
Bilkent University

Department of Computer Engineering

# Senior Design Project

## *PlumbAR*

## Project Specification Report

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This report is submitted to the Department of Computer Engineering of Bilkent University in partial fulfillment of the requirements of the Senior Design Project course CS491/2.

# Contents

# 1. Introduction

One of the critical points in construction work is to understand the plumbing and electrical installation system in the area where the work will be done. However, since these layouts in the areas are complex and hidden inside the closed walls, it is difficult for the employees to understand which pipe or cable goes where. In addition, since the layout drawings presented to the workers are two-dimensional, the understanding of the plumbing and electrical installation systems are realized in an ineffective way. *PlumbAR* is a mobile application that allows users to virtually see the plumbing and electrical installation layout of an area. In this way, during construction or maintenance work, we prevent employees from trying to figure out where the pipe and cable pass or wasting time with layout drawings [1].

In this report, we discuss certain constraints that must be examined in order to develop this application reliably, as well as their ethical and professional issues. Finally, we describe all of the functional and nonfunctional requirements that must be met in order for *PlumbAR* to be offered to the public.

## 1.1 Description

Main goal of this project is to present Augmented Reality based plumbing and electrical installation layout of an area. Users will give us information about the plumbing or electrical installation of an area and applications will convert this information into the Augmented Reality based pipe and cable models. Thus, users will be able to see the pipes and cables in the area as models with their cameras. In addition, thanks to the information we receive from the user, we will also present the characteristics of pipes and cables such as their type and remaining time. In this way, we help users when they want to change, repair or have information about the cable or pipe system of the region they are aiming for. With the help of the features we will offer, we can solve problems such as which pipe and cable goes where, which part of the wall should be used when there is a part to be removed or installed, or how long the existing pipes and cables have a lifespan.

## 1.2 Constraints

### 1.2.1 Economic Constraints

- The app will be free to download and use for any user.
- Publishing the app on Android App Store and IOS store will require a fee [2], [3].
- Project will be open source after release in order to increase interaction.

### 1.2.2 Environmental Constraints

- The augmented pipelines and the electrical wires will be restricted by the walls.
- The material of the wall will be available to be selected from the database that application provides.

### 1.2.3 Social Constraints

- The user who enters the pipeline data needs to be adequate for recognizing material of wall, pipelines and electrical wires.

### 1.2.4 Ethical Constraints

- In order to create pipelines using AR, the user's camera will be accessed.
- Pipeline and the electrical wires data will be stored locally by the user and will not be available to anyone else.

### 1.2.5 Health and Safety Constraints

- In order to safely apply changes to the wall of the pipeline, the application will provide accurate pipeline location and information about the material of the wall.
- Contacting electrical wires could cause serious health hazards and the application helps visualize the location of the wires before contacting.

### 1.2.6 Manufacturability Constraints

- The application will be using SOLID design principles to support object oriented programming.

### 1.2.7 Sustainability Constraints

- The application will provide sustainability information about the pipeline which contains data about sustainability performance of the pipelines and when to change the pipes.

## 1.3 Professional and Ethical Issues

Our main purpose in this application is to inform a user about the existing cable and pipe systems. Therefore, our primary professional responsibility is to ensure that the cable and pipe models we create with augmented reality are in the right positions. When placing these models, it is very important that they are close to their original position. Otherwise, a worker may damage the existing plumbing or electrical system with incorrect information from our application. This result also imposes ethical responsibility on us. Since plumbing and electrical systems are complex and interconnected, damage to these systems will be both costly and tiring in terms of restoring them [4]. To summarize, the consistency in the position of the model and cable figures from our application is of essential value. It is our responsibility to maintain this accuracy at a high level, both professionally and ethically.

In addition, since we will keep the types of cables and pipes, their remaining life and the materials from which they are made in our system, it is our responsibility to keep and present this information accurately. When we reflect the pipe and cable information of the region incorrectly, problems such as rupture and abrasion in the cables and pipes will cause serious problems to the advancing user and it is our duty not to allow such an ethical problem to occur.

# 2. Requirements

There are two requirements for the application. These requirements are as follows:

## 2.1 Functional Requirements [5], [6]

### 2.1.1 Adding API Links

The user shall be allowed to use API links to other databases and websites to display information.

### 2.1.2 Ease of Use

The application shall have a clear and easy to use user interface. The layout of the symbols shall be understood by non-software literate users.

### 2.1.3 Help

At any point in the application, users shall be able to get information about how the application works, what it is intended for, and what the items on the UI mean.

### 2.1.4 Display Plan of Area

The application shall be able to display a plumbing and electrical installation plan of the area viewed by the user if the plan exists and the AR content is visible.

### 2.1.5 Showing Augmented Reality Content

While the camera is open, the application should provide the following:

- Every defined pipe for plumbing shall be shown clearly in the area pointed by the camera.
- Every defined cable in the electrical and internet installation shall be shown clearly in the area pointed by the camera.
- The user shall be able to toggle the view of each different type of installation on or off.
- The user shall be able to define the area of the plumbing and installation view (i.e view of the plumbing of the user’s house only).

- The user shall be able to view the remaining life of each water pipe and cord.
- The user shall be able to view the color and type of the wall selected.

### 2.1.6 Deployment of Augmented Reality Content

The content shall be deployed on mobile devices.

### 2.1.7 Adding Augmented Reality Content

The users shall be able to add new plumbing and installation information about a selected area.

## 2.2 Non-Functional Requirements

### 2.2.1 Performance

The AR viewing performance shall be on parr with the performance of the camera application on the mobile device. This means that the real-time viewing of the AR items shall update as the camera moves and the frames per second will be higher than 24. The response time shall be less than a second.

### 2.2.2 Extensibility

The application shall be implemented in a way that it is easy to make new modifications, fix bugs and remove undesired features. In order to ensure this, the application will be implemented in an object oriented design allowing the classes and functions to be modified independently and in an organized fashion.

### 2.2.3 Reliability

The application shall be able to perform the tasks given by the user without crashing. The functions the users are allowed to do will be thoroughly tested to ensure software based errors are minimized. User errors will be minimized by preventing users from completing tasks leading to an error in the application.

### 2.2.4 Usability

By minimizing the errors and providing a pleasant user interface design, the application shall have a usable design. AR content will have distinguishing and appealing colours while the buttons and other UI content will be minimalistic to ensure a more satisfactory interface for the users.

## 3. References

[1] “Safety in design during piping engineering,” *Hydrocarbon Processing - Refining, Petrochemical, Gas Processing and LNG Magazine, Data and Information*. [Online]. Available: https://www.hydrocarbonprocessing.com/magazine/2018/february-2018/environment-and-safety/safety-in-design-during-piping-engineering. [Accessed: 10-Oct-2021].

[2] A. Inc., “Apple Developer Program,” *Apple Developer*. [Online]. Available: https://developer.apple.com/programs/. [Accessed: 10-Oct-2021].

[3] *Google play console | google play console*. [Online]. Available: https://play.google.com/intl/tr/console/about/. [Accessed: 10-Oct-2021].

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[5] “Open textbooks,” *Siyavula*. [Online]. Available: https://intl.siyavula.com/read/it/grade-12-it/software/06-software?id=sec6-3. [Accessed: 10-Oct-2021].

[6] “Augmented Reality Software & Content Generation Tools Functional Requirements for Industrial Industry Use Cases.” [Online]. Available: https://thearea.org/wp-content/uploads/2017/08/AR-Functional-Requirements-Software-rev1.pdf. [Accessed: 10-Oct-2021].