Right Move
Augmented Reality Project Documentation

Project in Computer and Informatics Engineering

University of Aveiro

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Group 1

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Chapter 1

Application Overview

1.1 Main Goal

Our main goal is develop an application that helps the user throughout a lego assembly, indicating the steps to be taken as well as notifying the user whenever those same steps are not completed correctly in order to train the user to perform the assembly in an increasingly faster and more efficient and independent way. This entire project was developed with the aim of transferring to the assembly of parts in an industrial environment.

1.2 How to use the app

First of all, the user must have a smartphone or tablet at the time he intends to carry out the construction in question, for a freer and more immersive experience the application will also be available for Google Glasses.

After installation, if it is on a compatible mobile device, the user will see the inicial menu, then needs to choice to make a scan, an assembly or an projection. If the user wants to make an assembly, he will have to scan the QR Code of an assembly and a list of the pieces IDs will appear and must collect them to carry out the assembly. After collecting the first piece correctly using the QR Code, the user must place the piece in the correct place on the green plate and point the mobile phone camera for the application to verify that was the correct place for that piece. The assembly will always take place within these modules until the last piece is correctly placed on the green plate. The catalog of assemblies can be consulted on the RightMoveWebsite. If the user wants to make a scan, he will just need to scan the QR Code of the piece and an image will appear of the part that was scanned on the mobile phone. If the user wants to make a projection, the user will check the environment in which he is inserted, and checks whether or not it is in the coordinates that we indicate in the DataBase before assembly.

Chapter 2

Project Deliverables

Chapter 3

Project Timeline

When starting a new project, one of the most important aspects is creating a timeline that outlines the different stages and milestones involved. A project timeline can help keep everyone on track, ensure that deadlines are met, and give a clear overview of the project's progress.

At the beginning of the project, it's important to identify the major milestones and deadlines. These might include completing a project plan, designing the product, and testing the final deliverables. Once these have been identified, they can be broken down into smaller, more manageable tasks.

3.1 Deliveries and Deliver Times

In our project, we were guided by a diagram made by the PECI professor, where all the dates that were imposed were strictly respected, from the delivery of reports (inception Phase), intermediate (Elaboration and Construction Phases) and final (Transition Phase) presentations and, finally, the presentation at Students@DETI.

In the Inception Phase, we do the validation of the project, do the project planning and the first presentation at (04/11/22), where we present the lifecycle objectives, overview of related work and work plan.

In the Elaboration Phase, we do the second presentation at (09/12/22), where we present the requirements elicitation, the system architecture and shows the first design and functional testing. First version of the report is done and submited.

In the Construction Phase, we do the third presentation at (16/03/23), where we present the prototype, do the peer evaluation and show the project progress assessment with individual demos.

In the Transition Phase, we do the fourth and final presentation at (25/05/2023) and preparated the materials for a public presentation at students@DETI.

This dates show that the project is broken down into several stages, each with its own set of tasks and deadlines. The timeline clearly shows when each task needs to be completed and who is responsible for it.

Having a project timeline like this can be incredibly useful for keeping everyone on track and ensuring that the project is completed on time. It also helps to give a clear overview of the project's progress, making it easier to identify any potential issues and make adjustments as needed.

Chapter 4

Project Requirements

Chapter 5

Project Resources

In order to develop this project, the 'Google Glasses Enterprise Edition 2' were made available to us by Huf Portuguesa. 'Google Glass Enterprise Edition 2' is an assisted reality wearable that helps businesses improve the quality of their output. It can also help their employees work faster, smarter, and safer. It provides hands-on workers and professionals with glanceable, voice-activated assistance that's designed to be worn all day, thanks to its comfortable, lightweight profile.

To test everything we developed in Android Studio, each member of the group used their Android smartphone or tablet. Android is a mobile operating system based on a modified version of the Linux kernel and other open-source software, designed primarily for touchscreen mobile devices such as smartphones and tablets.

It's important to note that while using the app for the project is convenient and efficient, it should always be complemented with the use of the project website as well. The website can be accessed via a PC and provides access to both the project catalog and QR codes that identify the different pieces and should be placed in their respective boxes. By utilizing both the app and website, users can ensure that they have all the information they need to complete the project successfully.

It's worth noting that, in addition to the technological materials involved, if we're talking about the ARUCO-based version of the app, it's essential to consider the final scenario where the ARUCO markers are placed precisely to ensure optimal performance of the application. The accuracy and positioning of these markers are critical to the functionality of the app, and as such, they should be placed with care and precision to ensure the best possible outcome.

Chapter 6

Project Risks and Mitigation Strategies

Project risks are events or conditions that may negatively affect the progress, budget, quality, or final delivery of a project. One common risk in many projects is the lack of availability of team members due to their individual work schedules or academic commitments. This can make it difficult to schedule meetings or collaborative work sessions, which can ultimately impact project timelines and deliverables.

To mitigate the risk of team member availability, project managers can implement a variety of strategies. One approach is to divide project tasks into smaller, more manageable parts that do not require all team members to be present at the same time. This can help ensure that work progresses smoothly, even if team members are not able to be present for every step of the process. By breaking down the project into smaller pieces, each team member can focus on their assigned tasks and contribute to the project at their own pace and schedule.

Another strategy is to divide the project repository on a platform such as GitHub into separate branches, allowing each team member to work on their own branch without affecting the work of others. This enables team members to make changes and test features independently, before merging their work into the main project branch at the end of the project. This approach also allows for easier management of version control and can help prevent errors and conflicts that may arise when multiple team members are working on the same codebase at the same time.

In addition to these strategies, effective communication and collaboration are also critical in mitigating the risk of team member availability. Project managers should schedule regular check-ins and progress updates, as well as provide clear instructions and expectations for each team member's role and responsibilities. By establishing clear lines of communication and collaboration, team members can work together more efficiently and effectively, even if they are not always able to be physically present at the same time.

In conclusion, the risk of team member availability can be a significant challenge in many projects. However, by breaking down tasks into smaller parts, dividing the project repository into branches, and establishing effective communication and collaboration, project managers can mitigate this risk and ensure that their projects are completed on time and to the desired quality.

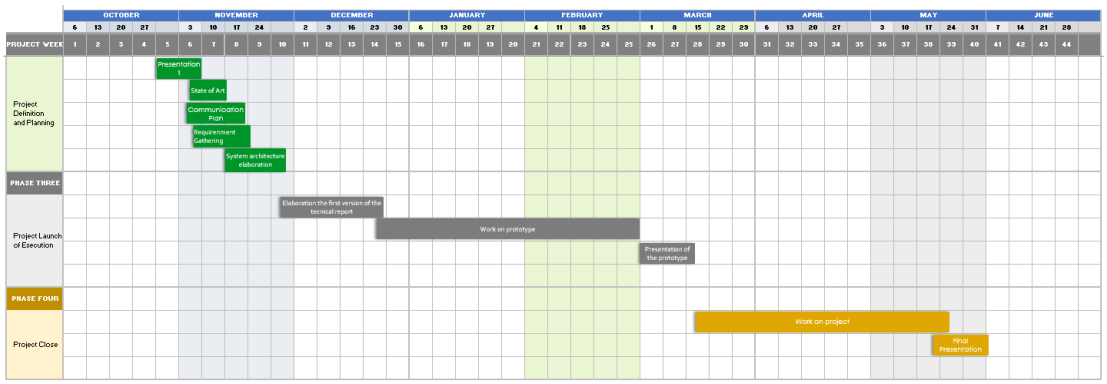
Chapter 7

Project Communication Plan

As part of our project management strategy, we have developed a project communication plan to ensure that all stakeholders are informed and involved throughout the project lifecycle. Effective communication is crucial to the success of any project, and our plan outlines the key communication channels, frequency, and methods we will use to keep everyone informed.

The project communication plan includes a comprehensive list of stakeholders, their roles, and their communication needs. It also includes details on how we will communicate with each stakeholder, such as email, phone calls, or MicrosoftTeams and how often we will provide updates.

To help visualize the timeline and tasks involved in the project, we have also created a Gantt chart that outlines the project schedule and identifies key milestones. The Gantt chart is an essential tool that will help us to manage the project effectively and ensure that we deliver on time and within budget.



The Gantt chart shows the different tasks involved in the project, their dependencies, and their start and end dates. It also includes the duration of each task and identifies any potential delays that may impact the project schedule.

By combining the project communication plan and the Gantt chart, we can keep all stakeholders informed and involved throughout the project lifecycle. This will ensure that everyone has a clear understanding of the project goals, timelines, and progress, and can contribute to the project's success.

Overall, we believe that our project communication plan and Gantt chart will help us to manage our project effectively, communicate with stakeholders efficiently, and deliver a successful outcome.

RightMoveWebsite

Chapter 8

Project Documentation

Chapter 9

Project Governance

9.1 Scenario creation

To test what we were developing in our project, we created a scenario that would serve to verify that everything was correct. This scenario is made up of a green LEGO board where we will assemble our pieces. Then with our functions we will check if everything is correct.

Bearing in mind that we initially developed an application based on position markers (arucos), 3 scenarios were developed that accompanied the evolution of the application. An initial scenario with a black background, consisting only of a piece of cardboard, where the arucos and some boxes where the lego pieces were stored next to the QR Codes that identified each type of piece were positioned in order to test the operation of the application in an initial phase. In addition, an initial construction catalog was also drawn up, which only included buildings with only 1 level in height. This catalog had several constructions that the user could choose to assemble, with the parts that were part of that construction and that the user would have to collect. Subsequently, the final scenario was elaborated, which then has a front and a back, in this way, in one of the verses of this scenario with a white background, constituted by a wooden board, there are the arches where it will be possible to demonstrate the first version of the RightMove Application, accompanied by a assembly catalog, as well as the boxes that contain both the parts and the respective QRs that identify their type, as in the previously explained provisional scenario, and another completely blank back where the final version of the app will be demonstrated where the recognition of board pins is independent of placeholders.

9.2 DataBase

To have some characteristics that differentiate the pieces from each other, taking into account that we are using official LEGO bricks, we used the brand's official nomenclature, so each model of the piece already has an id and that was the one we used. This official code only identifies the model and not the color, so we have added the initial of the color to which we want the piece to correspond at the end of each id. For example, if the piece id is 11111, our internal id is 11111W, if the piece is white(W).

Data relating to both parts and assemblies are currently stored locally in Json files, and more legibly organized in an excel file so that all elements of the group can consult it in a more practical way. We have two classes: pieces and assemblies. Pieces are made up of an id, color and dimensions. Assemblies consist of an id, four steps, each one with one piece, and a name.

We put in the excel that we talked about a little while ago 17 types of pieces, 3 type of assembly with 4 pieces and 4 steps each one just to test if we are doing correct things.

9.3 QR Code Detection App

During the planning stage of our application, we encountered three critical questions that would shape the rest of the app's development: How could we track the process of collecting and placing parts for assembly? How could we detect the pieces and the entire scenario? And how could we detect the color of the parts placed?

To address the first question, we developed a system for reading and generating QR codes. This section of our app is dedicated to the QR detection module and how it functions.

The QR code system allows us to track the movement of parts throughout the assembly process. Each part has a unique QR code that is scanned when it is collected and again when it is placed in its appropriate location. This allows us to ensure that all necessary parts have been collected and placed correctly, and if not, we can quickly identify the issue and make corrections.

In addition to tracking the parts, the QR codes also enable us to detect the scenario in which the assembly is taking place. By scanning a specific code at the beginning of the process, we can

identify the specific assembly scenario and adjust the app accordingly.

Finally, to detect the color of the parts, we use image recognition technology. The app captures an image of the part, analyzes it, and determines its color. This information is then used to ensure that the parts are placed correctly and in the right order.

So, we create a QR Detection App to detect QR Codes. Each LEGO piece has an associated QR Code. Each QR in the pieces scan contains a json file that works as an identifier for each of the pieces, with this ID the app searches the local files for which piece corresponds to the read identifier and displays the image of that same piece.

It will be used when the user wants to collect a piece to do the assembly and wants to know if collect the correct piece.

In conclusion, the development of the QR detection module was crucial in addressing the first of our three essential questions and ensuring the success of our assembly application.

9.3.1 Piece Scan

Initially, it was decided that identification in our project would be done using QR codes. As a result, the first phase of implementing this system involved identifying each of the pieces used. Each piece is assigned a unique QR code that contains a JSON file. The JSON file contains a JSON object that includes parameters such as: (ID, color, and coordinates).

The ID parameter helps us to identify the specific part that is being used. This is crucial as it allows us to ensure that each piece is in the right place and that the assembly is completed correctly.

The color parameter enables us to differentiate between different parts that may look similar but are, in fact, different. This ensures that the right parts are used and that the assembly process goes smoothly.

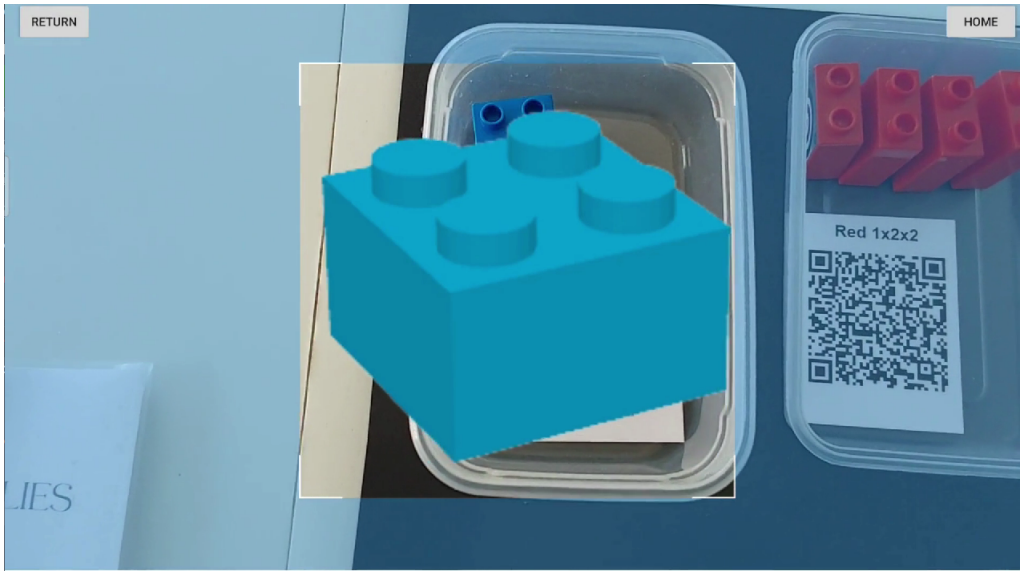
Finally, the coordinates parameter helps us to locate the position of each piece within the assembly process. By knowing the location of each piece, we can ensure that the assembly is completed correctly and that no parts are missed or misplaced.

This phase was merely transitional. Initially, the idea was only to use this system when building a specific assembly. However, we realized that it would be useful to use this same functionality in parallel, particularly when dealing with opaque boxes where the contents are not visible and need to be quickly consulted.

The scan have each type of piece stored in a different box, these boxes are identified by QR Codes that contain the fields: name, id, color and dimensions. The name helps the images to be shown in the application. The id is a unique identifier that identifies each QR Code.

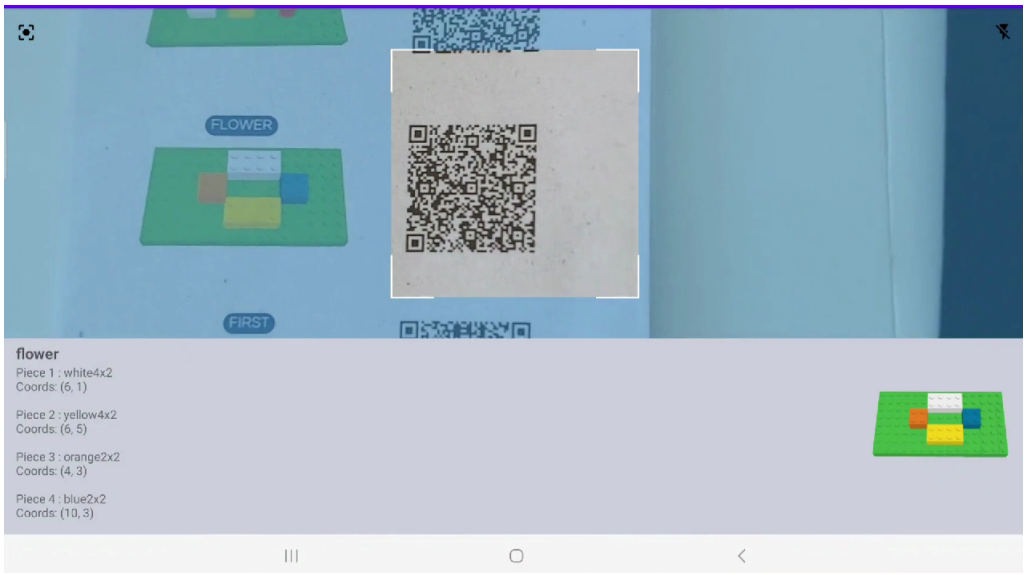
As it happens on a factory floor where all the components of a given part are stored by type of component in a given box, we decided to develop this functionality that will allow users to understand, in opaque boxes for example, what their content is and thus locate the part/component faster and more easily. When scanning this QR Code that contains all the data described, an image of the element contained in the box will be shown.

In conclusion, by using QR codes and JSON files, we have been able to develop a highly effective identification system that ensures that the assembly process is completed smoothly and accurately. The identification of each piece through QR codes and the associated JSON files has proved to be a critical component of our project.



9.3.2 Assembly Scan

From a catalog available on the website where all the already created assemblies are available, it is possible to scan the QR Code of the desired assembly, in this way the user will obtain an immersive follow-up while carrying out his assembly, in this option the app will indicate that parts are necessary for the construction of the chosen assembly and later it will verify both the collection and the placement of the same through the color and dimensions, which will detect if the user has collected the right part. The verification of the placement of the piece will be possible through the 'Coordinates Detection App' function, which will use the arucos to understand if the user is placing the piece in the right place.
Assembly Scan:



9.4 Assembly Maker

As previously indicated, two of the essential questions for the development of the app were: How could we detect the pieces and the whole scenario? How could we detect the color of the pieces placed? Taking into account section 9.3.2, we can conclude that each assembly present in the catalog is divided into steps, currently 4, so the verification of the position and color of each placed piece is easily executed between each step.

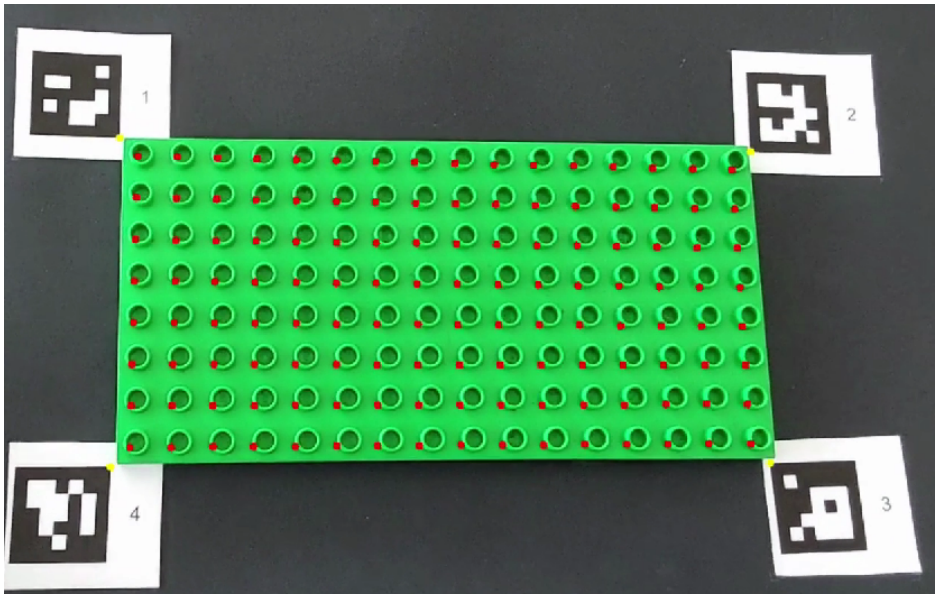
From the aforementioned catalog, the user will select the desired assembly by scanning its respective QR code, which contains an object of the Assembly type, identified by an ID. This ID present in the JSON object of the QR code will serve as a guide to find in the local JSON files an assembly with the same ID so that each step can be correctly tracked.

From a catalog of constructions with a QR Code for each one, the user will be able to select the one he wants, when scanning this qr he receives both the id of that assembly and the pieces necessary for that construction. Then the user collects piece by piece and place them one by one in the right place on the green board in order and when the last piece is placed correctly, the construction ends.

9.5 Coordinates Detection App

Based on arucos in the four corners of the green board, it calculates the size of the green board, calculates the distance between the pins and shows them on the image that is collected,

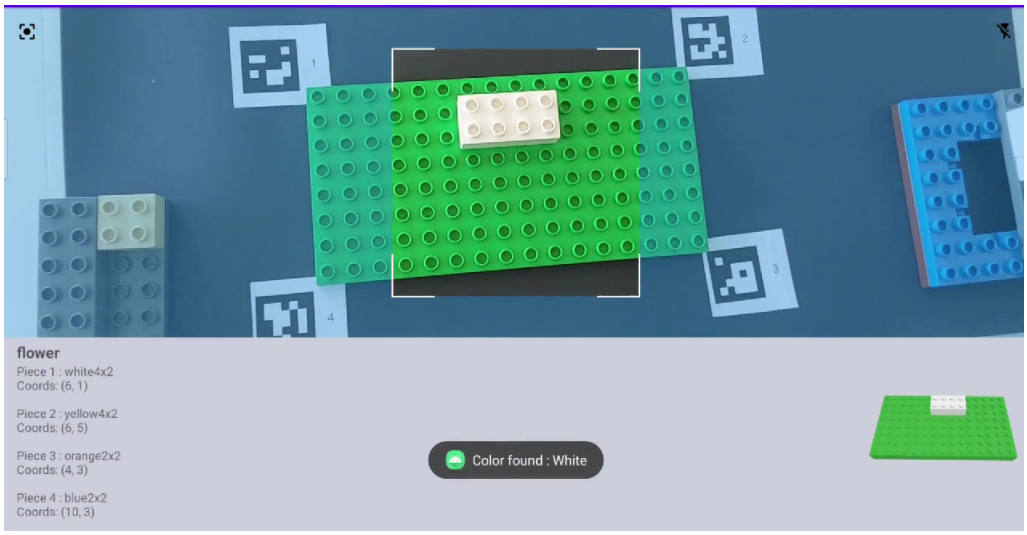
The application is developed in java and is using OpenCV libraries to collect a live camera image.



9.6 Color Detection App

The camera is activated and the app collects information about a given pixel, using an RGBA matrix, it calculates the Euclidean distance and returns the color detected in that given pixel.

The app was developed in the application that detects the pins of the board with the arucos and in this way we can detect the color that is in each one of the pins. This app was developed in java and also uses OpenCV libraries. (completar)



Chapter 10

Support

For any type of support, contact us with an e-mail to:

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Thank You for using our application!