An augmented reality workflow for creating 'live' wine labels

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Abstract: Augmented reality (AR) technologies are constantly developing in various fields of communication such as entertainment, education, information, and marketing and other fields such as industrial product design among others. This paper aims to present an integrated AR workflow for the labelling of wine products. The proposed wine label enhancement workflow may work as follows: the wine business comes up with the idea of creating an AR experience for its wine products, and then an AR expert designs the AR experience, and develops the AR application. As a final step in the process, the application is distributed to the users with the use of various platforms and the experience can then be activated by pointing the camera of a mobile device to the bottle label. The AR content is then generated and displayed to the user who can interact with the digital product on a whole new level.

Keywords: augmented reality; wine labels; animation; mobile application; unity.

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1 Introduction

Augmented, virtual, and mixed reality technologies are making up for lost time today in various fields of theoretical and technological foundations where among other include applications in education, computer science, entertainment, marketing, and advertising but also in other research fields such as medical applications and industrial product design (Akcayir and Akcayir, 2017; Flavián et al., 2019).

Furthermore, the techniques of interaction between the user and these systems are gaining ground while special emphasis is given to their applications in the field of modern digital forms of entertainment and the field of software application development in fixed and portable computing environments. Considering the large investments made today by some of the biggest technology companies such as Microsoft, Google, Apple, Amazon, and Meta (i.e., the immersive virtual environment that Facebook has been renamed to) by designing and developing software platforms and AR products such as Microsoft HoloLens (Taylor, 2016), Oculus, ARToolKit (https://github.com/artoolkit), and ARCore (https://arvr.google.com/arcore) which allow the use of AR technology in both Android- and IOS-based mobile devices. According to the VR/AR sector revenue by

Digi-Capital – Ubiquitous AR to Dominate Focused VR by 2022 (TechCrunch, 2022) most of the revenues in AR are expected to occur at hardware and e-commerce.

Augmented reality (AR) technology augments the sense of reality by overlaying visual, auditory, or other sensory information in the real world in real-time. Although AR is considered to be primarily a visual medium, it can stimulate many of our senses such as the sense of touch or audition. To this end, AR can be used to provide new experiences and affect communication outcomes. Azuma et al. (2001) proved a thorough analysis of the recent advantages and disadvantages of AR, stating that AR is not considered to be restricted to a particular type of display technology neither is it limited to the sense of sight.

In this paper, we aspire to provide an integrated and step-by-step AR workflow for the labelling of wine products for providing an exciting user experience. A typical wine label enhancement workflow may work as follows: The wine business comes up with the idea of creating an AR experience for its wine products, then an AR expert designs the AR experience, and develops the AR application. As a final step in the process, the application is distributed to the users with the use of various platforms and the experience can then be activated by pointing the camera of a mobile device to the bottle label. The AR content is then generated and displayed to the user who can interact with the digital product on a whole new level.

It is also worth noting AR technology has been used in a wide range of applications. For instance, one may use AR technology to digitally enhance product labels with digital AR watermarks that can be used to detect counterfeit products while at the same time this technology protects the production line through. Anti-counterfeit efforts aim to reduce the amount of lost revenue from smuggling, increase the value of products, protect trademarks and copyrights, and increase customer confidence (Youm et al., 2019).

The major contributions of our work are summarised as follows:

- The promotion of wine products with the use of AR technologies in its labelling.
- The establishment of added value for wine products.
- The foundation of opportunities for interactive advertising by enhancing the consumer experience.

The remainder of the paper is organised as follows: in Section 2, a brief review of the related work is presented. Section 3 presents the proposed AR algorithm including the implementation details of this work. In Section 4, a thorough discussion about the 'live' label application is given. Finally, conclusions are drawn in Section 5.

2 Related work

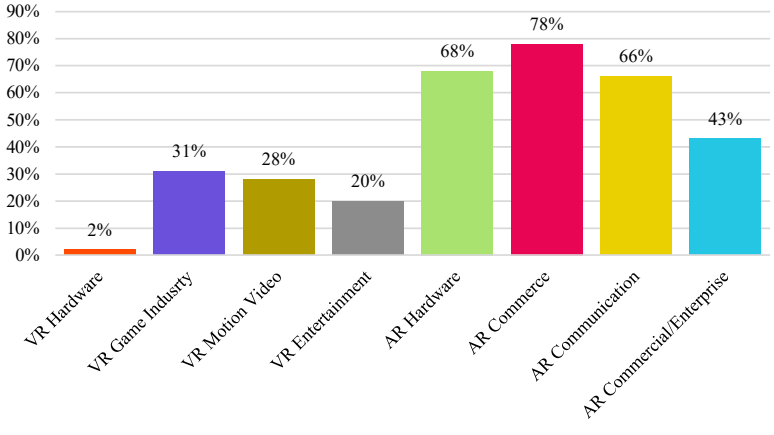
2.1 AR applications

In recent years, wine companies are increasingly using AR technology to attract more consumers and make their labels more appealing to them. Customers have access to a large variety of brands when they buy wine in retail stores. Yet consumers want to learn more about the brand they intend to buy. With the advent of virtual wine labels, wineries are now able to offer consumers an enchanting experience by including unlimited digital content to their labels. One may wonder, in what ways can a virtual wine label be useful?

The answer to this question is that video, 2D/3D animations, photos, and text can all be incorporated into the bottle's label thanks to AR (Vrigkas et al., 2021; Styliaras, 2021).

Mobile AR and enhanced user experiences has already been the subject of numerous studies (Penco et al., 2020). AR was valued at USD1.98 billion in 2020, and it is forecast to grow at a CAGR of 151.93% between 2021 and 2026 (AR Market, 2022–2027). Among the most remarkable characteristics of AR technology is the type of hardware used, as more powerful and portable hardware has been developed, while recording accuracy, graphics quality, and device size have been addressed to an acceptable level, resulting in rapid adoption and development. As depicted in Figure 1, hardware growth is expected to accelerate in the coming years.

Figure 1 Growth of various AR/VR applications (%), global (2020–2025) (see online version for colours)



Source: Citibank

In an AR mobile application, Ahn et al. (2015) created an AR-enhanced shopping cart that provides information about different products on a shelf. This application can act as an online and real-time grocery-shopping assistant application where AR can overlay tagging of products and reduce search time to find the corresponding product. In the same manner, the study of Zhu et al. (2008) describes a mobile shopping assistant using AR to place products in a virtual world and provide recommendations to the users. A further benefit of AR applications is that they can enhance this process by enriching real-world objects with information. In that sense, AR has been widely used in creating mobile grocery store assistants that help the users locate the product they want and support users with typical decision-making (Röddiger et al., 2018; Gutiérrez et al., 2018).

Another interesting and exciting use of AR technology in the promotion of packed products is the work of Juan et al. (2019). The authors deployed an AR application that may be used for providing a piece of nutritional information about carbohydrates in real packaged foods without the need to use additional image targets or markers. A mobile device's camera recognises the original shape of boxes, and then an AR app guides the user to the real package's surface or area where carbohydrates are listed. Using 40 participants to evaluate their application, the authors concluded that AR can be effectively incorporated on actual food and drink packaging.

2.2 AR applications in the wine industry

A personalised AR experience for their customers can be created and managed using Winerytale (2022), AR wine labels for every winery, an innovative platform. Regardless of the size characteristics of the wine bottle, this platform will work with any bottle. Through artificial intelligence, labels are scanned and recognised, and a fascinating world is displayed on the label. Videos of wineries' facilities, wine tasting notes, and suggestions for pairing food with wine are just some examples of multimedia interactive brand content that is displayed to the user. In addition to being able to share stories on social media, this platform allows users to submit their own stories.

Another interesting AR experience is Zappar (2022), Bombay Sapphire, which activates AR content using the bottle label as activation points. Upon scanning the label, the user will be treated to an impressive AR animation. Then customers are able to see exclusive video content that contain a mix of different Bombay Sapphire cocktail recipes. A wine brand from Australia, 19 crimes (Cheers to the Infamous – 19 Crimes, https://www.19crimes.com), has also used AR to enhance its wine labels. By animating the images on the labels and pushing the characters depicted in each bottle to tell their unique stories, each wine bottle tells the story of a person, related to the history of Australia's founding as an English penal colony. By placing a mobile device on top of each bottle, the image of a real person convicted of a crime is displayed.

In a recent project, the EMBRAZEN winery brand (EMBRAZEN Wine, https://www.embrazen.com) created a 'live' wine label celebrating the women of the past to provide an AR experience to customers. Users activate the AR application by scanning an icon on the bottle depicting a lighted torch, which burns to reveal new layers of art. AR applications then allow users to interact with historical women figures and get information about their accomplishments.

An online platform was developed by Barhorst et al. (2021) to study customers' AR wine bottle shopping experiences. A pair of experience video cases was created by the authors. Using AR technology, the first video shows a person picking a wine bottle from a store self, then launching an AR experience where the wine label begins interacting with the individual through narrative with the use of a mobile application. The second video demonstrates the same process without incorporating AR. A positive impact of AR experience on consumer outcomes is examined using two identical videos, which differ only in the AR experience. It was concluded by the authors that using an AR experience enhances product and service experiences and provides a range of benefits for individuals and the community.

As part of their study, Faddoul and Jin (2020) conducted interviews with both wine consumers and AR experts to understand the commercial impact of AR features on wine labels. Studying the use of AR in commercial products aimed to understand its role and characteristics. It was clear from the results that customers are more likely to stay focused on specific products if they have a quality and innovative AR experience. Observations indicate that the product has been redefined with two by-products: wine and AR labels. As a result of the combination of physical and digital elements, an 'enhanced product' is created.

An investigation of the use of augmented information related to wine products is reported by Álvarez Márquez and Ziegler (2021). So as to accomplish this, an AR application was developed to provide additional information about wine products using Microsoft's HoloLens (Taylor, 2016) and the Vuforia SDK (https://developer.vuforia.

com) to detect visual features onto the wine bottle. First, the mobile application uses the smartphone camera to locate and identify the wine bottles. The user is then presented with additional information relating to the bottle, such as calories, price of the bottle, awards, type of wine, customer reviews, and the grape used in the production. Using a fully interactive GUI where the user may use gestures to interact with the virtual world and reveal the hidden information the application provides to the user a whole new exciting AR experience.

The drink of wine is rich in history, culture, tradition, romance, art, and poetry. Companies have begun to attract the attention of customers in various ways. Consumers were able to engage and interact with these winemakers' stories through AR. A study conducted by Torrico et al. (2020) investigated how AR technology affects consumer perceptions, acceptability, and emotional reactions associated with wine tasting. According to the authors, AR can be used to understand how contextual effects affect consumer perceptions of Cabernet Sauvignon wine based on perception, sensory acceptability, and emotional responses. Javornika et al. (2021) explored the use of virtual experiences and how they affect consumer perception of the self. The authors demonstrated that AR technologies on commercial products may significantly change variety-seeking and lead to more personalised and thus commercially viable, AR experiences.

Ultimately, AR is about establishing new digital characteristics on a typical wine product, increasing the engagement of consumers, and finding new ways to stand out in a very crowded marketplace. In order to be successful on the market, winemakers are aware that their labels are an integral part of their presence. The use of AR technologies has grown increasingly popular among wineries around the world to stand out from the crowd.

3 The proposed AR algorithm for creating a wine 'live' label

A typical wine label enhancement algorithm could work as described in the proposed Algorithm 1. It is worthy to mention that in step 1 of the AR algorithm the input image can be either an AR or QR code or a more complex real-world image which can be taken as a snapshot of the wine bottle label. Moreover, to properly interpret the image from the real-world (i.e., identify the brand and type of wine) the bottle label must have discrete and/or unique characteristics on it, which could be identified by the sophisticated image recognition algorithm. Finally, the AR content may contain cases where some characters come to life by creating videos (e.g., 360° videos) and start telling their stories or creating unreal characters using 3D animations. The activated AR content can be in various forms such as 2D/3D animations that aim to impress the consumer and informative videos and text that target informing the consumer.

Specifically, the AR experience may start with a short 2D/3D animation clip placed onto or near the bottle label to impress the consumer. Then, a menu with options may be given to the user so he/she can navigate through informative multimedia material such as videos about the wine growing and winemaking process, information about the location of the vineyards and the competitive advantages of the location, information about the business as well as digital narratives that will target at triggering the emotions of the consumers. On an augmented label, a lot of information can be included about a wine product. There are several types of information that an augmented label may contain:

either location or production place information, myths or traditions associated with the area of production, the producer and his family tradition, or the production process itself, such as grape collection, distillation, storage, production techniques, production facilities, aging, quality assurance, and certification procedures.

Algorithm 1 Proposed algorithm for creating a wine 'live' label

Input: Image scanned by a mobile device.	
Step 1	Input image: The real-world digital content is captures using input devices, such as a smartphone camera.
Step 2	Image processing: The original received image is aligned and colour and brightness processing is performed using image processing algorithms.
Step 3	Computer vision: Image analysis algorithms are performed to identify the patterns of the AR code image or the bottle label and recognise the brand and type of wine.
Step 4	Create AR content: Create or retrieve the user-targeted digital synthetic content based on the recognised input image.
Step 5	Performance phase: This step contains the combination of synthetic content mixed with the real-world image which is then presented to the user through the AR application.
Output: An integrated AR application.	

The synthetic AR content can be stored on a mobile device or a web server and retrieved in real-time. Extensive discussions should take place with graphic designers, software engineers, and the winery business to decide on the way the AR technology can be applied to achieve the goals set from the outset. Image processing algorithms may also be employed to cover all types of variations in images captured as a snapshot of the wine bottle label.

An AR code is a superset of QR codes that redirects the user to an AR web or mobile application. AR codes allow us to add an extra dimension to wine products by creating interactive content in the world around us. Although AR and QR codes have similar goals in attracting users, they are very different. QR codes are 2D barcodes designed within a square frame. When the user scans a QR code with the camera of his/her device it redirects to a website, or a text/image is displayed. AR merges the view of the real environment in the augmented form with additional real-time information, which may consist of 2D videos or 3D animations.

To create an AR code, one may need access to an open-source or commercial library for AR web or mobile applications [e.g., ARToolKit (https://github.com/artoolkit), ARCore (https://arvr.google.com/arcore), Vuforia SDK (https://developer.vuforia.com), and Unity (Haas, 2014)], that provide features such as location-based AR and image or marker tracking. The image mage tracking step includes a 2D image detection algorithm that executes every time a user scans a wine product with his/her camera. The location-based AR allows using location coordinates retrieved by the mobile device integrated GPS sensor to show to the user-specific AR content based on his/her location. As the user moves in outdoor, AR content may adapt to the user's position and rotation. Finally, the marker tracking feature allows us to know where the user is pointing at the camera each time to display the relevant AR content. Therefore, the device must identify which image it is looking at through the camera (e.g., augmented books). This characteristic image is called AR code and it can be anything, as long as it has several

unique points of view. Images with many angles and edges such as wine labels, logos, flyers, or posters work particularly well.

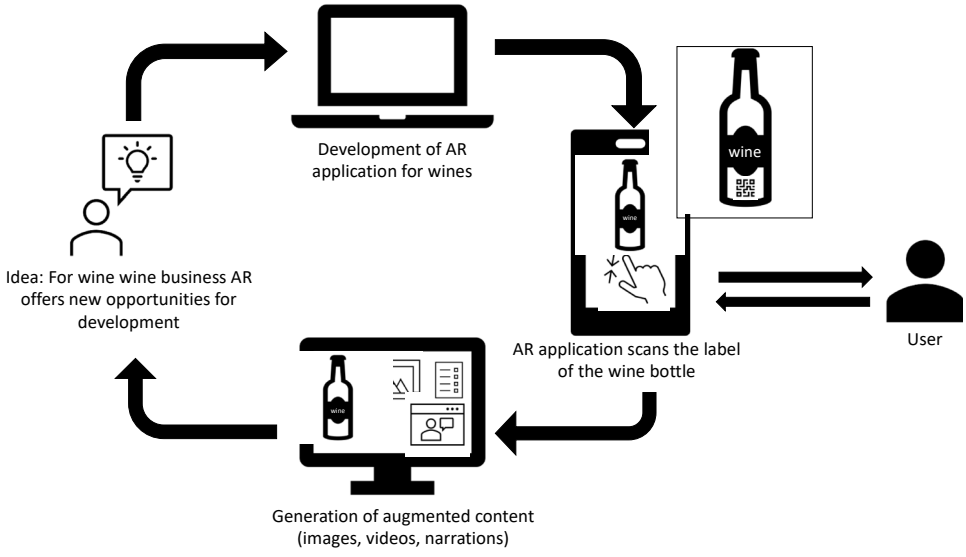
It should also be noted that before starting employing AR technology to create 'live' wine labels it is important to follow some pre-processing steps that will lead to an optimal result such as:

1 Understand the available options: Extensive discussions should take place with graphic designers, software engineers, and the winery business to decide on the way the AR technology can be applied to achieve the goals set from the outset.

2 Development of interactive AR content. This may also contain educational content.

3 AR label design: To activate AR content on a bottle label, it is essential that a robust image processing algorithm is selected, as it must be able to handle all types of variations. Training with many real or synthetic images is a prerequisite.

Figure 2 The proposed workflow for creating an AR application for wine products



The entire workflow of developing an AR application for wine products is depicted in Figure 2. The wine business comes up with the idea of creating an AR code for its wine products, then the AR expert develops the AR application and after the AR application is released, the user points the camera of the mobile device to the wine bottle to activate the AR application. The AR content is generated and displayed to the user who can interact with the digital product on a whole new level. The entire workflow is a cyclic process as the user may provide useful feedback about the AR application which in turn may lead to highlighting the services provided by the wine business to the users, enhance the overall experience of the customer, and help the wine business jump into the competition wave.

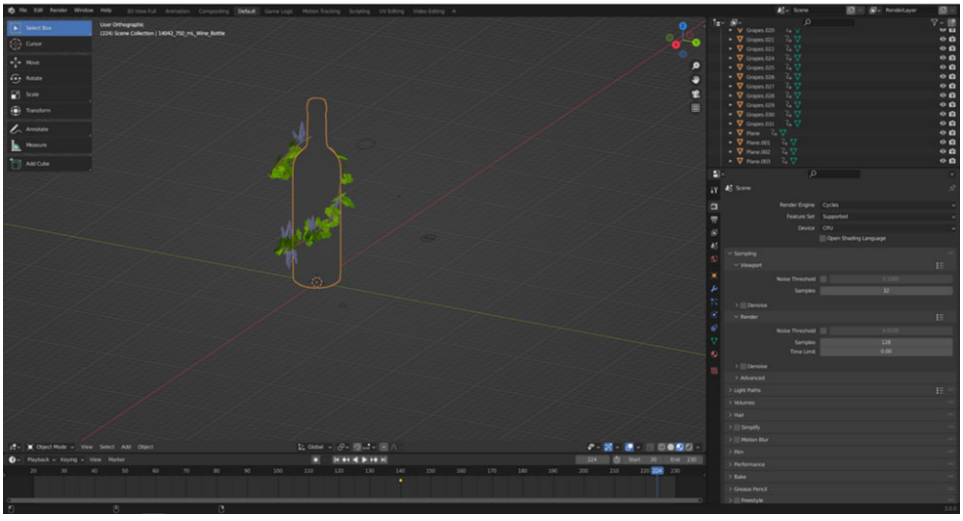
3.1 Implementation details

We implemented our approach using the available development programming languages and platforms such as C# Unity 2018.4.31f1, and Vuforia Engine 10.2. Unity is a

cross-platform game engine and C# was used for scripting in Unity. Also, the Vuforia Engine recognises and tracks the wine label target in real-time. In addition to image and multi-target tracking, Vuforia can also track cylinder targets, object targets, and models. Furthermore, the Vuforia platform incorporates ground plane, which enables the placement, detection, and tracking of digital content on horizontal surfaces, such as floors and tables.

Due to their compatibility with both Android and iOS mobile devices, Vuforia Engine and Unity are an excellent choice for developing AR apps. Initially, we chose to develop our app for Android mobile devices, and we installed the Android SDK, which is an open-source framework that allows gesture detection and tracking, as well as interaction with animated and static 3D objects created by the libGDX game development framework. Video overlays, image, text, button, video, and HTML augmentations are also provided, along with recognition and tracking of images, 3D models, and animations. Note that, Unity can be used to compile the entire app once and can run on any device. However, we did not consider the development of the app for iOS mobile devices. To do this Xcode is required, and the same code may be used for building the application for different platforms such as for Android or iOS mobile devices. Finally, for the implementation of the 3D graphics and the animation clips, we used Blender 3.0. An example of the development of the 3D wine bottle model in Blender with low poly, animated, rigged, game, and VR options can be seen in Figure 3.

Figure 3 Example of the development of the 3D wine bottle model in Blender 3.0 (see online version for colours)



However, one common challenge that needs to be addressed is the mobile screen size. AR mobile applications need to support a wide range of different mobile screen resolutions. The user interface system in Unity includes a variety of tools for this task. To this end, we used the provided by the Unity tools to guarantee that our app is compatible with different screen sizes.

In our implementation, we used images of real wine bottles as image targets and cylinder targets to activate the AR content. Note that the real win bottle image targets

represent images that Vuforia Engine can detect and track by extracting visual features using the camera image captured from the mobile device. Once the image target is detected, Vuforia Engine tracks the image and augment the wine label content seamlessly. An example of the wine bottle and the corresponding wine label used for the development of the 'live' wine label application can be seen in Figure 4. The logo shown in the middle provides sufficient detail to be detected by Vuforia Engine. The device tracker module allows us to track targets farther away from the camera. The maximum distance of the image target from the camera to have a robust feature representation is 40 cm.

It is worth noting that we only used real wine bottles and did not use any additional elements such as additional image targets or markers to activate the AR content. Figure 5 shows a screenshot of the development of the wine 'live' label application using Unity and Vuforia Engine.

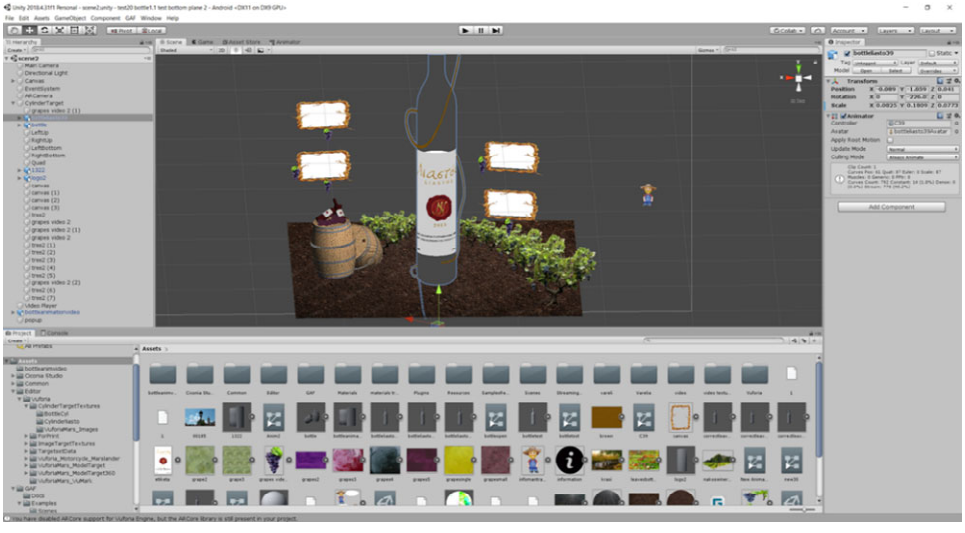
Figure 4 (a) Example of the wine bottle used for the development of the wine 'live' label application (b) The corresponding wine label that is used as image target to activate AR content on the bottle (see online version for colours)

(a) (b)

The development and testing of the AR wine 'live' label application were performed using an Android smartphone. The wine 'live' label application can run on most Android devices. An AR scene may suffer from severe flickering if the camera on a mobile device is not at least 5 MP. A camera with a lower resolution may cause problems at the image target recognition stage. Each of these problems can be solved by ensuring an appropriate amount of illumination in the scene or by ensuring an appropriate distance between the camera and the target. Finally, the minimum system requirements that a mobile device should have to effectively run the wine 'live' label application are an Android 6.0

operating system, 200 MB of free disc space, a quad-core CPU, 3 GB RAM, and at least 1920 × 1080p (full HD) screen resolution.

Figure 5 Example of the development of the wine 'live' label using Unity and Vuforia Engine (see online version for colours)



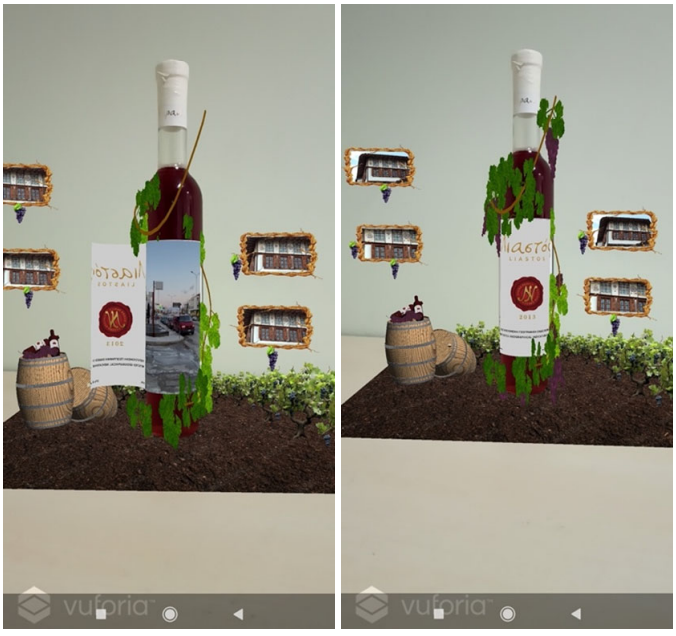
4 Discussion

The wine 'live' label application guides the user in finding the correct surface (i.e., the front label) of the wine bottle where the target image is located. Once the camera of the device focuses on the front label of the wine bottle the application recognises the target image. Then AR content appears in front of the user showing the augmented wine label which is surrounded by a menu and some videos that include multimedia content that consists of:

- Video recordings of the winery's production procedures such as harvesting and crushing grapes, fermenting, maturing, and bottling.
- Videos recordings of the infrastructure and human resources of the wine company.
- Video or animation narratives about wine products.
- Information on wine ingredients, calories, and storage temperatures in text format.
- Animated clips that provide the illusion of a 'live' character on the bottle label which are a great way to impress the consumer.

The user can interact with the AR content by touching the menu and the corresponding information pops up in front of his/her eyes. Moreover, a 2D animation character that is located on the bottom right side of the application shows information in both text and audio form such as wine ingredients, calories, storage temperature.

Figure 6 Different instances of the wine 'live' label application, (a) the device camera focuses on the bottle label and the 'virtual door' opens revealing a hidden video content (b) the 'virtual door' closes and the 2D animation of the vine branches progressively appears (see online version for colours)



(a) (b)

Furthermore, one important feature of the wine 'live' label application is the way the front image label interacts with the user. Once the image target is found by the user, the virtual augmented front image label appears to open as a 'virtual door' revealing hidden information to the user in the form of a short intro video that shows the infrastructure of the wine company. The intro video plays for a few seconds and the 'virtual door' automatically closes. Then a short 3D animation appears to the user that depicts some vine branches that progressively start to grow around the target image label. Figure 6 shows some indicative instances of the wine 'live' label application.

During the first use of the application, the user must locate the corresponding image target by pointing the camera of the mobile device at the front label of the wine bottle. Once the requested label is located, a virtual vineyard is also revealed on the screen. The bottom left side of the screen of the mobile device also shows the help information that explains how to use the application or shows additional information about it. By touching the information button, the user can view this information in more detail. The video menu that surrounds the target image label also contains important information about the application. The user may touch a video button and then it starts playing on full screen. Pressing the 'next' button allows the user to move on to the next video once he/she is done with previous one.

Finally, a short quiz game is incorporated in the wine 'live' label application that assesses the knowledge acquired by the user during his/her interaction with the application. A small multiple-choice survey is administered in this phase to ask the user questions about the wine product. While the quiz is not yet complete, the user is not given

feedback regarding his/her success or failure while choosing between four potential answers. Following the completion of all questions, a summary of correct and incorrect answers is displayed to the user.

The use of AR technology has increased profits for many wine companies around the world (Faddoul and Jin, 2020). As a result, AR technology can help winemakers sell their products by offering engaging and interactive content that includes stories, cultural connections to the wine region, and real-life stories. It is important to remember, however, that wine is more than just an alcoholic beverage. Not only do people enjoy drinking wine, but they also enjoy the stories that go along with it. The wine industry has benefited from the use of AR by allowing winemakers to digitally narrate these stories.

It is thus possible that AR will play a significant role in the future of not only winemakers but also other manufacturers in this field. The integration of interactive games (i.e., gamification) such as a quiz about the corresponding wine product, also supported by AR technologies, has been found that to increase wine sales (Humphreys and Carpenter, 2018). A lot of resulting points can be derived from the presentation and analysis of the proposed AR application namely the wine 'live' label, regarding the application's goals, its audience, and its appeal. The concept of AR applications related to wine products seemed impossible a few years ago. In spite of this, these applications are becoming increasingly popular today. A virtual and real world is combined in AR applications, where physical objects, such as wine bottles, are supplemented with additional computer-generated information to enhance human perceptions. Due to the COVID-19 outbreak, AR technology has been used more frequently in food marketing (How Can Augmented Reality Improve the Food Industry Post-Coronavirus?, 2020).

AR applications have proven to be highly effective for wine promotion, and typically begin with an image-based marker on a wine bottle that launches an interactive entertainment procedure, a game, or animated content. Several nutritional details as well as other information about the product are provided in the proposed app, which concludes with an enjoyable quiz game. Videos, digital narratives, and animations in 2D and 3D are some of the content that's different from what the wine brand traditionally promotes. Consequently, AR technology in the wine industry may be sufficient to provide more satisfactory end-user interactions.

One important question that arises is "what is the audience and the appeal of the application?" AR-based applications address mainly customers of certain branded products (e.g., Cheers to the Infamous – 19 Crimes, https://www.19crimes.com). We aspire that the proposed application will be a trend towards multiple audiences in this application and the combination of videos, digital narratives, 2D/3D animations, and a quiz game about wine production is evidence of this. To this end, the wine 'live' label application may offer multipurpose content and may also act as an entertainment and information tool to the users. Finally, the appeal of the application is a crucial element through which users may express their satisfaction while using the application. Note that with this application, we aspire not only to provide an application that offers pure entertainment content to the users but also to boost the wine business sales. To this end, a large number of downloads, high rates in online stores, and positive feedback from the users may lead to stronger user engagement with the wine 'live' label application and prove its value and consequently the value of the corresponding wine product.

4.1 Limitations of the AR applications in the wine industry

As with any AR platform, the wine industry faces several technical challenges and limitations. More specifically, the proposed AR application requires basic learning to effectively use AR-compliant devices. To render data properly, it must cover the whole field of vision, not just part of it. Also, another important limitation is internet connectivity. Since the proposed AR application includes multimedia content such as video recordings of the infrastructure, which are not inherently included in the application APK but are posted online, the availability of an internet connection is still an issue in many (outdoor) places. The effort or money that needs to be spent by the wine companies is mainly related to the creation of the AR application itself. Thus, it is necessary to lower the price of these AR applications for mainstream use. Therefore, the availability of the application on different platforms such as Apple Store and Google Play is one issue that the wine company must cope with.

Also, one problem that may also affect the effort and money required for the implementation of such a proposal is the image target used to activate AR content on the bottle. Because of dynamic lighting conditions and uncontrollable backgrounds in outdoor AR environments, presenting virtual content – particularly text information – is also a challenge when recognising image targets. Reflections from lighting sources and glossiness affect image targets. A moderately bright and evenly diffused light source is ideal for viewing the image target. As much of the image target as possible should be covered by unique features and graphics avoiding symmetrical patterns, repetitive shapes, and blank spaces. Thus, if the company's logo (mainly used as an image target) covers all these requirements no additional effort or money should be spent by the company on the development of the AR application. Otherwise, an additional step that includes AR label design is a prerequisite to activating AR content on a bottle label leading thus to more time and money that the company must invest for such a proposal. Finally, the price for using Unity and Vuforia Engine for developing as a proposal is a cost that the company must bear.

5 Conclusions

Nowadays AR applications may find an increasing field of development in the food and beverage industry and specifically in the education and training of human resources employed in the industry (through environments and simulation applications), the information of the consumer public about the products, and the marketing of these products. In this paper, we presented an AR workflow for the labelling of wine products and a new mobile AR application called the wine 'live' label that may be used to promote wine products and demonstrate additional information about the product in real wine bottles. A mobile application was developed for Android devices that implements the Vuforia Engine's cylinder target recognition functionality. Additionally, Blender 3.0 was used to create a 3D digital representation of the wine bottle. The use of the application by the end-users does not require additional equipment apart from simple smart devices such as a mobile phone or a tablet.

AR merges the view of the real-world environment in the augmented form with additional real-time information, where physical wine bottles are complemented by computer-generated synthetic information to enhance the perception of the natural

environment. By disclosing audiovisual information about the production processes, the surveillance infrastructure, and the human resources involved in the wine production process, a relationship of trust is established between the consumer and the wine company. Moreover, the audiovisual content may include other information such as the comparative advantages of the product as well as the delicacies (or recipes) that may accompany these products. As a result, AR technology might be the key to a wine product's success as it targets the public.

As future work, there will be an evaluation of the wine 'live' label application through research that will investigate consumer attitudes in terms of attractiveness and effectiveness of the application. For this purpose, questionnaires, and interviews with consumers-users of the application will be used as well as other methods such as observation (or video recordings) of users while using the application.

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Notes

1 The wine bottle and logo in Figures 4(a) and 4(b) are trademarks of Nakos Winery, member of the wine 'live' label project consortium and are used here for the project implementation requirements.