



Consortium for Computing Sciences in Colleges

Southeastern Region

32nd Annual Southeastern Conference

Student Research Contest

Extended Abstracts

**November 2 and 3, 2018
Roanoke College
Salem, Virginia**

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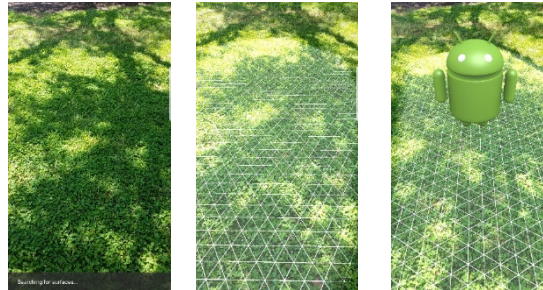
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Using Google's ARCore to Bridge the Gap Between Physical Reality and Virtual Reality

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ABSTRACT

This project implements Google's ARCore in order to produce an augmented reality image through the camera of an Android device. ARCore uses three key technologies, motion tracking, environmental understanding, and light estimation to integrate virtual content into the real world. Developing applications that implement ARCore will need Android Studio, any other three-dimensional image development tool (i.e. Unity), and an Android device. Within the manifest of the specified Android Studio project, the following lines will need to be included:

```
<uses-sdk android:minSdkVersion="{24 or higher}" />

...
<uses-feature android:name="android.hardware.camera.ar"
android:required="true" />

<application>
...
    <meta-data android:name="com.google.ar.core" android:value="required"
/>
...
```

These few lines of code will let the user of the application know that ARCore is required for the application. On the contrary, ARCore can also be set to "optional" by setting the value of `android:value` to optional; `android:value="optional"`. After the manifest has been updated, the project's *build.gradle* file will need to include Google's Maven repository as well as the ARCore library as a dependency. Once each of these items has been added to the project, there are many different methods available to check whether or not ARCore has been enabled on the user's device. The end results of this project were very pleasing, the three components of ARCore (motion tracking, environmental understanding, and light estimation) performed flawlessly and the three-dimensional image of "Andy" was able to be placed, scaled, and rotated. Future work would include the inclusion of many other three-

dimensional images and/or the ability to alter the entire world surrounding the user and not just one particular aspect.

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Experiencing Abraham: Envisioning Furman's Past through Augmented Reality

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Supervisors: Brandon Inabinet and Andrea Tartaro

Experiencing Abraham aims to build an understanding of the hidden ties to slavery and its legacies at Furman University. By being more transparent about the historical harms that the University and its leaders sanctioned, the community can move forward in a way to repair those harms and create more informed views in the present [1]. Towards this goal, this project asks: how can interactive technology be used to create authentic presence and humanistic values without exploiting black bodies for technological gain? We designed an augmented reality app that uses historical images in context combined with theoretically-motivated questions [4] to encourage the users to reflect on other's experiences. We use an interdisciplinary methodology including historical and archival analysis, theoretical context including presence in augmented reality and the DEAL pedagogical model of reflection [4], and technological implementation to create our system.

Archival Research

In order to find historical images for this project, we search in the Furman University archival databases, specifically locating certain historical figures related to the University. Some of the photos could not be found in the archival database, and the Library Special Collections staff had to manually find and digitize those photos. Following both of these processes, we had many great historical photos that would allow for the continuation of this project. For our initial demo, we chose a photo of Joseph Vaughn, the first African American student to enroll at Furman. The photo is set on the library steps with Joseph Vaughn walking in the foreground. In the background, a professor and two students are walking towards the library.

Augmented Reality and Presence

Augmented reality "aims at enhancing our perception and understanding of the real world by superimposing virtual information on our view of the real world" [2, 7:4]. In our case, we are using the display of a mobile device's camera as the "view of the real world" and a historical photo as "virtual information." We built an app that uses image processing software to recognize the setting in which the historical photo was taken. Once the app recognizes its surroundings, it displays the historical photo, adding the virtual content to the real-time environment.

A goal of this Augmented Reality app is to provide a sense of "presence" as well as connect the user to Furman's history when the user is looking at the photo in their environment. Presence is defined as "a psychological state in which virtual objects are experienced as actual objects in either sensory or non-sensory ways" [3]. The Experiencing Abraham app creates an environment where two different time periods are able to coexist, giving the user a unique opportunity to reflect upon the hidden history of Furman. Because the user is able to see the picture in their environment, we hypothesize that they will feel emotionally invested in the people in the photos. Therefore, the user would be better able to reflect upon and understand the history related to slavery and race at Furman.

Pedagogical Reflection

To encourage reflection, we pose various questions in the app based on the DEAL Model of Reflection [4]. Following the DEAL model, the questions are meant to make the user **D**escribe, **E**xamine, and **A**rticulate what they have **L**earned [4] from the photo. Each question is paired with

a specific rendering of the photo overlaid on the iOS device's camera's view. The first rendering of the photo displays the original photo with the full background. The second rendering of the photo cuts out all of the background, leaving Vaughn by himself. The third rendering of the photo removes Vaughn and the background but not the professor and students. The final rendering of the photo displays both Vaughn, the professor, and the two students, removing only the background. The questions posed with each rendering are:

1. Full background: Joseph Vaughn, the first African American student to enroll at Furman, is pictured here on the library steps on his first day. What else do you see in this picture.
2. Vaughn isolated: What would you be feeling if you were in Joseph Vaughn's position?
3. Background people only: What do you think the people in the background of the photo are thinking?
4. Vaughn and background people: Are there people today having similar experiences to Joseph Vaughn's? What would you say to them?

The specific renderings emphasize the focus of reflection: describing the whole scene (rendering 1), examining Vaughn's isolation (rendering 2) and the onlookers' perspectives (rendering 3), and applying learning to consider how users can work to help marginalized individuals overcome that isolation (rendering 4).

Implementation

We implemented the Augmented Reality system as an Apple iOS (mobile device) app using the Swift computing language. We used the following iOS libraries: SpriteKit is used to work with 2D elements such as the historical images in our system. ARKit provides image recognition software, which is how the app recognizes the setting in which the picture was taken. When using image detection software, the photo has to be added to an AR Resources group, and the specific real-life dimensions of the photo must be recorded.

Conclusion

Experiencing Abraham offers users an important opportunity to reflect on the lives and situations of people from the past. In our future work, we plan to evaluate our system as well as our hypothesis that a user is more likely to feel presence when viewing a historical photo in our app than on its own. In doing this, we will be able to learn more about presence in the field of Augmented Reality, which could be valuable for the future of mixed reality technologies.

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Molecules and Machine Learning:
Image Classification for an AR-Enabled Chemistry Classroom
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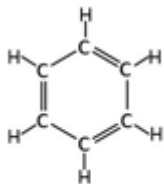


Figure 1 Benzene

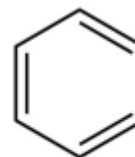


Figure 2 Benzene

Abstract:

In coordination with augmented reality (AR), object recognition using artificial intelligence (AI) and machine learning (ML) have the potential of creating a new way of interacting with the world, particularly in the field of education. A mobile device's camera can view a scene, and AI algorithms can identify objects such as trees or chairs within the scene without user interaction. Using an automated machine learning (AutoML) tool, our research team will train a model and utilize that model in a real time, in conjunction with an AR application that will help chemistry students understand molecular structures. The input to the application will be an image, hand-drawn or computer generated. The app will run the image through our trained model, label it, and use that label to generate an interactive 3D model of the molecule. Initially, our research will train models for small datasets and evaluate the recognition results.

Introduction:

Learning chemistry requires the integration of information from macroscopic, microscopic, and symbolic domains of the discipline (1). The learning process is further complicated by abstract nature of chemistry concepts. The use of molecular models makes concepts more concrete by providing a representation of the microscopic domain (1). Our work will transform 2D compounds into interactive 3D, AR representations.

With the help of AutoML, our ambition is to build an AR tool for students to utilize alongside a lecture, almost like a private tutor in the student's pocket. When using AI, it is best to supply viable training data that closely matches the data on which predictions are to be made (2). Therefore, our initial repository will consist of a small number of both hand-drawn and computer-generated images of very distinct molecules. The immediate goal is to create a trained model that will recognize an image previously unknown to the model based on its distinguishing features. When the app recognizes the structure, we will link the object to a database that holds information about the molecule, and display an interactive 3D image in AR.

Machine Learning:

Traditionally, computer software algorithms use looping and branching to model repetitive and predictable processes where decisions are made on unambiguous data. Not all

processes follow immutable rules, and not all decisions in the real world lead to a single unequivocal answer. Decisions made in ML systems are made on incomplete information. When using ML for image classification, the results are assigned a probabilistic value indicating the potential content of the image (3).

Machine Learning in Education and Chemistry:

ML currently has a positive impact in the educational field, for example, in the project Eduband, class content is adapted to each student – individually – based on their reactions (3). Another example is the platform Duolingo, which is used to learn new languages by studying the learning behavior of each student and adapting the learning material to the needs of that individual (4).

There are numerous ways that AI applications are used in chemistry. One application uses ML to construct quantitative structure-activity relationship models (QSAR). QSAR models help to find relationships between chemical structures and biological activities of studied components (5). A second application utilizes a deep-learning method to identify the molecular structure of natural products. A program called SMART (Small Molecule Accurate Recognition Technology) was able to accelerate the identification process of a molecular structure by using recognition software to identify key pieces of information to obtain the structure of the molecule (6).

AutoML:

The purpose of an AutoML tool is to enable developers with limited machine learning expertise access to train high-quality models specific to their needs (7). The goal of AutoML is to produce a machine learning model of a physical object or a label, using many images of the object or concept as input. A trained model has the capability to determine similarities in structures and can separate the parameters of the object from the surrounding scene. For example, a real estate company needs to split houses by category of ranch style home, apartment, and two-story home. An AutoML tool allows that company to upload images, train and validate a model, and release the model for use in applications. The process is outlined in Figure 3 below.

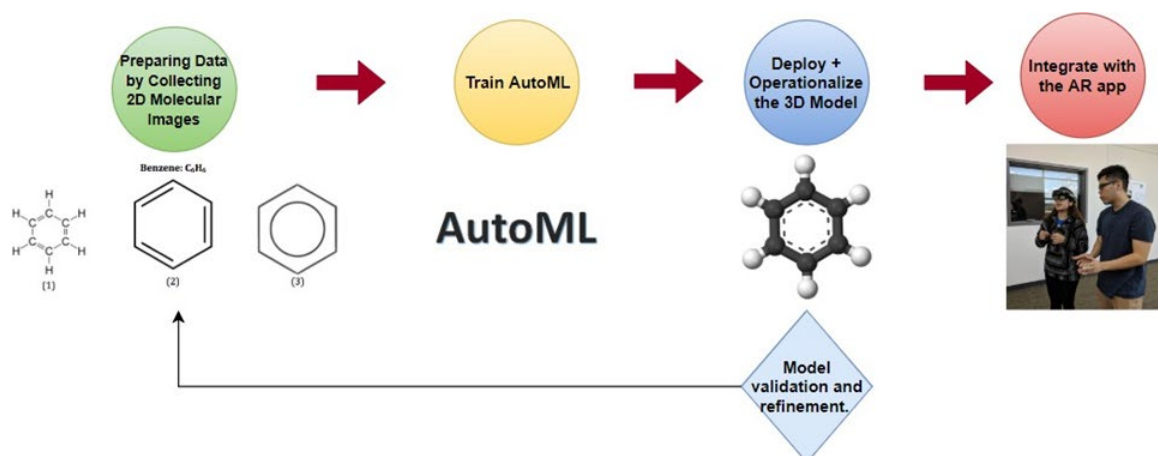


Figure 3: Process flow for training an AutoML tool.

Project Plan:

Initially our work focuses on preparing the model using AutoML. First, a repository of hand-drawn and computer-generated images are collected for a pair of very different molecules. The training process takes place and involves uploading the variety of representations (in an image format) of the molecular structures to the model. Then AutoML autonomously validates and tests the accuracy of the image recognition process. Ideally, afterwards, the model will recognize previously unknown structures and label the images appropriately. We will present our findings on the accuracy of the process flow depicted in Figure 3.

Future work involves increasing the number of molecules that the model can recognize, and integrating the AutoML image classification functionality as the input to present a 3D AR rendition of the molecule. Finally, we want to help ensure the continued growth of the AutoML community by donating our data set to the open source Kaggle library.

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Exploring the Tubercular Aesthetic: How 3D Modeling Enhances Understanding Historic Fashion

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Introduction

Access to fragile historical artifacts, such as historic fashion, is often limited to photographs. This 2D platform distorts proportion, color, and lacks observable angles. Since 2D photos also do not show movement, this causes a problem when investigating historic fashion.

Many of these limitations can be addressed with 3D modeling. Models enable digital access, let a designer manipulate rendered artifacts, facilitate collaboration, and return function to a garment. These dynamic, scalable objects can be viewed from any angle.

Precise measurements, physics, and animation can be applied to models to better understand an object's impact on a person's body, environment, and life. This is an increasingly important tool used in our project and can enhance historic exhibitions.

Literature Review

Our team conducted an interdisciplinary literature review that bridged fashion history, physiology, and computer science. Our primary inspiration was Dr. Carolyn Day's book *Consumptive Chic: A History of Beauty, Fashion, and Disease* that sheds light on an unhealthy 1840s fashion trend that made women look like they had tuberculosis, through the cut of their dresses and corsets.² We investigated the ways digital replicas demonstrate shape and function. Books on historic corset pattern construction and measurements showed us how historic garments can be mathematically transformed to fit a modern physique.¹ Several articles noted how 3D modeling is now being used in cultural heritage to preserve tangible and intangible artifacts.⁵ We also learned how corsets adversely affect a woman's body.^{2, 3} Dr. Day's book shows how skeletons were compressed and altered a wearer's posture.² We also uncovered an 1887 *New York Medical Journal* article that measured corset pressure and associated medical problems: respiratory difficulties, distorted organs, thinning of the abdominal wall, difficulty in childbirth, prolapsed uteruses, and fertility problems.³ In order to construct our two corset models, we found digital tools that examine historic dress, such as DC Suite software for fashion design.⁷ One of the issues that became apparent was the need to establish standardized protocols and peer-reviewed databases for 3D models.⁵

Methods

We used Udemy's online tutorials to learn how to create, combine, and manipulate 3D shapes to form objects in Blender 3D Modeling Software.⁶ We selected Blender because it is open source. More advanced tutorials taught us how to do the following: map textures, modify and extrude shapes, bevel edges, and mirror objects. The Blender bowling tutorial taught us to spin curves to make nonstandard shapes based on tracing the silhouette of an image (Fig. 2). We applied techniques to make 3D interiors of both corsets. Using background images of the corset as reference, we sliced sections with the knife tool and traced it with a pencil (Fig. 1). Blender's MakeHuman add-on enabled the creation of exact torso dimensions.⁶ Outside of Blender, we

projected photographs of a corset patent, a pencil sketch, and several angles of the corsets on a wall to construct paper patterns in order to obtain more precise measurements.

Results

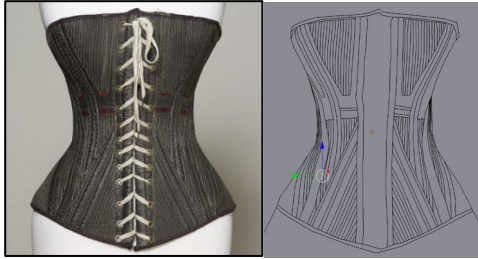


Fig. 1 1840s consumptive corset photo; Blender pencil model

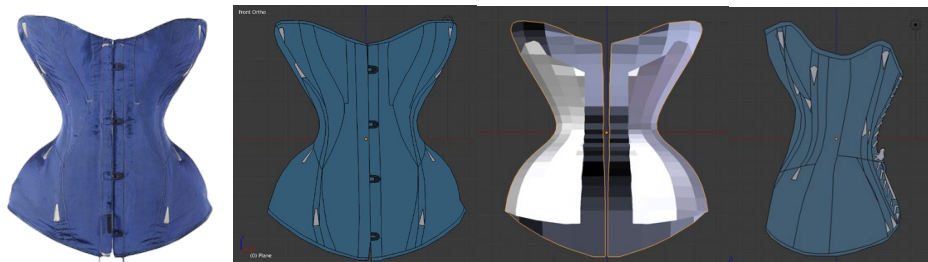


Fig. 2 1851 healthy corset photo; Blender models: front, 3D interior, and side views

Future Work

Since Blender is more suited for geometric shapes instead of movable garments, we plan to use DC Suite 3D modeling software specifically designed for clothing. With this software, we will incorporate our patterns and what we learned from Blender to construct more precise models that can be placed on walking female figures to show how the corsets affect movement. With our fabric replicas, we will look at fabrics, tensile strength, boning, thickness, and lacing to more fully explore these historic designs.

Notes

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Privacy and security issues as obstacles to product delivery

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Motivation:

One of the main benefits of technology is to make daily activities easier, but sometimes it comes with a cost. This cost can be your privacy, social activities, or trust in a company. Technology has improved the world of retail and shopping but it can still be stressful. The time it takes to browse items and lack of product availability can ruin a trip. Online shopping has grown to alleviate some of these problems, but online grocery shopping still has several obstacles. Having fresh products delivery in a reasonable time, in a safe location can be problematic. Amazon offers the AmazonFresh service, which delivers products to homes in a certain zip codes. Amazon Key is a further improvement, which delivers products into customer homes, if requested at check out. This requires one to have purchased and installed the Amazon Key system. These two services combined, having fresh groceries delivered in your home can save a lot of time, while keeping products fresh. However, it can be intimidating to allow someone step into your home. How do you know if the delivery person won't steal something or use your household appliances? But, what if a camera is installed that can give live monitoring of deliveries, or what if a special mini fridge is installed outside your home for deliveries? We investigate whether having these options makes a customer feel more secure and relieved about their delivery.

Hypothesis:

The millennial and centennial generations have grown with technology being a big factor in their lives. They understand how technology works, the privacy risk of some services, and the sense of security it can bring. But as these generations enter the workforce and start families, time constraints become an obstacle for grocery shopping. We hypothesize that these generations will be in favor of having in-home deliveries of grocery products with strong security measures. In contrast, we predict the previous generations will favor a brick and mortar shopping experience.

Method:

We plan to address the societal impacts of these technologies by conducting a survey among a population of college students, retail professionals, online shoppers and retail shoppers. The survey consist of about 25 questions relating to the participants' knowledge and feelings towards privacy, technology and the impacts on their grocery. The results will be grouped and compared based on the age groups of the respondents, and analyzed to determine whether favoring the next phase in delivery technological advancements.

Conclusion:

After surveying several participant in the metro Atlanta area, our results showed the millennials who were surveyed were in favor of trying the outdoors fridge idea because of time savings and as

they are already familiar with online shopping. Outdoors fridge was preferred to inside-home deliveries, citing concerns about security, and live surveillance monitoring of deliveries was also popular. Even though participants are shopping online, there were several who preferred to shop both in store and online. Shopping in store gives them the chance to choose their own produce items while shopping online save them time on gas and driving. Figure 1 shows the results from just a few generic question ask to see if participants knew about other types of delivery methods or services. Figure 2 shows the age range of the participants and its correlation to their responses to technology and security. The goal of this ongoing experiment is to determine if the current and future generations will be willing to sacrifice their privacy to allow technology it improve their deliveries of grocery items.

Figure 1:

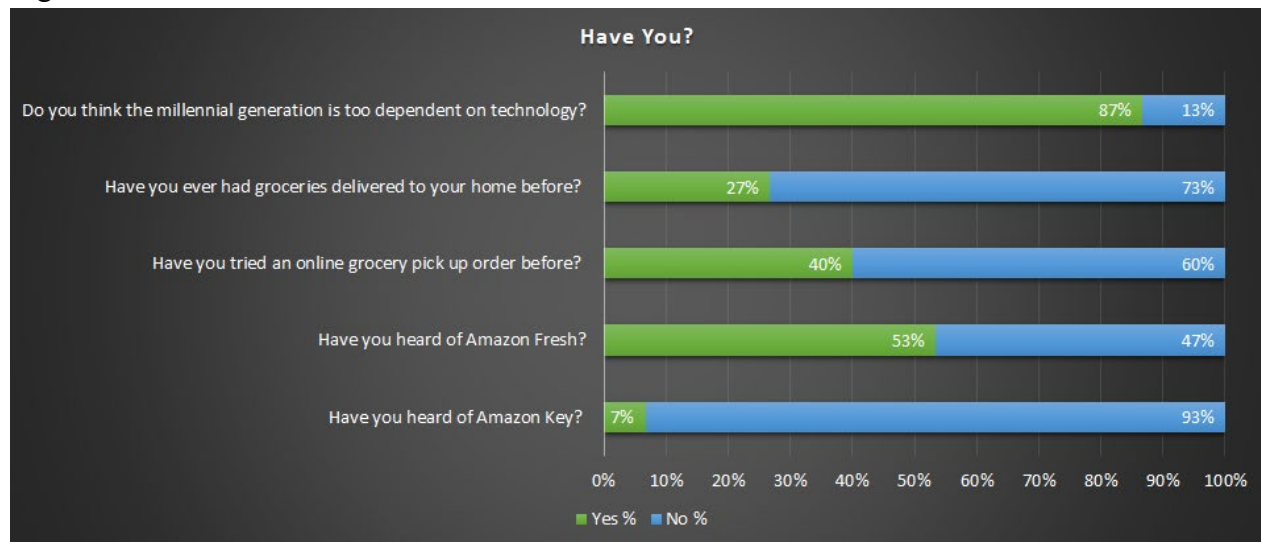


Figure 2:

