a

resolution of 1024x768pixels. With a larger screen size the user will be able to experience 3D models with greater detail and it also makes the use of touch based interaction more viable because the targets will be easier to select.

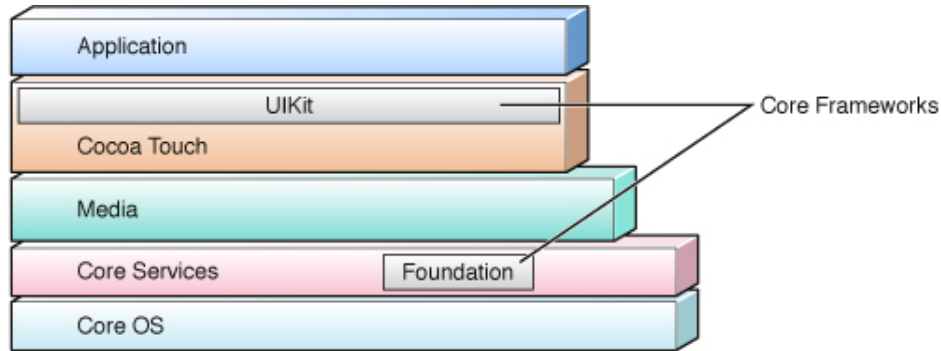


Figure 3.1: The iOS Architecture

*Source: Apple Inc.*

The iPad 2 runs the iOS 4 operating system [32], which is a purely touch based operating system. The interface is controlled by selecting options with your finger or by making a number of multi-touch gestures. Applications can be added to the system by downloading them from the App store. Downloaded apps are then displayed on one of the devices home screens where they can be launched or organised. Applications that run on iOS are written in Objective-C [33].

### 3.1.1 Developing for the iPad 2

In order to develop for the iPad 2 you must first register as an Apple developer, download the Xcode development environment and learn objective-C. This section will briefly introduce Xcode, objective-C and some of the steps taken while learning objective-C.

#### XCode

Xcode is the development environment created by Apple for developing software on Mac OS X and iOS. Its main function is that of an integrated development environment (IDE) but it also includes an interface builder, Apple documentation and an iPhone and iPad

simulator. It is possible to download Xcode 3 for free and create apps that can only be tested on the simulator. If you want to test your app on an actual iOS device (which is necessary for AR) you must become a registered developer first. Xcode also allows you to debug applications that are running on either the simulator or an external device. Once you get passed the confusing registration and licensing process the IDE itself is very nice to use.

## Objective-C

Objective-C is the programming language that is used to develop on all devices that run iOS. It is an object oriented programming language that was developed by combining features from the Smalltalk [34] language to the C programming language. All object oriented syntax comes from Smalltalk and the rest of the syntax is the same as C.

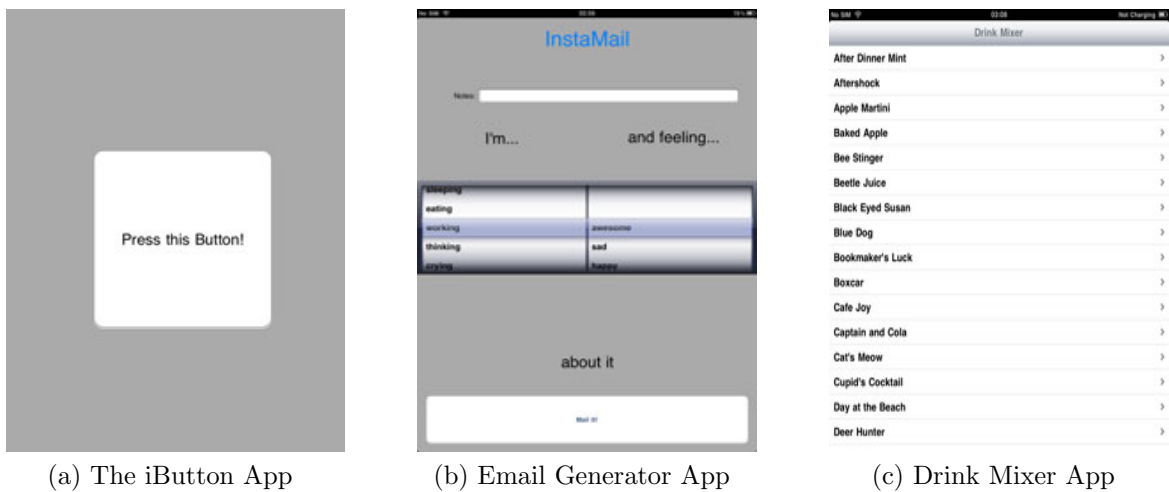


Figure 3.2: Objective-C Training Apps

## The Learning Process

At the beginning of this project a basic knowledge of the C programming language was known but upon seeing the syntax of an Objective-C program for iOS, it was like starting from scratch. The learning process was slow at first but once the first self-made application was loaded onto the iPad2, things started to speed up. A number of practice applications

were made to get the feel for iPad development; ranging from a simple single-buttoned application to a more advanced drink mixer application that provides a list of cocktails from a database and displays how to make them upon selection.

## 3.2 junaio

As mentioned in section 2.3.1 the AR platform junaio was selected as most appropriate for this research. In this section we give reasons for choosing junaio and explain its architecture.

Reasons for choosing junaio:

- First of all, we wanted our application to be available to the largest audience possible and to trigger an AR experience from a traditional ad form, e.g. a printed ad. A channel created for junaio will work on both Android and iOS devices without having to rewrite the entire code.
- A junaio GLUE channel allows a developer to use any image as a tracking image and one channel can track up to seven images.
- The junaio platform is aimed at both beginner and experienced users so they provide a lot of comprehensive getting started tutorials and documentation.
- Its API supports the addition of sound and video to a channel as well as 3D models.
- It supports animated MD2 models and high resolution, static OBJ models.
- It provides a channel builder that can quickly create a basic GLUE channel.
- It allows touch based interaction with models and can handle navigation to a specified location, website links, email and phone numbers.
- All channel content is stored on the channel owner's server and is only downloaded to the junaio app when required. This keeps the application light weight.

### 3.2.1 junaio Architecture



Figure 3.3: The junaio Architecture

*Source: junaio*

The junaio system is made of three main components; the mobile client, junaio web servers and external web servers (see Figure 3.3). The mobile client, which is the downloadable application, is simply a channel viewer and AR browser. The mobile client receives all of its information from the junaio web servers. This includes channel listings and details. The junaio servers manage channel details but not their content. Channel content is stored on the channel owner's external server. The junaio server acts as a middle man by taking a content request from a client and forwarding that request to the correct external server. If the external server's response adheres to the junaio API then the content is accepted by the junaio servers and is finally relayed back to the client. The AR browser on the client then displays the correct models or POIs to the user and does not need additional communication with the junaio servers until another request is made.

Server side scripts should be written in Php and all messages sent from external servers to the junaio servers must be in XML and adhere to the structure specified in the API.

New channels must be registered on the junaio website and an external sever location must be specified. All channels must pass a series of validation tests before they can be submitted to be made publicly available. A junaio employee inspects the channel content and tracking image quality before approving the channel.

The sequence diagram below (-Fig 3.4) shows the interactions that occur between the client, server and external server and the order in which they occur.

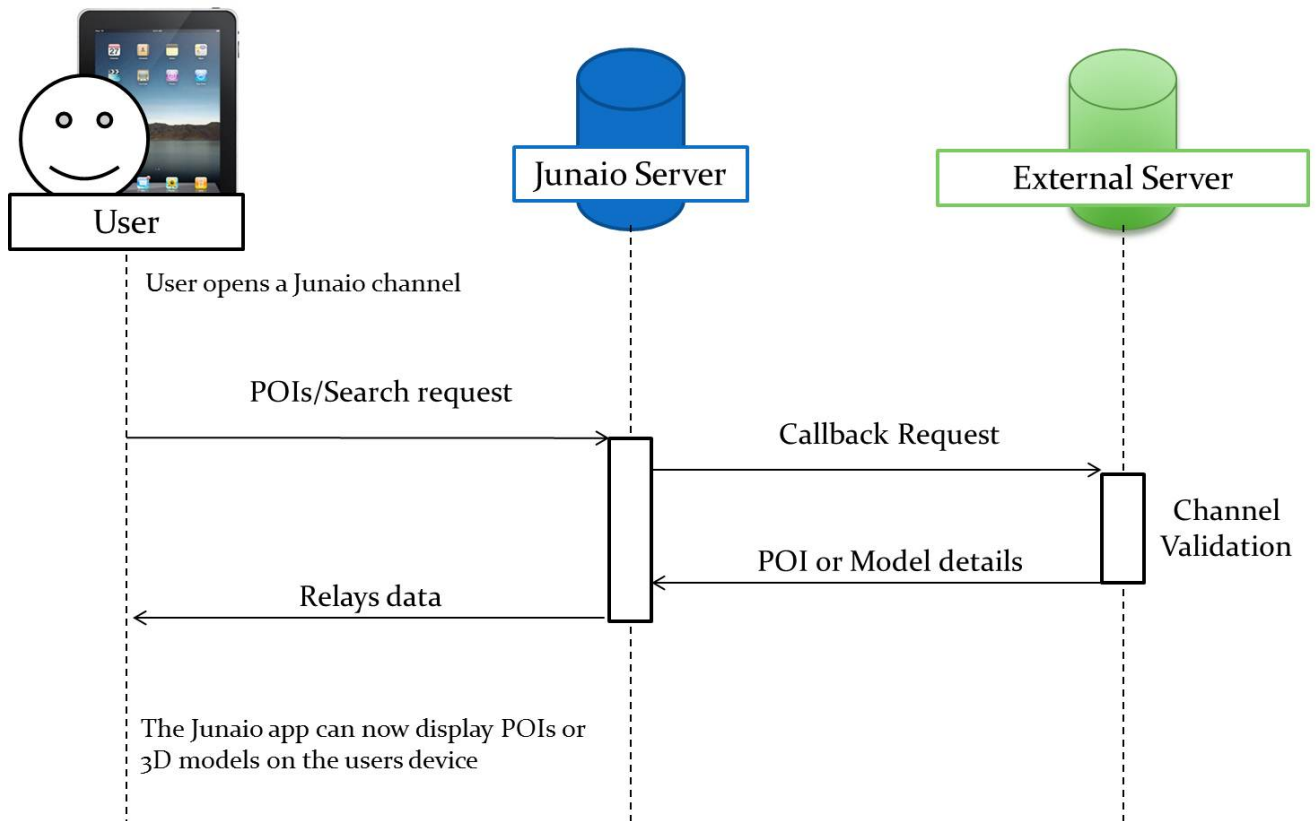


Figure 3.4: The sequence of events upon opening a channel

1. The user launches the junaio application and opens a channel.
2. A request called a “pois/search request” is automatically sent from the client to the junaio server.

3. The junaio server sends a “callback request” to the channels external server asking for channel content.
4. The channel is validated and the content such as POI locations or models are sent back to the junaio server. The external server will only reply with channel content if the original request came from one of its own channels. Channels and their servers share a secret API key and all requests that do not have the same key are denied access.
5. The junaio server relays the channel content back to the client.
6. The client can now display channel content on screen.

### **3.2.2 Limitations of junaio**

The junaio platform has the following limitations:

- GLUE channels can only track one image at a time.
- There is no indication of how well a tracking image will work until you test it. Even if the tracking quality is acceptable to you, your channel may be rejected at validation stage if the tracking quality does not meet junaio’s standard. You are not informed about this until a few days after submission when you receive a rejection email.
- 3D animation is limited to the use of MD2 models. These models are out-dated and not used often anymore.
- There are limits on the file sizes of all content that can be used in a channel. This makes the use of high quality models, videos or sounds less feasible or impossible.
- A detailed documentation of all the php functions that can be used in the server side scripts is not provided, despite including some in tutorials.

- There are consistency issues between the Android and iOS versions of the application; i.e. if a channel looks correct on Android devices it may look all wrong on the iOS devices. There are no details provided on how channels can be made look consistent on both platforms.

# Chapter 4

## User-centred Design

The background research has shown that with the technology available to us (iPad 2 and the junaio AR platform) it is possible to make an interactive AR application that will run smoothly on mobile devices. The key points of interest of this research are: finding out what is wanted by Irish advertisers from an AR application, analysing findings to make a requirements list and finally designing and developing an interactive application that meets those requirements.

In this project a user-centred approach to design was taken. Interviews with marketing professionals around Dublin were carried out in order to discover the voice of the customer [35], i.e. what they really want from an AR application. This information was used to optimise the application design around how the marketing professionals want the users to interact with the application and as a result, get the maximum benefit for the brand or product being advertised.

### 4.1 The Development Process

The development process is divided up as follows:

- Research Interviews
- Application Design

- Rapid Prototype
- Final Application

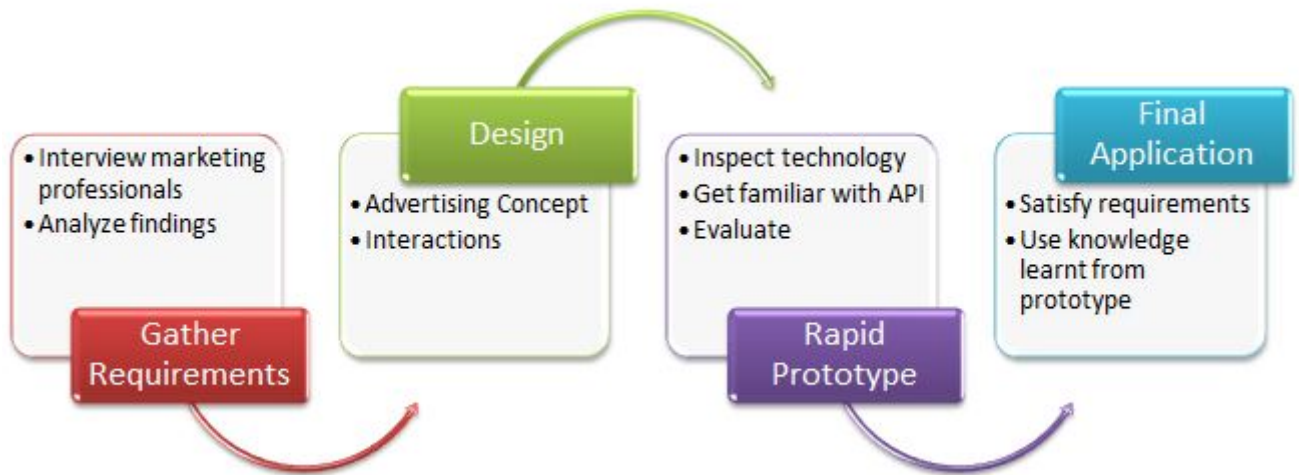


Figure 4.1: The Development Process

The research interviews are used to gather all the necessary information about what is needed and wanted in the application. The results of the interviews are analysed and prioritised so they can be converted into a list of key requirements. The requirements are used to design the application interactions and the advertising concept. The use of rapid-prototyping was chosen to inspect how well the available technology work together (iPad 2 and junaio) and to get familiar with the junaio API. Issues discovered while creating the prototype are used to improve the design of the final application. The final application aims to satisfy all of the requirements gathered in the design phase and incorporates knowledge gained from evaluating the prototype.

## 4.2 Research Interviews

Interviews with marketing professionals were carried out around Dublin. Potential interviewees were gathered by a contact in the advertising industry. The professionals that

were selected for interviewing had at least a basic knowledge of what AR was; some had experienced working on an AR campaign in the past.

A question sheet was prepared prior to the interviews. Questions were designed in a way to best discover the voice of the customer, i.e. their expectations, preferences and aversions regarding an AR advertising application. Questions were also aimed at discovering both the ideal outcome of an AR campaign and the barriers that are preventing the majority of Irish advertisers from using AR in a campaign.

The interviews took place from the end of July to early August. The interviews were generally in a one-to-one format and lasted about one hour. The questions, which were all optional, were normally asked in their order of appearance on the prepared sheet but the interviewees were not discouraged from talking about related topics, examples from personal experiences or just additional information if a thought came to mind. The interviews were recorded so that the flow of the conversation was not broken up from taking notes and so they could be transcribed and analysed at a later date.

### **4.2.1 Findings**

After the interviews were transcribed they were analysed to find relationships between them and key points. The results were organised and prioritised by creating several mind maps. A mind map is a diagram that is used to represent ideas that are linked together around a central key word or idea. The mind map that was created from the interviews is too large to be displayed in this document so it has been broken down into several mini mind maps describing the major topics. The rest of this section will go through each mind map in turn and explain their key points.

Figure 4.2, the centre of the entire mind map, shows the main topics that were discussed in the interviews.

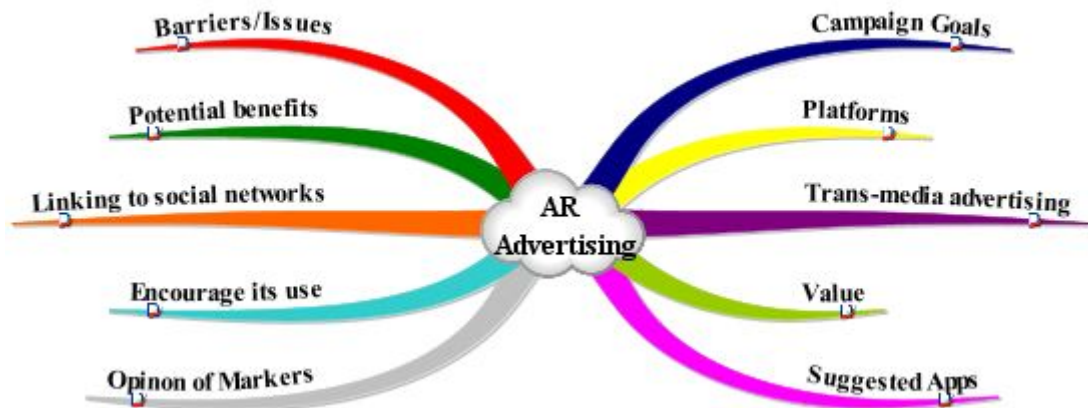


Figure 4.2: Mind Map: AR Advertising

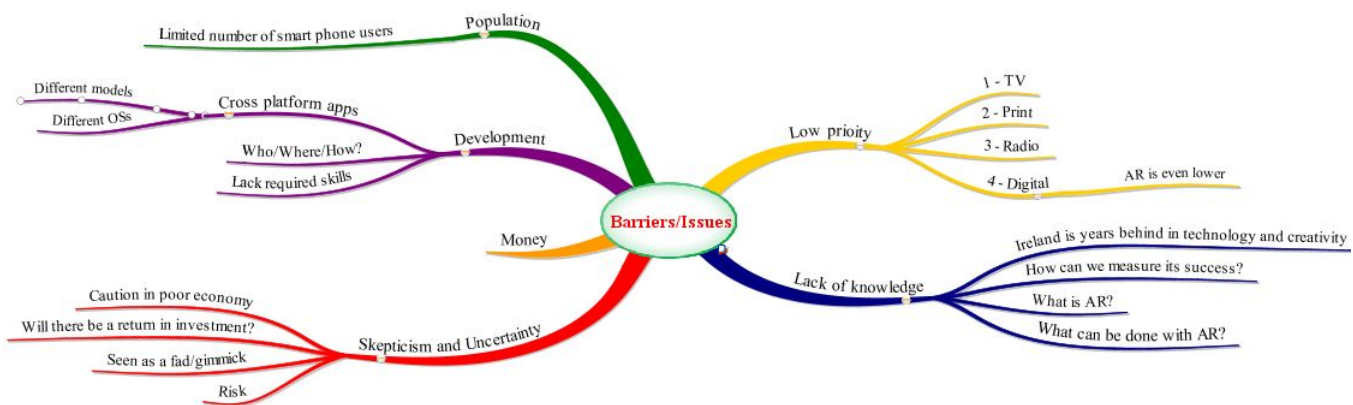


Figure 4.3: Mind Map: AR Barriers/Issues

### Barriers/Issues of AR

The main barrier preventing Irish advertising companies and brand owners from getting involved with AR is a lack of knowledge. The main response from all interviews was that most brand owners didn't know what AR is, or if they have heard about it before then they don't know what can be done with it. There was also an issue about not knowing how to measure the success of an AR campaign. Some of the interviewees had the perception that Ireland is years behind other countries in both technology and creativity.

Another barrier of AR is that there is a lot of scepticism and uncertainty about it.

Advertisers are not sure if there will be a return on an investment made in AR so they are not willing to take the risk, especially in this poor economy. Some advertisers and brand owners see AR as a gimmick and don't think it will be around for a long time.

Another key issue was about development. Some advertising companies lack the required skills to create an AR application and they also don't know who can develop an app for them.

Digital advertising was seen as the lowest priority by some advertisers; falling after TV, print and radio. Even within the realm of digital advertising the priority for AR was not high.

### **Potential Benefits**

The potential benefits of AR that the advertisers found most attractive are:

- AR can gain the 1-on-1 undivided attention of its viewer.
- It can improve the public's perception of the brand.
- It can be used to bridge the gaps between different advertising mediums, i.e. as a trans-media marketing tool.
- It's engaging and there are endless creative possibilities for AR.
- It allows users to interact with the brand.
- An AR app can connect to social networks, generate a buzz and then spread virally over the internet.

### **AR and Social Networks**

Advertisers and brand owners are very interested in social networks. Many brand owners in Ireland are just beginning to make facebook [36] pages and twitter [37] accounts. All interviewees expressed a great interest in an AR application that could connect to the

facebook page of the brand being advertised; preferably in one click. Another reason that connectivity with social networks is so high valued is because they are very good for data capture and market research. Social networks also facilitate advanced targeting.

## Encouraging its use

Encouraging people to use an AR application once it has been launched is really important.

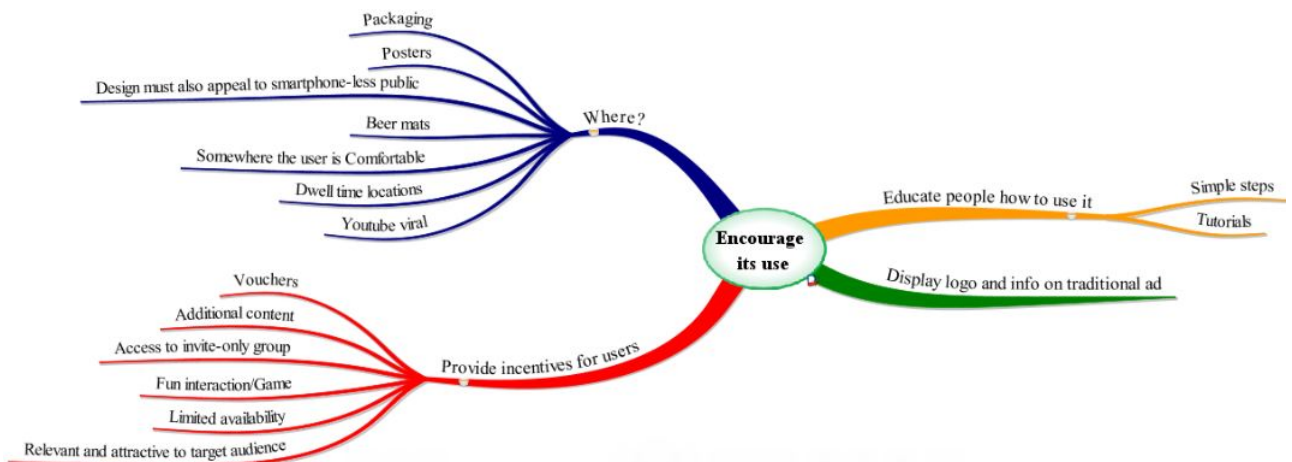


Figure 4.4: Mind Map: Encouraging AR Use

Here are the interviewee’s suggestions:

- Display an AR logo and information about the application on a traditional ad form such as TV or print ads.
- Educate people how to use the app through the use of simple, easy to understand steps or even tutorial videos.
- AR should be used somewhere the user is comfortable. That way they won’t feel embarrassed taking out their phone and searching for AR trackers in public.
- Locations where there is dwell time, like at a bus stop, would be good places to display the advert.
- Provide an incentive for viewers who download and use the app.

It was stated that because AR is not so popular in Ireland, that it is necessary that use of an AR app is incentivised. A user will have to take time to download the AR app and then figure out how it works. If there isn't any incentive then people will be less likely to go through the initial steps. Giving out discount vouchers, providing additional content and the use of fun interaction were all possible incentives that were mentioned during the interviews.

It is also very important that the advert design also appeals to those in the general public that don't have a smartphone and can't experience the AR.

### Opinion of Markers

Some of the interviewee's mentioned machine readable tags such as QR-codes. Their opinion of QR-codes is that when people see them they generally know what they are for and how to use them. Despite being visually unattractive, they still choose to include them in their print ads. When asked about the idea of marker-less tracking, they said that it would be great to use a brand logo as a tracker but they worry about people not knowing that there is an AR feature associated with that image.

### Campaign Goals

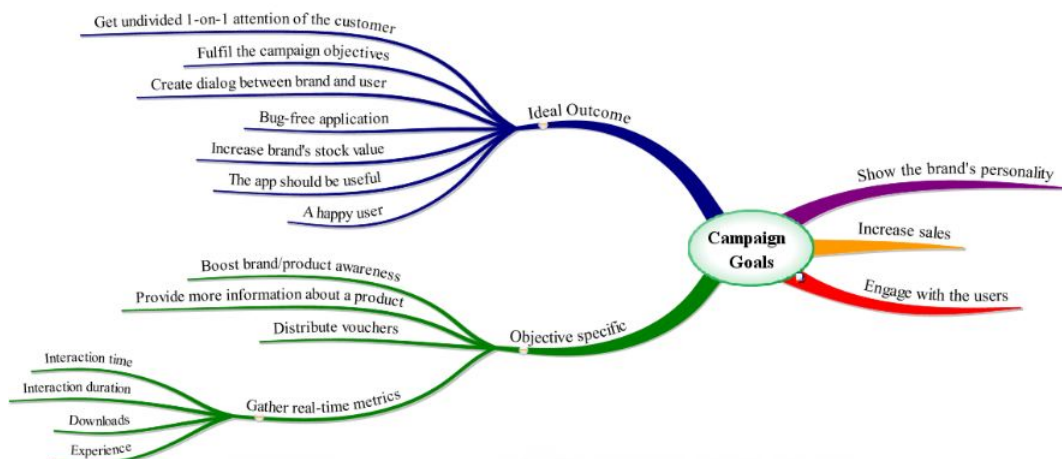


Figure 4.5: Mind Map: Campaign Goals

Here is a list of what the professionals said about what the ideal outcome or goals of an AR campaign would be:

- Engage with the user.
- Show the brands personality.
- Get the undivided attention of the customer.
- Fulfil a campaign specific objectives such as boosting product awareness.
- Create a dialog between the brand and the customer.
- Increase sales or stock value.
- The app should be useful.
- The app should be fun and make the user happy.
- The app should be bug free so it will not give its users a bad impression of the brand.

## **Platforms**

When asked about smartphone platforms, all interviewees said that they would develop for iOS (iPhone/iPad) first if they could only choose one platform. If resources were available they would prefer to release an app on all platforms.

Most of the interviewees had heard about the AR platform Layar. They liked it but didn't have experience working with it. A couple of the interviewees mentioned the junaio platform and had worked with it before. They recommended it because of its features and multi-platform support.

## **Trans-media Advertising**

The idea of AR being able to facilitate trans-media advertising came up mainly in reference to social networks. Advertisers often mention their facebook page on posters or print ads but it is up to those who are interested to find the page themselves when they are next online and that's if they remember. AR provides a way to get the user from the print/TV ad to the facebook page or website through in-app interactions. This was seen as a great ability of AR.

## **Value of an AR Application**

When the interviewees were asked to estimate a value for an AR application they found it very difficult. They mentioned that it really depends on what features the app has and what the objective of the advertising campaign is. They did mention however, that the ability to get customer information, details on how the app was used and customer feedback would definitely add to the value of any app.

## **Thoughts on Sample Applications**

Three application concepts were explained to each person interviewed and they were asked which idea they liked the best. Here are the concepts:

1. An app that enables the users to gather tokens by finding advertisements in the real world and capturing them with the camera of the mobile device. Tokens can be used to unlock additional online content or discounts.
2. An app that when a camera phone is pointed at a product, additional information about the product, video, sound or animations is displayed on the screen and it allows the user to visit the product's website.
3. An app that upon recognizing a product it shows the user the nearest retailer of that product, retailer details (such as opening hours) and also provides a map of how to get there.

Here is the feedback:

1. This is the best concept for product awareness. It provides a good incentive which is necessary in order to get people to download the app in the first place.
2. This is good for brand transparency, it allows the customer to find out more about the product but couldn't this be done with a QR-code linking to a website?
3. This application is good because it encourages a purchase by showing the nearest retailer. The problem with this app is that it lacks an incentive. This should be an add-on feature to a bigger app rather than a full app itself.

## 4.3 Application Design

After analysing the interview results a list of the five key requirements for any AR advertising app was made:

- Gain the undivided one-to-one user attention by being visually attractive or through the use of interaction.
- Fulfil the objectives of the advertising campaign.
- Show the brand's personality.
- Provide useful features.
- Provide a link to social networks.

Of course these listed requirements are all advertising related and they should be added to the standard functional and non-functional requirements that are normally associated with a mobile phone application.

### 4.3.1 Concept

After gathering the requirements the next step was to come up with an interesting concept for an advertising campaign. This was a nontrivial task. Even professional advertisers can have difficulty coming up with new concepts for advertising campaigns but they usually have the benefit of knowing what product or brand they are advertising before having to think of a concept.

Our first step was to choose a brand to design the campaign for. This step was made a little bit easier by the limited selection of open source MD2 models that were available online. A number of different car models of different size and detail quality were acquired and as a result the car brand Volkswagen (VW) [38] was chosen for the campaign. None of the models looked remotely like a VW car, but this did not matter because they could fit in with a car themed advertisement.

It was decided that the tracking image for the application would appear in a printed ad that may be included in a newspaper or magazine. It was also decided that the tracking image should be of a car park because it is a common place to see cars. Several sketches of car park layouts were drawn before one was finally selected.

Final concept decisions:

- The car models should appear in empty parking spaces and the user should be able to interact with each model by touching them.
- Some of the spaces should be already filled by VW cars.
- The empty spaces should contain an icon that informs the user of what sort of interaction they can expect from the car in that space.
- The campaign should be called AR Car Park and its title should be in the centre of the image in the form of an Irish license plate.

### 4.3.2 Interactions

The last part of the design involved deciding on what interactions and features should be included in the app. This was just a matter of comparing the features that were liked by the marketing professionals during the interviews with the types of interaction that are supported by junaio.

These are the interactions/features that we planned to include:

- Additional brand information such email address, phone number and website address.
- Award the user with a discount voucher.
- Display a video of a VW commercial.
- Plot a route to a VW dealer in Dublin using the Google maps app.
- A one-click link to the campaign's Facebook page
- Allow the user to save a snapshot of the application while in use or share it with their friends on Facebook.

# Chapter 5

## Implementation

This chapter gives an in-depth look at the implementation of both the Marker-based prototype and the final application AR Car Park.

### 5.1 Marker-based Prototype

A prototype is a “first or preliminary model of something from which other forms are developed or copied” [39]. Prototyping is a valuable part of the development process for a number of reasons; it provides early visibility of what aspects of the end product will look like, it allows for early identification of problems that were not foreseen in the design phase and it works as an initial milestone for the creator to work towards. For this project it was useful because it allowed us to get more familiar with the junaio platform and its API.

In order to rapidly develop an AR prototype three simple template markers (see Figure 5.1) were designed to trigger some basic features of the junaio platform; a 2D model with touch interaction (-Fig. 5.1a), a 3D animated model (-Fig. 5.1b) and streaming video (-Fig. 5.1c).

To speed up the prototype creation phase the junaio Channel Creator was used. The junaio Channel Creator (see Figure 5.2) is a web service of the junaio platform that

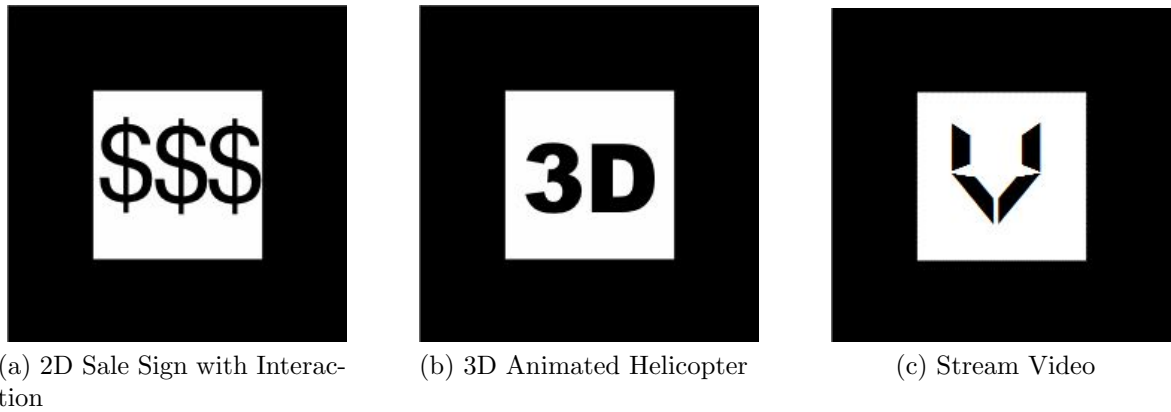


Figure 5.1: Prototype: Template Markers

facilitates the creation of a rudimentary GLUE channel that is testable on both iOS and Android devices. The channel creator is extremely simple to use but at the cost of reduced channel customisability. The channel creator allows the user to add up to seven tracking images to the channel and associate one model or video with each image. A number of free MD2 models are provided by the channel creator and their orientation, scale and position can all be set using its GUI. The channel creator allows the user to enable the basic click interaction and fill out what is displayed on screen after the model has been clicked. A video in .mp4 format can be uploaded and assigned to a tracking image provided it is less than 10MB in size. One of the best features of the channel creator is that a channel that is created with it does not require an external webserver. The channel content is stored on junaio's sever. The major downside of the channel creator is that it does not show you any of the code that it generates to make your channel. If you wanted to replicate a generated channel on your own sever you would have to start from scratch.

### 5.1.1 Challenges and Solutions

Simple template markers were used as tracking images for the prototype to speed up development and get a usable channel up and running as soon as possible. An assumption was made that because template markers are normally the standard markers for AR platforms that they would work well. This was not the case. After submitting the channel

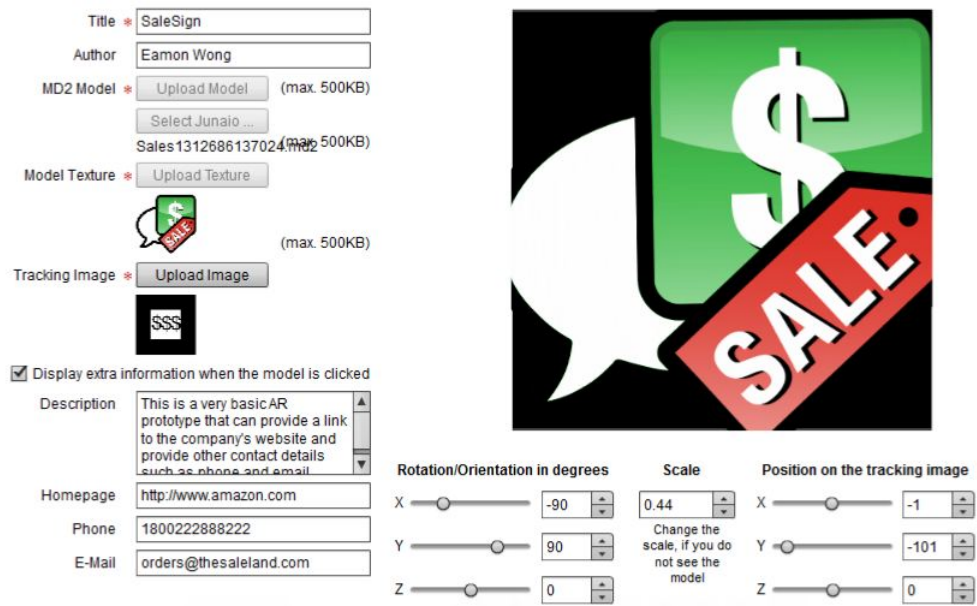
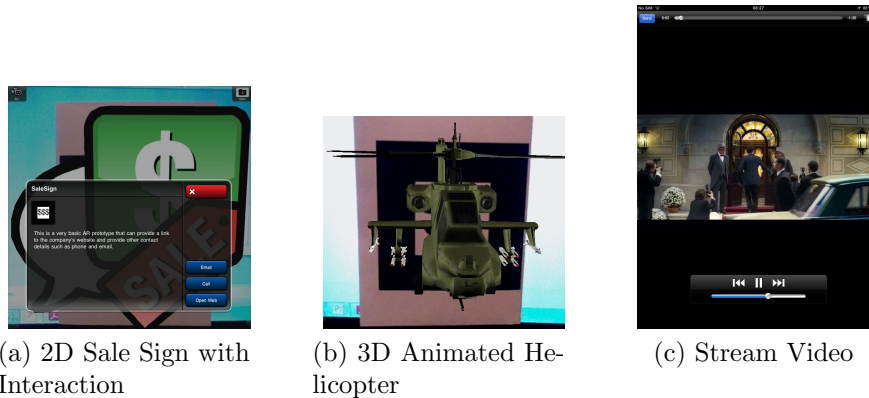


Figure 5.2: The junaio Channel Creator



(a) 2D Sale Sign with Interaction

(b) 3D Animated Helicopter

(c) Stream Video

Figure 5.3: Prototype: Template Markers - In-channel View

for validation a message from junaio was received stating:

[A] “Standard marker” as known from other tools are not very sufficient for using in GLUE, since the big black frame does not hold unique information.

This explained why sometimes the helicopter model (-Fig. 5.3b) would appear to shake when being displayed on the screen. This was initially thought to be an effect of using an animated model. The video tag (-Fig. 5.1c) at times did not trigger the video steaming process fast enough. In attempt to prevent such problems from occurring in the final application we researched how to make the “best” tracking image for use on the junaio

platform.



Figure 5.4: Good and Bad Tracking Images

*Source: junaio*

Figure 5.4 shows examples of good (green) and bad (red) tracking images for use on junaio. The best image should be colourful, include sharp edges and high contrasts. It is not enough to make a colourful picture with Photoshop or take a colourful photo from your collection and submit that to become a tracking image. It was found that for the best results the following steps should be followed:

1. Create or find a colourful image.
2. Print the image on standard paper without using the “photo quality printing” option that some printers have; this gives the image a glossy effect and increases glare.
3. Bring the printed image to a place that has similar lighting conditions to where you expect the application to be used. Natural light works best.
4. Take a picture of the image using your primary testing device (iPad2). If your device has a very high quality camera it may be best to reduce the quality down from maximum settings before shooting. Be sure to take the picture from directly in front of it and be careful not to make a shadow or glare from your shooting angle.

5. send the picture to your computer, crop everything but the desired target and then scale the image down to around 500px on its longest side.
6. Submit this image to junaio to receive a tracking image you can use on your channel.

Another design issue that was discovered from the prototype was that the augmented models were arranged for vertical use, i.e. the channel expected the tracking images to be standing upright as if they were hanging on the wall. This would have to be changed for the final application because the tracking image is supposed to appear in a magazine. It makes more sense for it to be lying flat (horizontally).

Through the repetitive use of our prototype it was realised that while appearing cool and interesting at first, just seeing 3D models without allowing for much interaction became boring. This spurred a rethink of the interactions that were planned for the final application. It was decided that the user should have to complete an interactive game first before being able to retrieve a discount voucher as a reward. This would make the application more interesting and also lengthen the time that the customer interacts with the brand. This is explained in more detail in section 5.2.

### **5.1.2 Discussion**

The use of rapid prototyping proved to be quite a useful section of the design process because it pointed out subtle issues that would not have been discovered until late into the development of the final application. The most useful issue raised was regarding the tracking image. Modifications were made to the design of the tracking image before it was created so it would be both attractive enough to appear in a magazine and also suitable for overlaying 3D models on.

## 5.2 AR Car Park

The final application AR Car Park was redesigned to solve issues that were brought to light during the prototyping stage. The AR Car Park Implementation can be split up into the following sections:

- Concept Redesign.
- Creating the Tracking Image.
- 3D Model Preparation.
- Server-side Scripting
- Bringing it all together

Unfortunately the code used to create the prototype is not provided by the channel creator so all coding for the server side scripts had to be written from scratch. Luckily junaio provide a series of tutorials to help both beginners and experienced users get familiar with their API.

### 5.2.1 Concept

As mentioned earlier, after using the prototype a number of times the 3D models seemed to lose their appeal. It was decided to make the application more interactive to prevent it from becoming boring so fast. The idea was inspired from the VW commercial that was selected for use on the video streaming feature of the app. The commercial, titled “The Force” has a sci-fi feel to it so it was decided to add an interactive game involving an alien spaceship or UFO.

It was decided to add this extra interaction to the car that gives out a discount voucher because the original voucher interaction was the least interesting and would probably be the most used. The idea for the new sequence of events goes as follows:

1. When the user clicks on the discount car a message is displayed to them informing them that an alien has stolen their voucher.
2. Suddenly a UFO appears above the car and an alien sound is heard.
3. The user can look at the UFO to see it from all angles or click on it to destroy it; triggering its explosion animation.
4. A victory sound is played and a red balloon appears in place of the UFO.
5. When the user clicks on the balloon they are congratulated for destroying the alien and are rewarded with a discount voucher code.

While the game may not be very challenging it does make the application more interesting and will attract the user's attention for a longer time. With the addition of a new sci-fi model, the icon on the tracking image that was placed under the voucher car had to be modified to show some hint of the extra-terrestrial presence. The design of the tracking image was also modified to contain some bright colours, sharp edges and contrast to improve how well it is tracked by the app.

### **5.2.2 Creating the Tracking Image**

It was important that the tracking image was made first because it was needed to trigger an augmentation. All models that are overlaid on an image have to be positioned, scaled and orientated relative to that image in order to appear correctly.

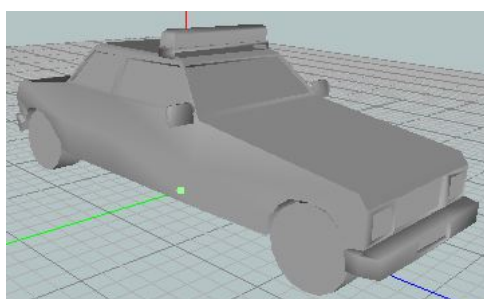
The tracking image of AR Car Park was created using Photoshop. It was created in a high resolution so it could be displayed on a poster or on a full page of a magazine without any visible loss in quality. The lengthy creation process of the tracking image will not be explained here. Instead a picture of the final image will be shown (see Figure 5.5).



Figure 5.5: The AR Car Park Tracking Image

### 5.2.3 3D Model Preparation

The junaio platform only accepts two types of models to be used in its channels; they are MD2 and OBJ models. A website called Sitters Electronics [40] was found that provides low poly 3D model packs in both MD2 and OBJ formats for open source games. The model packs are downloadable and free to use. This site provides a number of vehicle model packs and that is one of the initial reasons why a car brand was chosen for our concept.



(a) Police car model



(b) Police car model with texture applied

Figure 5.6: MD2 Model before and after applying texture

Along with every model provided in the packs is an accompanying texture that comes in the form of an image file. The two files are combined by junaio at runtime to show the fully textured model (see Figure 5.6).

The provided textures for the car models all seemed to be either dark or red in colour. Having all of the models the same colour was not appropriate for our advertisement so new textures were created. Sometimes multiple textures were created for a single model (see Figure 5.7) so they could be tested in-app to find out which colour combination worked best.

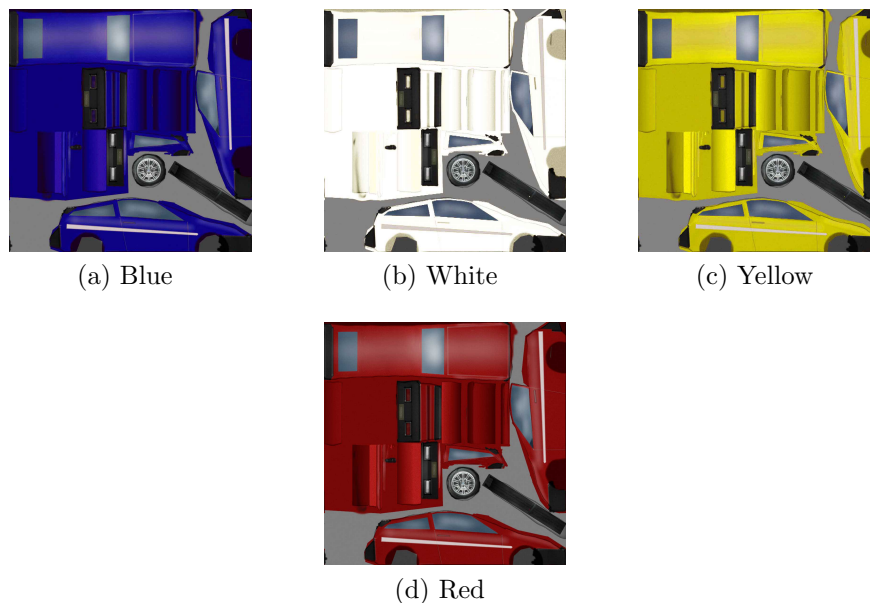


Figure 5.7: 4 Possible textures for one model

Before a model can be used in a channel it must be encrypted. junaio don't provide information on what type of encryption is applied to the models but it prevents the details of the model's structure and animations from being extracted in modelling program. There is also a file size limit of 750kb on all models. The majority of the models used in our application have a size close to 100kb. Models that contain animations (such as the UFO) are larger in size. Because all models and their textures must be downloaded by the client when the channel is first opened it is important that their file size isn't too large. All textures were converted to JPG format and their quality was reduced to speed

up channel loading times.

## 5.2.4 Server-side Scripting

In order to create a fully featured GLUE channel on junaio a webserver is required. This server holds all of the channel content and also handles all requests sent to it from the junaio servers. A free webserver was set up on 000WebHost [41]. The webserver that is chosen must support php, .htaccess and a Zend framework.

Php scripts were written to respond to the two main requests that can be received by the server. These requests are:

- pois/search: A request that is sent from a client when a new channel is opened. It is a request for the channel content such as model and tracking image data.
- pois/event: A request that is sent from the client when an interaction has occurred that triggers an event. It is a request for event data which can be models, sounds or videos.

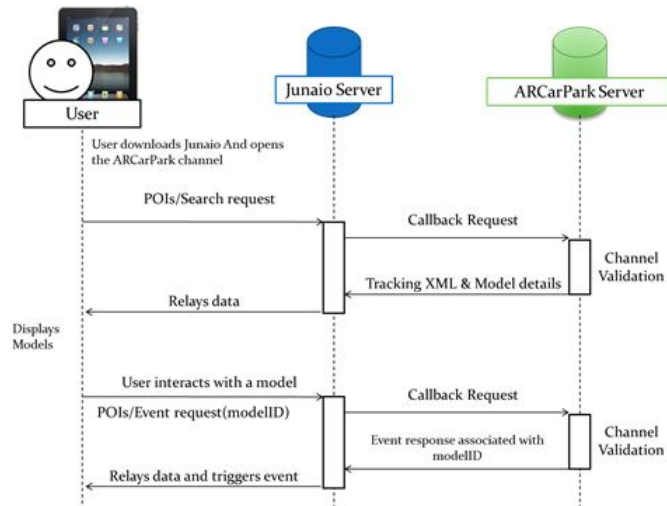


Figure 5.8: Sequence Diagram: Interactions in AR Car Park

Figure 5.8 shows the sequence of events that occur when requests that are sent between the client, junaio's servers and the AR Car Park server. When the user interacts with a

car, a pois/event request that includes the model ID of the car that has been clicked, is sent to the junaio server who then communicates with the AR Car Park server asking for the information and data that are associated with that event. The channel is validated and then the appropriate data is sent back to the junaio server before it is relayed back to the client and displayed on the screen.

Three main scripts on the server handle the data and interactions in the channel; “index.php”, “search.php” and “event.php”.

### **Index.php**

This script is called every time the junaio server communicates with the AR Car Park server. It first authenticates the request using the junaio “checkAuthentication()” function and then determines what type of request it is (see Fig 5.9) before calling the correct script to handle it.

```
if(in_array('pois', $aUrl))
{
    if(in_array_substr('search', $aUrl))
    {
        include '../src/search.php';
        exit;
    }
    else if(in_array_substr('event', $aUrl))
    {
        include '../src/event.php';
        exit;
    }
}
```

Figure 5.9: Code Snippet: Determining the request type

### **search.php**

If the request is of type pois/search then the search.php script is started. This script tells the client what image to track, details about the models and their positions, orientations

and scale and also what interactions each of them provide. Figure 5.10 shows a function that tells the client to display a model that cannot be interacted with.

```
function makePoi ($pid, $trans, $o, $s, $modelType, $modelURL, $skin)
{
    echo "<poi id=\"\$pid\" cosid=\"1\" interactionfeedback=\"click\">
        <name><![CDATA[Basic Glue With Event]]></name>
        <author><![CDATA[EaMo]]></author>

        <translation>$trans</translation>
        <o>$o</o>
        <mime-type>model/$modelType</mime-type>
        <mainresource><![CDATA[$modelURL]]></mainresource>
        <thumbnail>http://eamon.site90.net/AR/html/resources/logo.jpg</thumbnail>
        <icon>http://eamon.site90.net/AR/html/resources/icon.jpg</icon>
        <route>>false</route>
        <force3d>>true</force3d>
        <s>$s</s>
        <behaviours>
            <behaviour type=\"idle\">
                <length>0</length>
                <node_id>frame</node_id>
            </behaviour>
        </behaviours>
        <customizations/>
        <resources>
            <resource>$skin</resource>
        </resources>
    </poi>
    ";
}
```

Figure 5.10: Code Snippet: Create a model without interactions

## event.php

If the request is of type pois/event then the event.php script is started. This script expects to receive a model identifier when it is run. Depending on what model ID is received, different event details are sent back to the client. If there isn't any event associated with a received ID then the request is ignored. Models that are generated from an event can also trigger events themselves. This is how a chain of interaction occurs.

## 5.2.5 End Product

When all previously mentioned sections of development were completed the last step was to open the junaio app and tune into the AR Car Park Channel. Figure 5.11 shows screenshots of the finished channel in use. Figure 5.11b shows the AR Car Park channel running on both the iPad2 and an Android device. Figure 5.11e shows the screenshot option the user can select by pressing the button on the bottom left corner of the screen. This also allows them to share their screenshot on Facebook.

The five interactions by touching different cars that were included in the final application are:

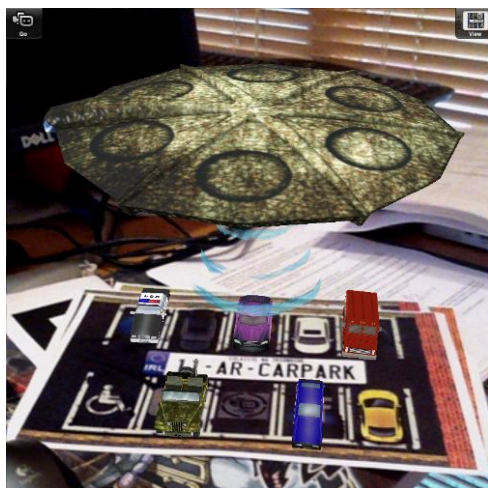
- Additional brand information - When selected details of the brand are displayed to the user. This includes buttons to send an email, phone and visit the brand's website.
- Voucher game - This causes a UFO to appear above the selected car which must be destroyed before a voucher code is rewarded to the user.
- View commercial - Streams the Volkswagen "The Force" commercial.
- Plot route - Displays details about a Volkswagen dealer in Dublin, a link to their website and also can plot a route from the users current location to that dealer using the Google maps app.
- Facebook - Takes the user to the AR Car Park Facebook page.



(a) First View



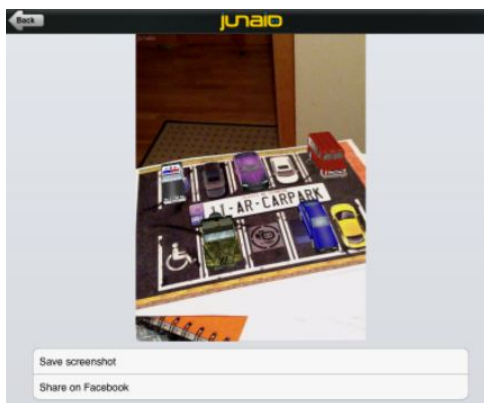
(b) Running on both iPad and Android



(c) UFO Appears



(d) Congratulations!



(e) Share on Facebook

Figure 5.11: Screenshots of AR Car Park

# Chapter 6

## Evaluation

This chapter describes the two evaluation methods carried out in this research. Feedback from a marketing professional was received to get a real world critique on the AR Car Park channel and a user survey was carried out to find out how users feel about the AR advertising experience.

### 6.1 Professional Feedback

A meeting was scheduled with a marketing professional to discover how good or bad the AR Car Park channel is from the perspective of an advertiser. Questions were prepared in advance to discover the positives and negatives of the ad and if it successfully meets the requirements of an AR advertising application. Before asking the prepared questions the AR Car Park channel was demoed to the marketing professional and any queries about it were answered.

#### 6.1.1 Interview Results

Interviewer: What are the positive and negative aspects of this ad?

Advertiser: One positive aspect is that It looks really good, especially the way the cars pop out of the picture. I also like the facebook link and the Maps feature.

I could see myself using this application just to see how far away the car dealer is. If I was a car fanatic I would like the brand's page on facebook. A negative aspect is that the discount may need to be reworked. A car brand wouldn't give out such a large discount, so the incentive is a bit presumptuous.

Interviewer: How do you feel about the tracking image?

Advertiser: I love it! It looks funky. It's very colourful so if it's in a magazine amongst generic car dealer ads it would definitely stand out. The Irish license plate gives it a sense of locality. The viewer can see that the ad has been designed specifically for the Irish market. That's a plus.

Interviewer: Would it appeal to non-smartphone users?

Advertiser: It would need a Volkswagen logo and an information section that explains what the advert contains. This info should be kept to a minimum. If the instructions are too long people won't bother try it. Perhaps add a short phrase like "Want to know where the nearest VW dealer to you is?"

Interviewer: From the interviews conducted earlier in my research I have compiled a list of requirements or ideal outcomes for an AR app. Could you please comment on how successfully or unsuccessfully my application meets these requirements/outcomes.

1. Get the undivided 1-on-1 attention of the customer.

Advertiser: That's definitely going to happen if it's in a magazine because the ad stands out a lot. It's eye catching.

Interviewer: 2. Create a dialog between the brand and user or facilitate the creation of such a dialog.

Advertiser: Yes this can be done through the facebook link. The snapshot sharing feature could be very good for viral spread. It tells the user where the nearest dealer is and provides information such as phone/email.

Interviewer: 3. Be useful or have useful features.

Advertiser: The map feature is the most useful. The information feature is a necessity. The incentive is the reason why people will open the app. The link to facebook is also quite useful but it depends on what the user is interested in. A car fanatic might like it but someone who is simply curious about the AR would not.

Interviewer: 4. Fulfil a campaign specific objective:

a. Boost brand/product awareness.

Advertiser: It would boost brand awareness but it needs to focus on a specific car and provide more information about that. It would be interesting if the video that is displayed from clicking the van could change or update with new content. For example show a video about how the car was made. Tell more about VW as a brand.

Interviewer: b. Provide more info about the brand/product.

Advertiser: Same answer as to the previous question. Links to the website, map and information feature are good for this.

Interviewer: c. Distribute vouchers.

Advertiser: Successful.

Interviewer: 5. Engage with the user

Advertiser: For the first time use it is very successful but it will lose effectiveness after the first go. It would need updatable content to encourage re-use.

Interviewer: 6. Show the brand's personality

Advertiser: This is fun and quirky. If their personality is fun and quirky then it is successful.

Interviewer: 7. Increase sales or stock value

Advertiser: This is better at increasing brand awareness. It should gather information

about the user and then make profiles for potential customers. This would be more valuable. Find details such as gender, age range, living area etc. This could be done through facebook perhaps?

Interviewer: 8. Be easy to use and bug free.

Advertiser: Yes it's very easy to use. It's as easy as it can be. You just need to tell people that they need to scan the image with the app in a small information section. Remember sometimes less is more.

Interviewer: 9. Link to a social network.

Advertiser: Successful!

Interviewer: 10. Be fun.

Advertiser: It's fun and quirky!

Interviewer: Could this ad potentially make it as a real ad or feature in part of a campaign? If not, what changes should be made?

Advertiser: It should be tweaked with the suggestions mentioned earlier. The incentive needs to be more realistic. With some small tweaks then yes, it could work as a real ad. But I worry about how much it would cost to develop or deploy. The ideas behind each feature or interaction are the right ones.

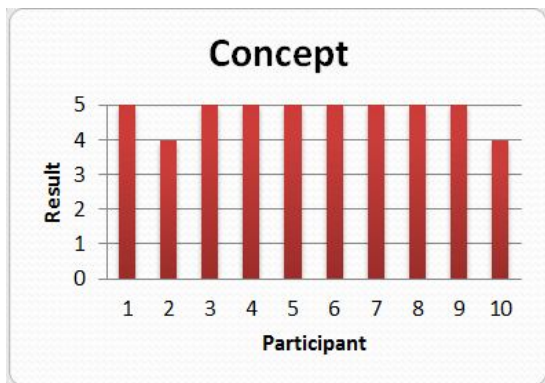
Interviewer: Any comments or additional feedback? Perhaps some important topic I haven't mentioned?

Advertiser: Not really...You should work on a way of encouraging repeat use. Here's an idea for the incentive. Perhaps half the discount could be given after destroying the alien and the rest of the discount is given after sharing a snapshot with facebook. This will encourage viral spread of the campaign.

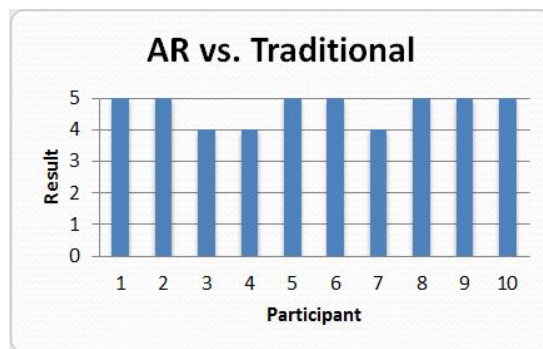
## 6.2 User Survey

Finding out user opinions is an important way of evaluating any application, especially one that will be open to the use of the general public. Ten subjects were asked to try out the AR Car Park channel on the iPad 2. They were asked to try out each feature in the channel and then were asked to fill out an anonymous questionnaire about their experience (See Appendix). There were 5 questions in the questionnaire each of which had a 5 multiple choice answers arranged in a Likert-type scale. This means that the answers were arranged from most negative (1) to most positive (5). This scale is good for capturing the intensity of the subjects' feelings.

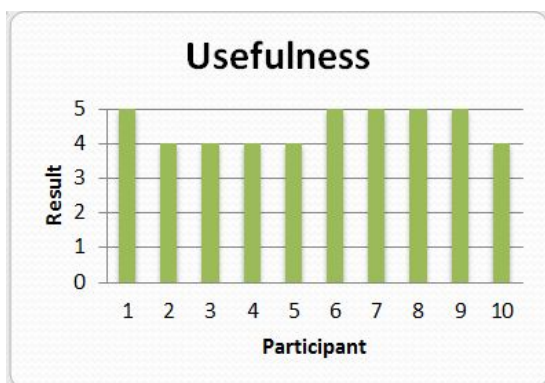
The results of the survey are displayed in Tables 6.1a to 6.1e. Table 6.1f shows the average results for each question. There was a superbly positive response to the concept of the advertisement. 8 out of 10 people asked said that they liked it a lot and the other 2 just liked it. All subjects believed that AR Car Park's ability to hold their attention was better than that of a traditional printed ad; 8 people said it was much better. The average value for the overall usefulness of the features that were included in the application was 4.5; between useful and very useful. All subjects had a positive impression of the brand after seeing the ad and 6 out of 10 people said they felt the brand was cool, modern and advanced. 6 out of 10 also said that they would be very likely to tell a friend about the AR Car Park. Overall the results of the questionnaires are tremendous, with the average of each result being positive (above 4).



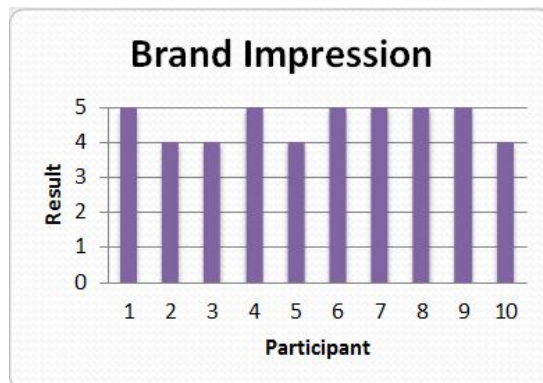
(a) Concept



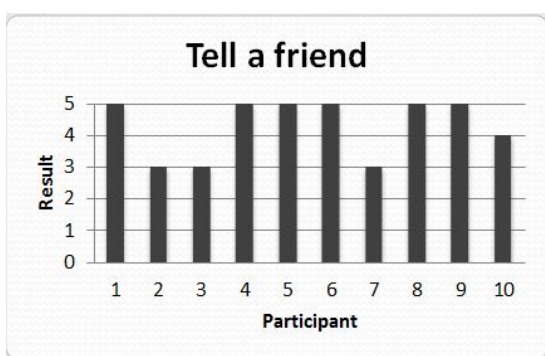
(b) Ability to hold your attention



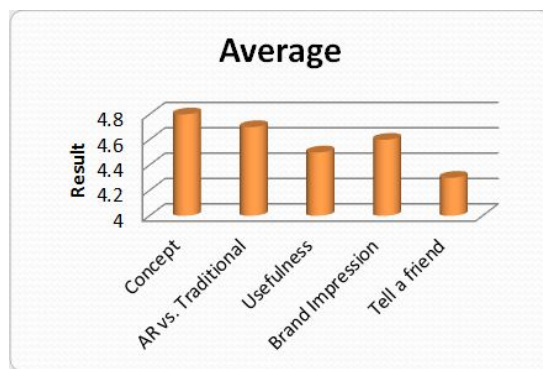
(c) Usefulness



(d) Brand Impression



(e) Tell a Friend



(f) Average Results

Table 6.1: User Survey Results

# Chapter 7

## Conclusions

This research began by investigating the use of AR in advertising with an aim of discovering what it is that the advertisers want from a mobile AR application and then, building an application that provides them with what they really need. In the process of trying to reach our goals, several interesting points have also been brought to light. The initial research in AR shows that the use of AR has been growing rapidly in recent years and it is a trend that is likely to continue due to the improvements that occur in the mobile phone industry every year. Researchers believe that mobile AR will have an almost \$800 million market by 2014 and that advertising will play a large role in that market. This could be the reason why more and more brand owners are using AR to advertise their products. AR allows for a type of interaction that can't be achieved from the traditional mediums for advertising; TV, radio and print. The analysing of the state of the art review shows that researchers have been exploring different possible uses of mobile AR; all of which involve enriching the user's experience of something familiar like visiting a museum or reading a map. This is also the case for research in the use of AR in advertising. It can be seen in the AR platform review section that AR advertising ideas in literature are now being used by the AR platforms. The features of the current AR platforms suggest a trend towards the use of marker-less AR to make interactions where there previously were none. With well-known companies like Layar getting involved with the marker-less AR

scene it can easily said that mobile AR will become more ubiquitous with every passing day.

The research interviews with Irish marketing specialists paint a picture of the AR advertising scene in Ireland and on the most part, it's not pretty. The leading advertisers in Ireland know about AR and the benefits that it can bring to a brand but they are only a small percentage of the advertising population in Ireland. The interviews consistently show that a one of the major barriers preventing AR from properly taking off in Ireland is a lack of knowledge. Many brand owners don't know what AR is so when a campaign around AR is pitched to them it gets quickly dismissed; often using the current economic situation as an excuse or saying that the smartphone population is not high enough. Research from this year has shown that 50% of Ireland's mobiles have smartphone features. This statistic is only going to rise as time goes on because of the advancements of technology. The interviews show that what advertisers want most of all is to gain the absolute attention of the customers for as long as possible. In the case of an AR application the user experience should be fun and interesting and leave the user with a better impression of the brand than they had before they first used the application. This also encourages the much sought after viral spread of a campaign through the internet.

Using what was discovered from the research interviews a mobile AR application was developed and then developed to a marketing specialist to get professional feedback. The feedback results speak for themselves. The marketing specialist was very impressed with the application and said that with a few tweaks it could be used as part of a real advertising campaign. That's not a bad result considering this researcher has no previous experience with marketing. A key aspect that was left out of the AR Car Park is branding. If it were to be used as part of a real campaign then brand logos should be obvious on both the tracking image and on the 3D models. The important of easy to understand instructions was also highlighted in the evaluation section. If a set of instructions are too long then it will scare people away from trying them but if they are too short then potential customers will be left confused and not get to experience the full AR advertisement. A

last point raised in the evaluation interview is the importance of incentivising people to go to the effort to download and use your application. Getting a campaign incentive right is something that advertisers spend a lot of effort thinking about.

In relation to the junaio AR platform; it provides the basic framework needed to create an AR app but there is still a lot to be desired functionality wise. The allowed interaction is too basic; view and touch. We would like to be able to control a model like a game character instead of just looping an animation. Junaio also doesn't allow access to phone specific hardware such as the accelerometer and gyro. When controlling everything from the server side you can't discover much information about the user and their device. This makes keeping a channel consistent across all potential devices quite difficult.

The findings of this research all point towards one thing. Irish advertisers should get involved with AR. It is not just a gimmick that will no longer be around in a couple of months. Hopefully this research shows why AR is such a powerful tool for advertisers and why AR as a technology is not going to disappear any time soon.

## **7.1 Future Work**

The future work of this project could go in two different directions; the first being to continue on working with junaio and adding more features to the app; the second involves trying out other AR platforms and comparing their results.

To continue working with and experimenting with junaio as an AR platform would require the creation of a white label application. The junaio plugin allows the developer to add the features of a junaio channel to their own application. This means that AR could be used to unlock additional features in the rest of the application or for the case of a gaming app, items or characters found hidden in the AR world could be played with in the game's world. Having a white label application would also make it easier to update the app with new content on a regular basis. Users would be able to skip the login and searching for a channel process that must be done in the free junaio app if the junaio

plugin was used.

Another idea to improve the advertising campaign would be to create multiple tracking images; each image depicting a different scene that is somehow related to the brand. Each tracking image should focus on a specific car model. Having more tracking images would mean that the customer gets more use from the app and more brand interaction as a result.

Another possible path for this research is to try to recreate the AR Car Park application using the other AR platforms mentioned in the background research. This would lead to an in-depth knowledge of the leading platforms and true “best” platform could be discovered.

# Appendix A

## Questionnaire

Date: \_\_/\_\_/\_\_

### AR Car Park Evaluation Questionnaire

All questions are optional and confidential. Individual results will be aggregated anonymously.

#### General Questions

What do you think about the concept of AR Car Park?

Hate it       Dislike it       Indifferent       Like it       Like it a lot

How is this ad's ability to hold your attention compared to a traditional printed ad?

Much worse       Worse       No difference       Better       Much better

How would you rate the usefulness of the features in this app?

Useless       1       2       3       4       5      Very Useful

How would you rate your impression of the brand after viewing this AR ad?

Bad       1       2       3       4       5      Good  
Uncool/gimmicky      Cool/modern/Advanced

How likely would you tell others about this type of advertisement either through word of mouth or through the use of social networks such as facebook or twitter?

Not likely       1       2       3       4       5      Very likely

# Appendix B

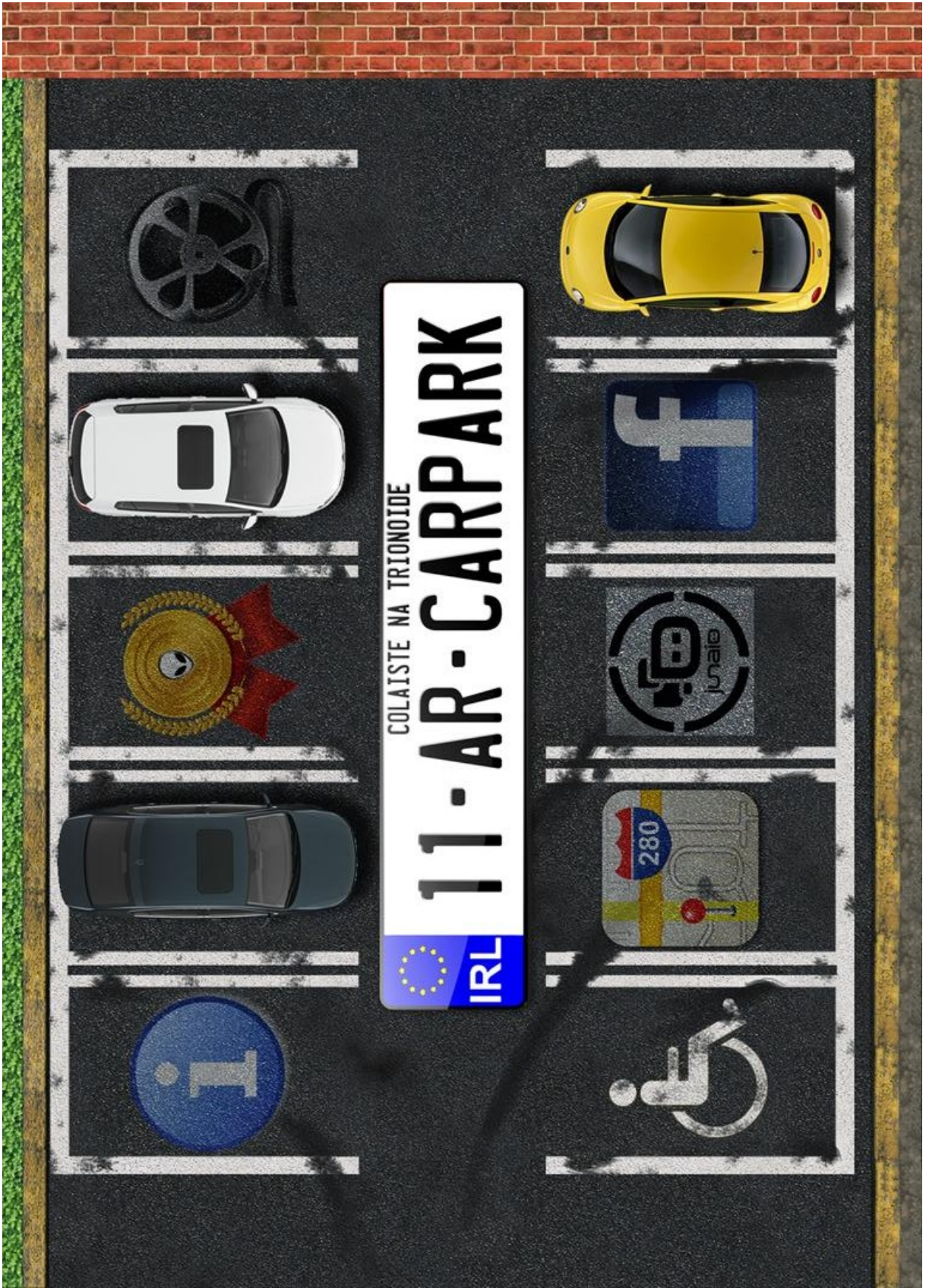
## Try It Yourself

### B.1 Get AR Car Park



You can use any QR code reader to scan this marker. If junaio is not installed, it will lead to the Android Market or App Store, otherwise junaio will be opened with AR Car Park preselected.

### B.2 Tracking Image



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