SAREA

Implementing Augmented Reality

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Preface

This document is written in the context of my graduation assignment to conclude my education in Communication & Multimedia Design major Game Design and Development at Hanze University of Applied Sciences Groningen.

From the 18th of November 2019 to May 2020 I was busy with the design cycle for this assignment to create a standalone Augmented Reality Application. The application is based on the client's existing application Sarea, which will be used when searching for missing persons. It is to see if Augmented Reality can be useful for the Sarea application. This is an extension of Sarea.

I would like to give thanks to the entire Innovatiehuis for helping me throughout this process. Their help and participation was outstanding.

Summary (Abstract)

The summary should briefly describe the content of the report. It should cover the aims of the report, what was found and what, if any, action is called for. Aim for about 1/2 a page in length and avoid detail or discussion; just outline the main points. Remember that the summary is the first thing that is read. It should provide the reader with a clear, helpful overview of the content of the report. Write this part of the document last.

This report will be focusing on comparing the Sarea application in its usual 2d flat screen mode with its augmented reality counterpart.

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1. Introduction

1.1 Project description

Every year there are people around the world, and in the Netherlands that goes missing. In the Netherland alone, the number of missing person reports filed per year is around 30 000 to 40 000 (Schouten, Eshof, Schijf, & Schippers, 2016). From that 40 000 people that were reported missing, roughly about 80% of those individuals are located within the first two days of reporting the missing person (Politie, 2019). The leftover 20% is what the client Innovatiehuis Politie Noord-Nederland is focused on.

1.2 Client

The client of this project is Innovatiehuis Politie Noord-Nederland, they are a subsection of the police force that focuses on developing new applications, and other things that could help the police force in their activities. At the time of writing this report is developing an application called Sarea. The application would be used as a tool to help the users locate the missing person. There are multiple groups focusing on different parts of the application's development.

With Extended Reality becoming more popular these days (Forbes, 2020), the aim and objective would be to provide insight to the added value that Augmented reality and virtual reality can bring inside the Sarea application, a way to improve communication and information presented through visualization.

The client's wishes are the following:

1. You would be able to see where the other users are using XR (distant /visual)
2. Make Information visual.
3. Let the user's see the findings and where they were.
4. A virtual avatar that gives search advice to the user.
5. The application should be a standalone application
6. That the user will only use AR when they are passively searching.

1.3 Problem Statement

To formulate a proper problem statement, the five W should be applied (University Of Sheffield, n.d.). With the five W it is referred to: What, Where, When, Who, and Why. Starting with what is the problem, then asking where does the problem occur, follow by when does it occur, hereafter for who is this a problem for, and last why is it a problem? By asking all the questions, the problem statement emerged.

- What: Around 40 000 people get reported missing, and people don't know how to effectively search for them.
- Where: Nederland.
- When: Yearly.
- Who: For the people who care for the missing person.
- Why: It could be a bigger problem than just a person gone missing.

Yearly around 40 000 people get reported missing in the Netherland, and people don't know how to effectively search for them. It leaves people worried because it could be something bigger than just a person missing.

1.4 Social relevance

The social relevance of this project can be huge when inevitably another person goes missing. It will help organize, structure and coordinate the search for the missing person, thus giving the missing more of a chance of being found. Also, because the current plan is to release this application for free, it will help get the application into more users' hands. If this application turns out to be successful it might be picked up by other countries as well.

1.5 target audience

The target audience of the Sarea application would be everyday citizens who want to volunteer to help other civilians to search for the missing person. The application's function is to organize, inform its users on how to search for missing persons and keep track of all the findings in a log. Other possible users of the application could be the Veteran Search Team, or the SAR (search and Rescue) unit Nederland.

1.6 Objective for this project

This study aims to find out the added value of Augmented Reality for Sarea, in terms of how fast and how amusing the users find it to be informed and prepared for when they want to participate in a search with Sarea.

The reason is that the more efficiently a user can be armed with the necessary knowledge, the faster they can assimilate in assisting in searching for a missing person.

1.7 Key concepts

Since the whole idea behind this project is to find out whether Augmented Reality would be useful within the application of Sarea, the key concepts that were conceived are:

- User Experience: To make the experience feel as normal as it could possibly be. This is to make it so the users would just be able to pick up the application and use it immediately.
- Augmented Reality: Learn more about what is possible with Augmented Reality, what some of the challenges, and how should we use it.
- Missing Person: Knowing what the most important pieces of information are when it comes to searching for them, how you go about searching for them, and what information is needed for the search but should not be shown.

1.8 Method

The way this project will be approached by going through 6 steps. Those being: Understanding, Research, Concepting & Ideation, Prototyping, Testing & Evaluation, and as of last Reflection.

Understanding → Research → Concepting & Ideation → Prototyping → Testing & Evaluation → Reflection

Understanding: The first step is the one that the reader is currently on, which is to try to understand what the issue is. Empathize with their client, listen to what the client is trying to achieve, find out or they are trying to solve.

Research: This is where the reader gets to see what the research process was like, also see what design requirements come out of the research and see why they are design requirements.

Concepting & Ideation: After finding out what and why something is a design requirement, this section will focus on how they will be implemented with the project.

Prototyping: Literary building upon the design requirements and how they will/should be implemented, the prototyping step is where the reader can go through the steps that the developer took to get their prototype working and the decisions that were made, to make them work.

Testing & Evaluation: To truly see if the prototype would work as intended it needs to be tested. In this step, the reader would read up on how the tests were conducted, what the findings were, and did they reveal.

Reflection: This last step is about giving a conclusion to the thesis paper, while also reflecting on each step and the project.

1.9 Research Question

The aim of this research can be achieved by the following research question:

How can Augmented Reality help civilians with the process of searching for a missing person in Sarea?

1. Which information is needed to brief the civilian, so they are 'well-prepared' to participate in a search with the Sarea application?
2. How can AR be used/adapted to help in the search for a missing person?
    a. What are the limitations/opportunities of augmented reality in Sarea?
    b. How do we overcome the limitations in Sarea?
    c. How should the possibilities of AR be designed in Sarea?
3. Are there any noticeable difference between the current prototype and a possible prototype with the developed AR features in terms of:
    a. User-friendly
    b. Onboarding/ preparation
   c. The general overview; search members and found objects

The sub-questions are there to help answer the primary questions and later the research question.

1.10 Possible solution before research

There exists another application named "*Lost Person Behavior*" by *dbS Productions* that does the same thing that Sarea wants to do, with the difference being that the other application cost about 10 $. That may detract people from using the app if they are just volunteers.

1.11 Design Requirement

1. You would be able to see where the other users are using XR (distant /visual)
2. Let the user's see the findings and where they were.
3. keep track of all the findings in a log.
4. That the user will only use AR when they are passively searching.
5. A virtual avatar that gives search advice to the user
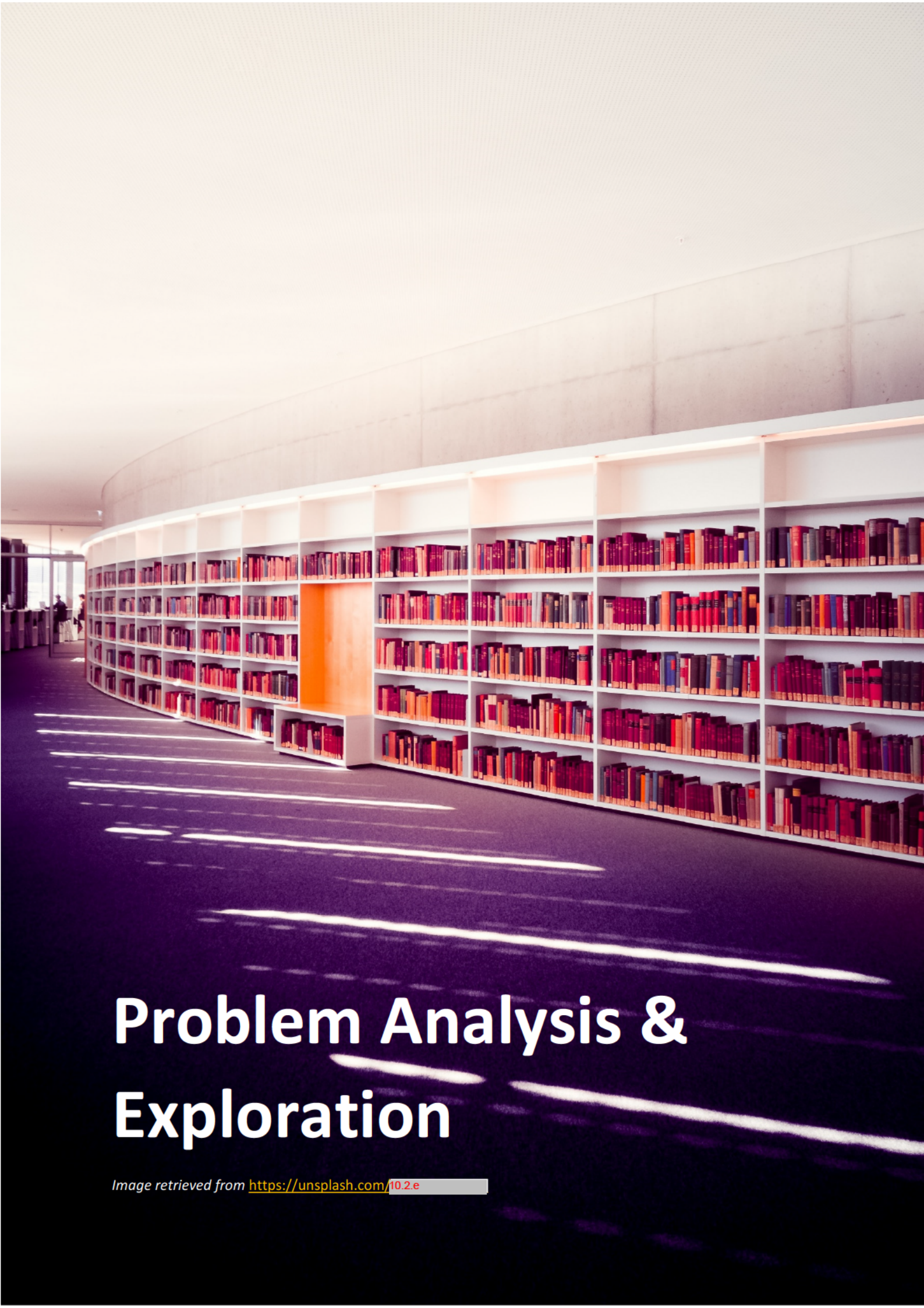
Problem Analysis & Exploration

2. Research phase

2.1 Research strategy

The research consists of many different types of research as an example of primary research, field research, literature research, etc. With different types of research, it is good to have a strategy of how to approach each of them.

With literature research, the strategy that has been used consist of using Books, Google Scholar, ResearchGate, Boolean search, snowballing, search for the authorities on the subject matter and checking out if they have blogs, posts or any documentation about the subject, and using the C.R.A.A.P. method to filter out what is not needed.

The use of google scholar and Research gate is to find research that has been done on the subjects matters. They were used as a search tool.

Boolean search is something that has been used to filter out the search findings. By using terms such as OR, NOT, AND it allowed the author to get better search results for this report.

The snowballing search method is when a person grabs research and goes through their source links. From there they will continue going from source to source until they find what they are looking for.

By using the CRAAP test it functioned as a filter to get rid of research that does not fit into this one. The way the CRAAP test works is to check 5 things: how current is the source, the relevancy of the source, is the source an authoritative figure in the field or just a random person, how accurate is the source, and what was the purpose that the source was written (Blakeslee, 2004). If for whatever reason the source does not pass the test, it will be discarded.

By finding the authorities on the subject matter, the idea is to check what blogs, articles, or online videos that they have made on the subject at hand.

The strategy for field research is going to be to conduct Interviews with experts, attend a conference with expert, and do a survey with the target audience.

2.2 Desk research findings

2.2.1 Augmented Reality

Before getting into the design requirement for augmented reality it is important to know what augmented reality is and to not confuse it with virtual reality, mixed reality or extended reality. When referring to extended reality, it is referring to the umbrella term used to cover AR, VR, and MR (State, 2017). With VR the user is fully immersed in the virtual world, their vision is fully covered with a headgear that allows them to see the virtual world in its whole. That also means that they should be in a safe area specifically prepared for the use of VR, otherwise they might injure themselves. MR unlike VR blends the real world with the digital world, but also allows the user to interact with a virtual object to change the state of an object in the real and vice versa. AR like MR it gives the users the illusion of having a virtual object in the real world. But unlike MR it does not fully blend with the real world in the sense that you cannot change the state of a physical object by interacting with the virtual ones. Generally, AR applications are made for handheld devices such as cell phones (Kaminsky, 2019). The picture below shows the difference between VR, AR, and MR.
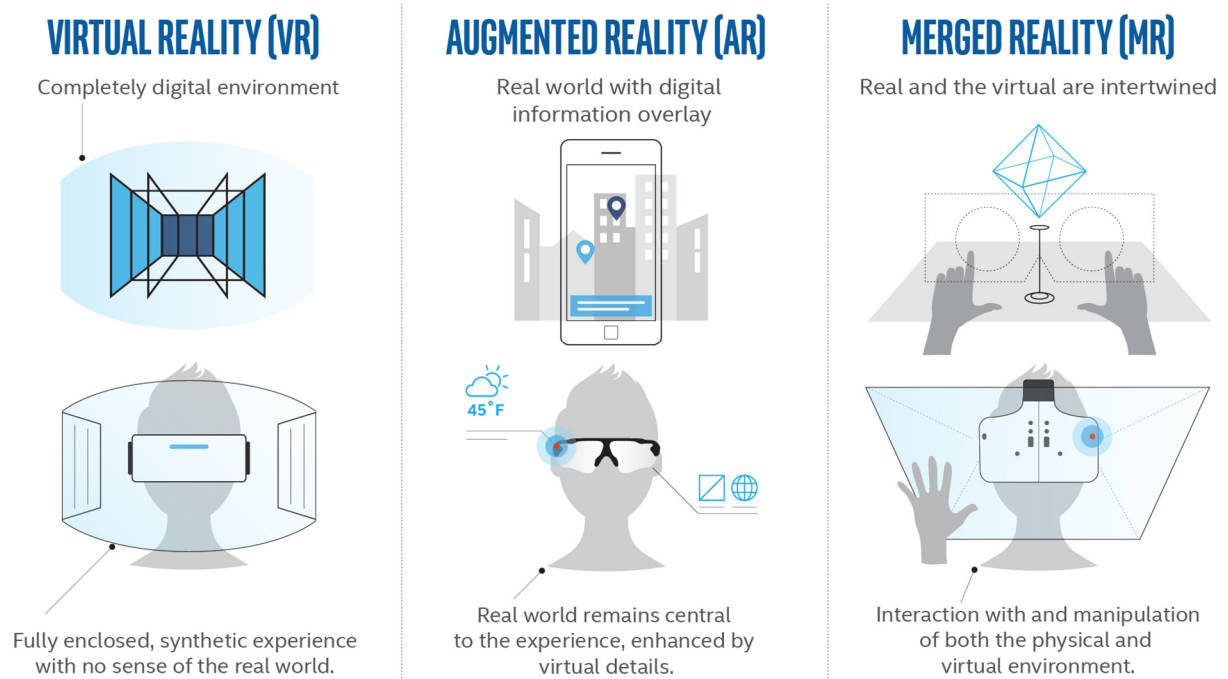
VIRTUAL REALITY (VR)

Completely digital environment

AUGMENTED REALITY (AR)

Real world with digital
information overlay

MERGED REALITY (MR)

Real and the virtual are intertwined

45°F

Fully enclosed, synthetic experience
with no sense of the real world.

Real world remains central
to the experience, enhanced by
virtual details.

Interaction with and manipulation
of both the physical and
virtual environment.

Figure 1 retrieved from http://www.appliedart.com/blog/vr-ar-or-mr-what-s-the-difference-why-should-i-care

A survey conducted by Unity 3D with 1000 creative professionals as participants to see what their biggest hurdles are when implementing AR in their application. From the survey, they share that 38% found that the challenge they face is that the users don't have the knowledge on how to use AR (Shriar, 2019). While from the same study it revealed that 26% of costumers are afraid of trying something new. If those two reasons are combined it means that around 66% of users do not know how to use or interact with AR. This means that some of the users need to be educated on how to go about with AR.

DR 1: The user should be able to get an onboarding experience.

Not all application will be AR exclusive, some application has both 2d and AR as features. It is important to make the transition from the standard 2d to AR, and vice versa as clear as possible. In this way, the user does not get confused or lost within the application (Unpingco & Faaborg, 2018).

DR 2: The user should be able to recognize when the application is switching from AR to standard and vice versa.

One thing to keep in mind about AR is that AR has different scales. By scale, it is referred to as the amount of space that an application that is using AR could use (Unpingco & Faaborg, 2018). The scales are categorized into 3 types of scales: Table, Room, World. The scale that is going to be used for this project would be the world scale since the users will actively participate in searches in the real world. Just like in the real world the interaction we have with objects depends on far away the objects are. In AR the application should also allow the user to interact differently with an object depending on the distance between them. In the world scale, there are 3 types of distances that can influence the interaction, they are: Close, semi far, and far away (Hamilton, 2019) (Olarnyk, 2018). Because there are different ranges in which people can interact with the virtual object, it is important that the scale of the virtual objects to a proper proportion-based on the distance.

DR 3: The user should be able to have different interaction based on distance

DR 4: The application should scale objects base off the distance between the user and them.

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When the user is going to experience AR on a world scale there be a few objects that are off-screen to the user. The users should be notified and be able to tell where the virtual objects are around them. This will encourage the user to look around and it will feel more natural to the user (Apple, 2020) (Google (blog), 2017).

DR 5: As a user I want to be guided towards offscreen virtual objects

It is a given that different people like different phones. Because of that, not every individual's screen size is going to be the same. There are some who even prefer a tablet over a smartphone (Flarup, 2018) (Google (blog), 2017).

DR 6: As a user I want to be able to enjoy AR with different screen sizes.

To interact with the application in its AR mode, one should keep in mind the User Interface. To create a more immersive experience for the user the application should make more use of a volumetric user interface. 2D UI should be used sparingly, meaning only for controls that the user will often use or other sort controls that the user requires fast access to (Unpingco & Faaborg, 2018).

DR 7: The application should only use 2D UI for important task or task that is repeatedly done.

Since there are going to be 2d UI, the UI should be able to adapt to the device's orientation. Either in the Landscape or Portrait. If it is not possible for the developer to develop for both orientations, they should choose whichever orientation that gives the user the best experience (Google (designguidelines), n.d.).

DR 8: The 2D UI should adapt based on the orientation of the user's phone.

For the application to feel more natural, the users should be able to tell when they can place an object within the scene. This means that the application should guide the user throughout the process of instantiating an object. The first step is showing the user how to get anchor points to form a plane. The second step is to use a ghost object to help the user visualize where the object can be put. And lastly, give the user feedback when they set the object in the world, this helps to immerse the user (Stumbo & Weiers, 2018).

DR 9: As a User I want to be able to see where I can put a 3d object.

DR 10: As a User I want to know if the object I want to place has been placed.

When placing objects into the real world, there are cases where a user can get an error or the virtual object is not placed, sized, or rotated properly (Apple, 2020). Give the user the ability to move, rotate or resize the objects. There are cases where none of these are possible, in this case, the user should be able to reset their AR session (Flarup, 2018) (Stumbo & Weiers, 2018) (Google (designguidelines), n.d.). Another reason for this is that AR still isn't perfect at the moment when this report is being written.

DR 11: As a user I want to be able to manipulate the virtual object that has been placed in the world.

DR 12: As a User I want to be able to reset my AR Session.

Sometimes when using AR, the users start to see that the virtual object starts to jitter. This happens because the session has lost virtual tracking. It is best to hide or destroy those jittery objects, in this manner it makes the application feel more professional and frees up system resources. When this

happens, it is important to let the user know what happened, and why it happened (Stumbo & Weiers, 2018). This can happen because of a dip in the framerate.

DR 13: The application should hide or destroy objects when it loses their tracking.

Indirect selection controls should be considered when you need to have consistency. They are generally used as 2d controls on the screen. These types of controls should be placed or implemented in a way that allows the user to use them without having them adjusting their hold. This type of control can be useful for larger devices such as tablets (Apple, 2020) (Flarup, 2018).

DR 14: As a user I want to have indirect selection as well as direct selection.

All design requirements from this key concept:

1. DR 1: The user should be able to get an onboarding experience.
2. DR 2: The user should be able to recognize when the application is switching from AR to standard and vice versa.
3. DR 3: The user should be able to have different interaction based on distance
4. DR 4: The application should scale objects base off the distance between the user and them.
5. DR 5: As a user I want to be guided towards offscreen virtual objects
6. DR 6: As a user I want to be able to enjoy AR with different screen sizes.
7. DR 7: The application should only use 2D UI for important task or task that is repeatedly done.
8. DR 8: The 2D UI should adapt based on the orientation of the user's phone.
9. DR 9: As a User I want to be able to see where I can put a 3d object.
10. DR 10: As a User I want to know if the object I want to place has been placed.
11. DR 11: As a user I want to be able to manipulate the virtual object that has been placed in the world.
12. DR 12: As a User I want to be able to reset my AR Session.
13. DR 13: The application should hide or destroy objects when it loses their tracking.
14. DR 14: As a user I want to have indirect selection as well as direct selection.

With AR there are some limitation can hinder the experience. As previously stated, AR is not perfect and sometimes suffers from jitter with it loses tracking of a surface area. This can happen when you are in an environment that is either too bright or too dim. If the user is moving their phone too fast or if the phone vibrates. Also, if the user blocks their phone camera. Or you have objects that looks flat if there is something or someone behind them, this happen when a occlusion isn't implemented properly. These hindrances can be avoided by giving the user feedback based on their action.

2.2.2 User Experience

When using an application, it is important to be able to distinguish objects that can be interacted with and those you cannot. The reason is by knowing with what one can interact, it takes out the guesswork and frustration that the user would have had. Chances are high that if the user is frustrated with the application that may never use it again (Wilson, 2017).

DR 1: As a user I want to be able to distinguish interactable objects from the non-interactable objects

A user can also get frustrated with an application if the instructions are not clear and concise (Flarup, 2018). This could happen when an application uses technical terms to communicate with the user, instead of using everyday language (Apple, 2020). This can also happen when the text is too small or

is too blurry to read. How the text is constructed is also important it's not just to if the user can read the text but also whether they want to read it (Kucheriavy, 2018).

DR 2: As a user I want to have clear instructions on what I need to do in the application.

DR 3: The application should use everyday language for instruction and errors.

When the user is not used to using AR, it is important to breakdown their learning into small chunks that they can understand and not get overwhelmed. You can split them up into groups (e.g. How to interact with the world, movement, spatial awareness.) depending on what is needed for the application (Stumbo & Weiers, 2018).

DR 4: When learning how to use the AR application, the user should get the relevant information into small pieces, so they do not become overwhelm.

 It only takes a few seconds before a person decides if they like an application or dislike it. It is paramount that the application is easy to use and understand without having to learn how to use the application (Norman, 2013)

DR 5: As a user I want to use the application without having to learn on how to use it

While every app strives to be natural to use there are cases where the user might get stuck on an action. If such time should happen it is important to have the application give the user some tips on how to navigate further. Ideally, this feature should not be used but is still important to have in case it is needed (Kucheriavy, 2018) (Stumbo & Weiers, 2018). The hint should appear a few seconds after the user is idle, to not disrupt their flow.

DR 6: As a user I would like to get hint if after while of getting stuck when using the application and do not know what to do.

For some of the interaction with a virtual object, they should be believable like they belong to whichever location or scene you put them in. This can be done by letting the virtual object react to a few external factors such as the lighting of the surrounding area, the temperature, place that they are found, or other such things like a collision with the real objects.

DR 7: The application to the best of its capacity should make the user believe that the virtual object belongs in the area that it has been place or found.

Affordance (Norman, 2013) is an essential part of everyday design, affordance is when you see an object and you will naturally understand how the interaction between you and an object should be or what they represent. Affordance is used a lot with symbols, such as the floppy disk icon in Microsoft Word, which is used as the safe button. By using affordance, it makes an application much simpler to navigate.

DR 8: The application should make use of affordance to make navigating the application easy for first time users.

Feedback is like a guide for the users when they are using the application. Feedback is about giving information to the users and with the information the users can adjust their activities in the application. Few things to consider when using feedback are the timing and the tone of the feedback that is given (Thomas, 2011).

The tone of the feedback given should be taken into consideration. There are 3 tones of feedback: positive, neutral, and negative. Positive feedback can be seen in different applications and is usually

used in games when they give you badges or stars at the end of a level that you've completed. Neutral feedbacks are given when scrolling over a button in an application and you see a tooltip pop up. Negative feedback can be seen on morning-game shows, like *Jeopardy*. When a contestant gives a wrong answer, they play a buzzing sound letting the player know that they've made a mistake (Thomas, 2011).

Feedback comes in 4 different delivery methods: Visual, Aural, Tactile, and Motion. Each one of these types of feedback can be used to give the user a more immersive experience with the application. They all serve one purpose which is to give the user information about something or their action (Kapp, Blair, & Mesch, 2013)

DR 9: The application should provide the user with the appropriate type of feedback depending on context of what the user is doing.

All design requirements from this key concept:

1. As a user I want to be able to distinguish interactable objects from the non-interactable objects
2. As a user I want to have clear instructions on what I need to do in the application.
3. The application should use everyday language for instruction and errors.
4. When learning how to use the AR application, the user should get the relevant information into small pieces, so they do not become overwhelm.
5. As a user I want to use the application without having to learn on how to use it
6. As a user I would like to get hint if after while of getting stuck when using the application and do not know what to do.
7. The application to the best of its capacity should make the user believe that the virtual object belongs in the area that it has been place or found.
8. The application should make use of affordance to make navigating the application easy for first time users.
9. The application should provide the user with the appropriate type of feedback depending on context of what the user is doing.

2.2.3 Missing person

Yearly in the Netherlands, there is around 30 000 to 40 000 missing person reports filed (Schouten, Eshof, Schijf, & Schippers, 2016). Out of that amount, about 80% of those reported missing are found within the first 48 hours of filing the missing person report (Politie, 2019). Common things that happen when referring to the 80% of missing person reports are that sometimes it is just a case of people aren't reachable, or someone just forgot that they had a commitment to attend. Fortunately, the majority, about 90%, are recovered within a week. But the other 10 % could be that something serious has happened to them. With the remaining 10% percent, the search may take much longer to find the missing person. It could take weeks, months, years or it might remain a mystery.

When it comes to a missing person's case, there are some important factors that play a role in the disappearance. Such factors are: Age, health, domestic life, addictions, societal, was in accident, abduction, murder (Schouten, Eshof, Schijf, & Schippers, 2016). With so many factors, one can see that each missing case could be different. But throughout the years there are a couple of patterns that emerged.

In these patterns, one can put them into categories. Previously above in the interview with the policeman, there were four categories mentioned, and those categories also have subcategories. Each of them has some commonalities that can provide the best place to start searching for them. An example of this would be a child. A good place to look for a child would be in an area that they are not allowed to go, or places that draws their attention, backyard, parks, etc. (Schouten, Eshof, Schijf, & Schippers, 2016).

Here is some general action that a person can take when they suspect that their loved one is missing (ministerie van Veiligheid en Justitie, 2014).

1. Do not panic stay calm.
2. Search in and around your house in every room and passage.
3. Look for clues to their whereabouts. Search the person's room, phone, calendar, posted notes, dairy, or computer. See if they had any plans for that day. (Do not clean their room, also do not mess it up.)
4. Call the suspected missing person on their cellphone.
5. Check on their social media to see if there was anything new posted (photo, status, etc.). See if you can reach them via their socials.
6. Contact friends, family, known Associates, neighbors, former neighbors, if divorced ex-spouse or another former partner.
7. Look around your local area.
8. Contact the Police
9. Check with your local county jail, they might have gotten arrested
10. Contact the local hospital to see if their loved ones might have check in for whatever reason.
11. Alert the local media
12. Look at the places they frequent such as:
    a. School or work.
    b. Sports fields and sports centers.
    c. Catering establishments.
    d. Stations and shopping centers
    e. Parks or play areas.

When a missing person is found, please inform the police immediately. It happens often that the police are still investigating for a person that has already been found, and therefore wasting time that could be used for another investigation or other important task. This also plays into the fact that it is useful for the police so they can get a better understanding of the person's background. Therefore, it is important that the police have a conversation with the former missing person. Also know that whenever a missing person is found or decides to come back of their free will, it is advised not to confront, blame or question the person immediately. Best to give them some time so they can get their life back together and not be overwhelmed.

DR 1: The User should have points of interest that relate to the missing person type.

It also goes without saying but to search for a person, the volunteers should have an idea of how the reported missing person looks like, what is their ethnic background, eye color, skin color. The kind of attire were they wearing when they were last seen, the color of their jacket, shirt, pants, shoes. Noticeable features that they could be easily recognized by the people searching for them.

DR 2: As a user I want to be able to see what the missing person looks like at the time of their disappearance.

Searching for an individual can be difficult, especially when you don't have information on what type of transport they often use. Depending on the type of transport they frequent, the bigger or smaller the potential search area would be. For example, if a person often uses a bike compare to a person who usually walks, the person who uses the big would have a bigger search range simply because the bicycle makes him more mobile.

DR 3: As a user I would like to see how big or small the search range is for the individual based on their main way of commuting.

With Netherland having different living areas such as urban, suburban, rural, and forest. It is natural that each of these areas needs to be searched differently. The user of the application should be able to get information based on off their location (Olarnyk, 2018). This included the flora, the fauna, and the terrain of the area, also what the weather is like before and during the search (Australian National Search and Rescue Council, September 2018). This is important for the volunteer to know, so they can keep themselves safe from any danger.

DR 4: The user should be information based on their location

DR 5: As a user I would like to be informed on the weather before and during the search.

A part of searching is knowing where you are, and where you have been to decide where you will go next. Using any type of map and marking it can achieve this. This can also be done digitally by using the GPS in the user's phone, to track all the area that the user has walked, and search. This can also be good in case the user gets themselves lost somewhere while searching for the missing person.

DR 6: As a user I would like to know the areas that have already been searched.

DR 7: As a user I would like to know where my location is on a map.

All design requirements from this key concept:

1. The User should have points of interest that relate to the missing person type.
2. As a user I want to be able to see what the missing person looks like at the time of their disappearance.
3. As a user I would like to see how big or small the search range is for the individual based on their main way of commuting.
4. The user should be information based on their location
5. As a user I would like to be informed on the weather before and during the search.
6. As a user I would like to know the areas that have already been searched.
7. As a user I would like to know where my location is on a map.

2.3 Field research findings

2.3.1 Interview policeman

This interview was conducted with a police officer that has over 14 years of experience, working on the street and handling complaints. The officer just started working at the Innovatiehuis, but before

that said officer has worked as an emergency responder and as an assigned patroller. Handling an array of different cases, which also includes various amounts of missing person cases.

In a lot of the cases, the people who were left behind by the missing person have a lot of questions and don't know where to begin searching for the missing person. The first step they usually take is to ask everyone that they know if they have seen the missing individual.

When asked if every missing person case is the same, the officer replied: "No, every case is different but some of them do fall into a few categories that you can use to group them". Some of those categories are Minors (Runaways or gone missing), people who have psychological background such as dementia, people who just want to disappear or not want to be found for a while, people who had something bad happen to them, also people who don't have a lot of contacts and haven't been seen in quite some time. If someone has little contact with other people (family, friend, co-worker) those cases are usually difficult.

People do not need to wait to file a missing person report, they can always go to the police and fill in a report. What the police try to do is get as much information as possible when a report is filed. The police officers then go and have a conversation with the person filing the report. They try to look at what the daily routine is of the missing person and other background information. Daily routines include going to work, going to the gym, bars, etc. All those places are points of interest, which are the places where they will start looking. From there they can assess how urgent the case is, and what course of action they'll take. When it comes to minors, the urgency level is always high.

Key takeaway:

- People do not need to wait to file a missing person report.
- There are different kinds of categories of missing person (Minors, people using their right to be forgotten, people with mental backgrounds, and people who had something bad happen to them).
- A person's information is important to know when searching for them, the points of interest.

2.3.2 Interview with expert (10.2.e ⬜⬜⬜⬜⬜⬜⬜ / Data Scientist at KPN ICT Consulting)

The interview conducted with a data scientist who is a consultant at KPN ICT has shared its opinion on how a few features could help the application. One of these ideas was that the application needs a faster way to put in the information with having to type all that much. This could be done with buttons, sliders, dropdowns, keeping in mind where they are applied.

The consultant goes on to say that it is important to remind the user to only use their phone when they passively searching, and to put it away when they become active once more. Passive searching is when a person is still in the mindset of searching but is taking a break to look at important things concerning the search.

One such important thing could be a to-do list, that is easily accessible and usable. This will help the user to have an idea of how or where to start when they are going to search for the missing person. The app should feel more like a friend or a mentor is guiding you instead of just another application.

Key takeaway:

- Use less typing input where possible.
- Remind the user to only use their phone when they passively searching.

- Add a to-do list to help the user.

2.3.3 Interview with a lecturer at Hanze University of Applied Sciences, Groningen 10.2.e

When interviewing the Lecturer at Hanze, the interview began with the interviewee introducing himself. With how he was teaching about VR and later changed to AR.

There are multiple things that AR could be used for examples of these would be: Use AR for navigation, location-based entertainment, mixed reality application getting the virtual world to interact with the real world and vice versa. It is good to design or develop in a 3d environment when using AR. Consider your environment when creating things for AR.

For using UI in AR, it is good to have volumetric UI. This makes better use of AR because it doesn't clutter the screen, allowing the user to have multiple objects in use. Also, when talking about UI one should consider using transparent or translucent UI. Where transparent UI can be used in places where safety is a concern and translucent when the user needs something to be more readable.

Key takeaway:

- Transparent (safety) vs translucent (readability).
- Use volumetric UI.

2.3.4 Veteranen Search Team conference

The VST or Veteranen Search Team foundation exists since 2013. The VST foundation consists of more than 1400 trained volunteers of which 90% of them are (actively serving) veterans. With their experience as (former) military and or other uniformed professions. They also have a Rapid Support Team or RST that are used in events that are extremely urgent in nature, such as when a small child or an elderly person with dementia goes missing. They only assist or deploy when asked by and or coordinated by the police force, also only searches the area designated to them. VST only works with their own volunteers.

It is important for VST that there is no contact with the family of the missing person, the media, and no posting stuff on social media when talking about a missing person be it a current or past missing-person search event. It can mess with the investigation, open old emotional wounds or spread miss information.

People who usually go searching are: The family, direct friends, civilian volunteers, and invited volunteers such as themselves. What is important to know the motivation as to why someone is going to join the search: some are emotional (usually friends and family), some for civic duty, others curiosity which is a bit on the dangerous side, and the most dangerous is the one who just wants a day out meaning those looking for an adventure or those who comes with their kids.

A few things to know that are important is that there is a minimum age of 16 requirement when you are going to join the search also for the people who are assisting in the search to go back home safely, and there is always a chance that the missing person is dead.

A group of people from the search party should consist of a maximum of 15 people. With the two people on the flank wearing an orange jacket. So, people could easily see where the line is. The ones on the flank are the ones who should have the equipment while the ones in the should just be focusing on the search. There needs to be structure when searching for missing persons.

For collecting tracks there should be a time gap in between when the important tracks are collected and the time that is appropriate to have volunteers join the search, so they do not contaminate the important tracks.

If an object of interest is found such as a phone that is believed to be from the missing person or a dead person. Do not pick it up and notify the appropriate coordinator. In the event, you happened to pick it up or touch it by accident, be honest if you had that way when the forensic team comes to investigate, you will not become a suspect because of your fingerprint. If the found item is important, it is essential that people do not gather around the object to avoid contaminating the scene or the object, which can hinder the investigation. After you have notified the corresponding people, if the object is not relevant, pick it up, so other people don't stumble onto that item and waste their time.

Every volunteer should know their limits, searching can be tiring. If you are helping in the search do not let that get to your head. Just because you are searching that does not mean you are friends with the victim's family. It is better to search early than late, due to temperature.

Critical points for participating in a search:

- minimum age of 16 requirement (avoid baby-sitting).
- If you found a suspicious object, don't touch it or pick it up, and call the appropriate authority.
- Be honest if you did when the appropriate authority arrives.
- Mindset (people should go there for the search, not to go do something else like make selfies or something along those lines)
- Keep yourself safe
- The degree of involvement (don't interact with the media, and don't think your friends with the victim's family)
- Proper clothing attire/ equipment (wear boots, always use long sleeves, and long pants) it helps keeps you safe from the environment, cuts, wildlife. This helps to keep the participant focus on the search.
- Do not go with too much stuffs (i.e. like a bag packer/camper)
- A group of people from the search party should consist of maximum 15 people
- There needs to be structure when searching for missing person. (walking in line)
- Start searching early because of the temperature.

2.3.5 Survey with target audience

A survey was conducted with the target audience, the survey contains 7 main questions with 3 sub questions and lastly a suggestion box marked as the eighth question. The idea behind the survey is to get a better understanding of the target audience. See how much they know about AR, whether

they want an application like Sarea or Sarea with AR.

1) Do you think a mobile application can help volunteers during a missing person search?
35 responses
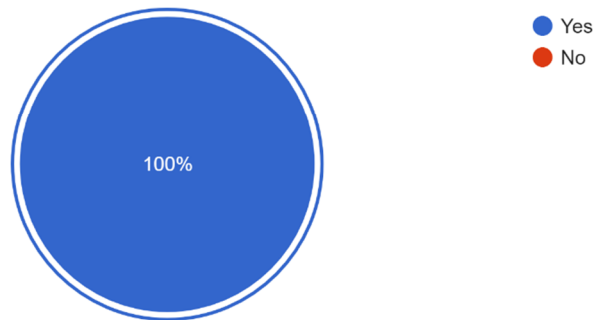
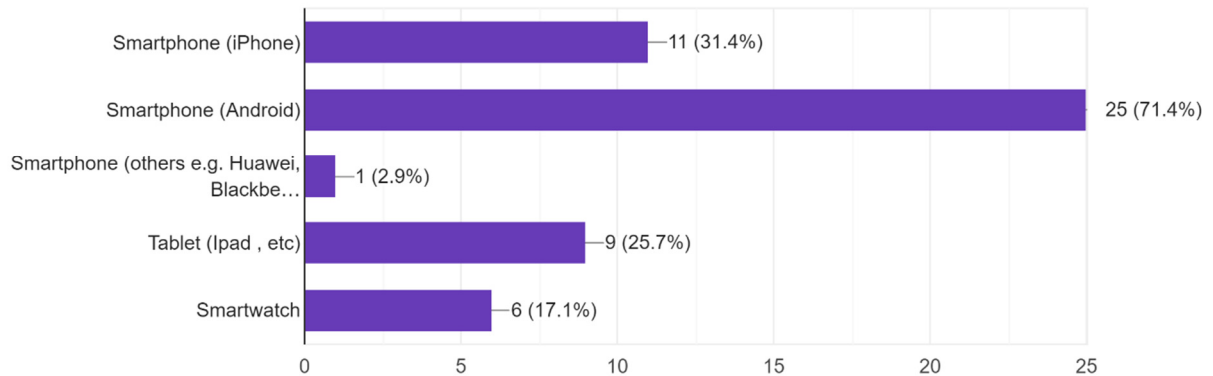1.1)If you chose yes by question 1, how can it be helpful?

From the result came a lot of ideas from the target audiences. These are some of the ways that the target audience thinks that the application can be helpful:

- Organizing and structuring the search.
- Improve coordination and navigation.
- Give them advice about searching.
- Mark all the routes where someone has walked/searched.
- Able to add points of interest.
- List everyone that is participating in the search.
- Invite other volunteers to help, the more people there are, the higher the probability is to find the person.
- Give real-time information about the search, the weather.
- Let them keep track of all the gathered information.
- Have relevant information about the missing person.

The second question is to see what platform will be used more when it comes to the Sarea application.

2) What type of devices do you own? select all that applies.

35 responses

Device	Count
Smartphone (iPhone)	11 (31.4%)
Smartphone (Android)	25 (71.4%)
Smartphone (others e.g. Huawei, Blackbe…)	1 (2.9%)
Tablet (Ipad , etc)	9 (25.7%)
Smartwatch	6 (17.1%)

3) What do you know about Augmented Reality?

From the survey conducted, 37% of the participant reported that they don't know what AR is. This is troublesome because if AR would be implemented then it is possible that 37% of users would not use it.

4) Have you ever used any AR applications? If so, please name them. (e.g. Pokémon Go, IKEA Place app, Snapchat, or the image shown below, etc)

14% of the survey participant say that they have never used an application that has AR in it. While the most popular AR application seems to be Snapchat and then followed by Pokémon go.
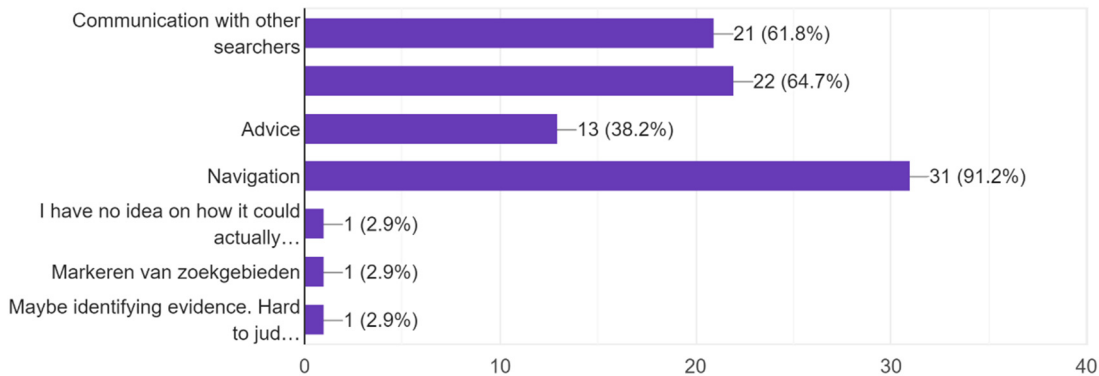
5) Do you think that interactive AR as a feature can improve an application that assists a search for a missing person?

35 responses

- yes — 60%
- no
- Mixed opinion — 37.1%
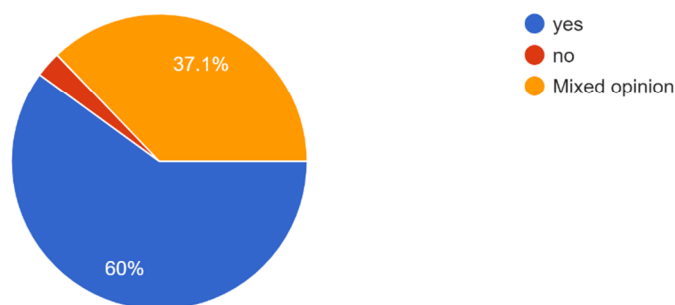
5.1) Please select the cases in which you think AR will improve the quality of the search.
34 responses

Communication with other searchers	21 (61.8%)
	22 (64.7%)
Advice	13 (38.2%)
Navigation	31 (91.2%)
I have no idea on how it could actually…	1 (2.9%)
Markeren van zoekgebieden	1 (2.9%)
Maybe identifying evidence. Hard to jud…	1 (2.9%)

5.2) Do you have any concerns about using AR features in an application that searches for missing persons?
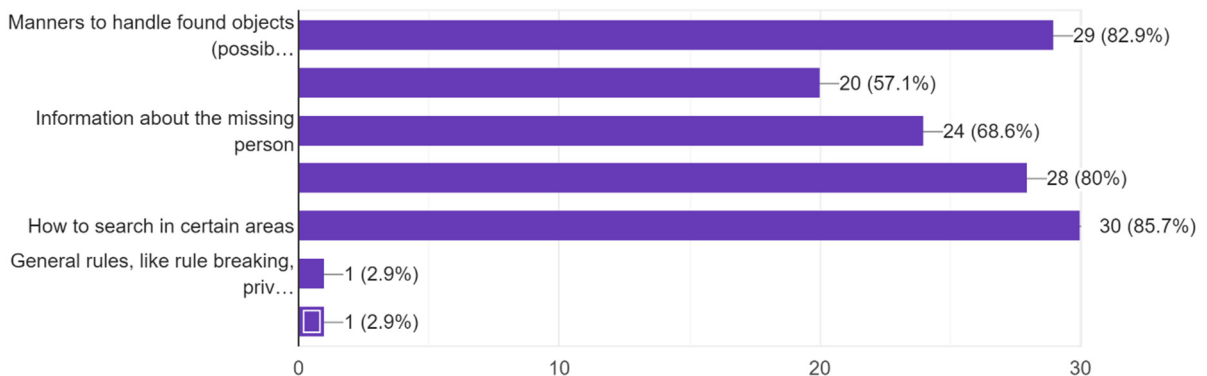
When the participants were asked about the concerns that they might have with using AR, the general replies are the following:

- AR can't/doesn't add anything extra that can help volunteers search for the missing person that normal screen can't do.
- People might become over-reliant on using AR and therefore not focus on the search itself
- Privacy issues.
- False alarms by pranksters.
- People not understanding how to use AR and simply not using it for that reason.
- Too much information that will confuse the user of the application
- Missing the human factor.

6) The ability to know how to search based of off certain areas, general laws so the volunteer doesn't break one accidently, digital rendering of the missing person,

6) What type of advice would you like to have when searching for a missing person in AR?
35 responses

Manners to handle found objects (possib…	29 (82.9%)
	20 (57.1%)
Information about the missing person	24 (68.6%)
	28 (80%)
How to search in certain areas	30 (85.7%)
General rules, like rule breaking, priv…	1 (2.9%)
	1 (2.9%)

7) In which way would you like the advice to be delivered? Select all that applies
35 responses
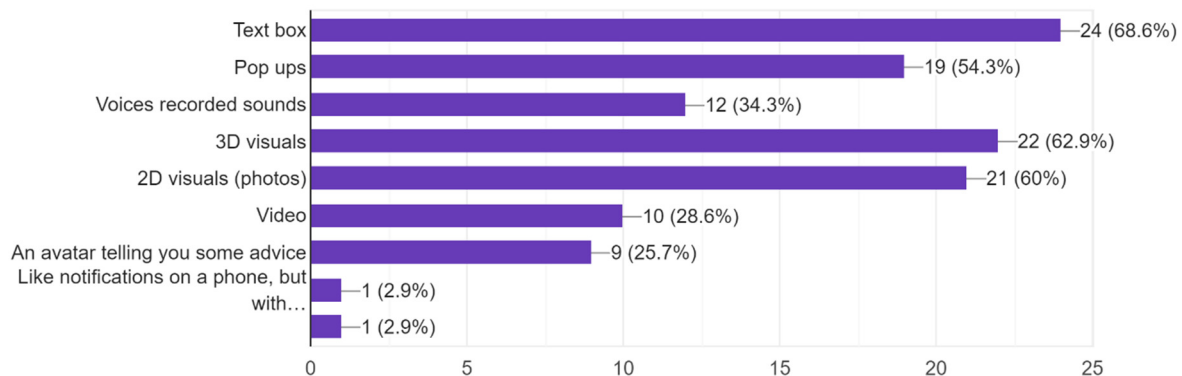
8) Do you have any additional tips, opinions, remarks or ideas, about using AR in an application that can assist a search, that you would like to share with us? Please note them below;

The last question was a suggestion box to see if the target audience had some other ideas that they would like to share for the project. But there weren't many only a few: optimized for the battery usage, keep it simple, extra information based on location when it becomes relevant. The ability to see where other people are searching.

Design requirement
Client

1. DR 1: You would be able to see where the other users are using XR (distant /visual)
2. DR 2: Let the user's see the findings and where they were.
3. DR 3: keep track of all the findings in a log.
4. DR 4: That the user will only use AR when they are passively searching.
5. DR 5: A virtual avatar that gives search advice to the user

Augmented Reality

6. DR 1: The user should be able to get an onboarding experience.
7. DR 2: The user should be able to recognize when the application is switching from AR to standard and vice versa.
8. DR 3: The user should be able to have different interaction based on distance
9. DR 4: The application should scale objects base off the distance between the user and them.
10. DR 5: As a user I want to be guided towards offscreen virtual objects
11. DR 6: As a user I want to be able to enjoy AR with different screen sizes.
12. DR 7: The application should only use 2D UI for important task or task that is repeatedly done.
13. DR 8: The 2D UI should adapt based on the orientation of the user's phone.
14. DR 9: As a User I want to be able to see where I can put a 3d object.
15. DR 10: As a User I want to know if the object I want to place has been placed.
16. DR 11: As a user I want to be able to manipulate the virtual object that has been placed in the world.

17. DR 12: As a User I want to be able to reset my AR Session.
18. DR 13: The application should hide or destroy objects when it loses their tracking.
19. DR 14: As a user I want to have indirect selection as well as direct selection.

User Experience

20. DR 1: As a user I want to be able to distinguish interactable objects from the non-interactable objects
21. DR 2: As a user I want to have clear instructions on what I need to do in the application.
22. DR 3: The application should use everyday language for instruction and errors.
23. DR 4: When learning how to use the AR application, the user should get the relevant information into small pieces, so they do not become overwhelm.
24. DR 5: As a user I want to use the application without having to learn on how to use it
25. DR 6: As a user I would like to get hint if after while of getting stuck when using the application and do not know what to do.
26. DR 7: The application to the best of its capacity should make the user believe that the virtual object belongs in the area that it has been place or found.
27. DR 8: The application should make use of affordance to make navigating the application easy for first time users.
28. DR 9: The application should provide the user with the appropriate type of feedback depending on context of what the user is doing.

Missing Person

29. DR 1: The User should have points of interest that relate to the missing person type.
30. DR 2: As a user I want to be able to see what the missing person looks like at the time of their disappearance.
31. DR 3: As a user I would like to see how big or small the search range is for the individual based on their main way of commuting.
32. DR 4: The user should be information based on their location
33. DR 5: As a user I would like to be informed on the weather before and during the search.
34. DR 6: As a user I would like to know the areas that have already been searched.
35. DR 7: As a user I would like to know where my location is on a map.

Moscow method

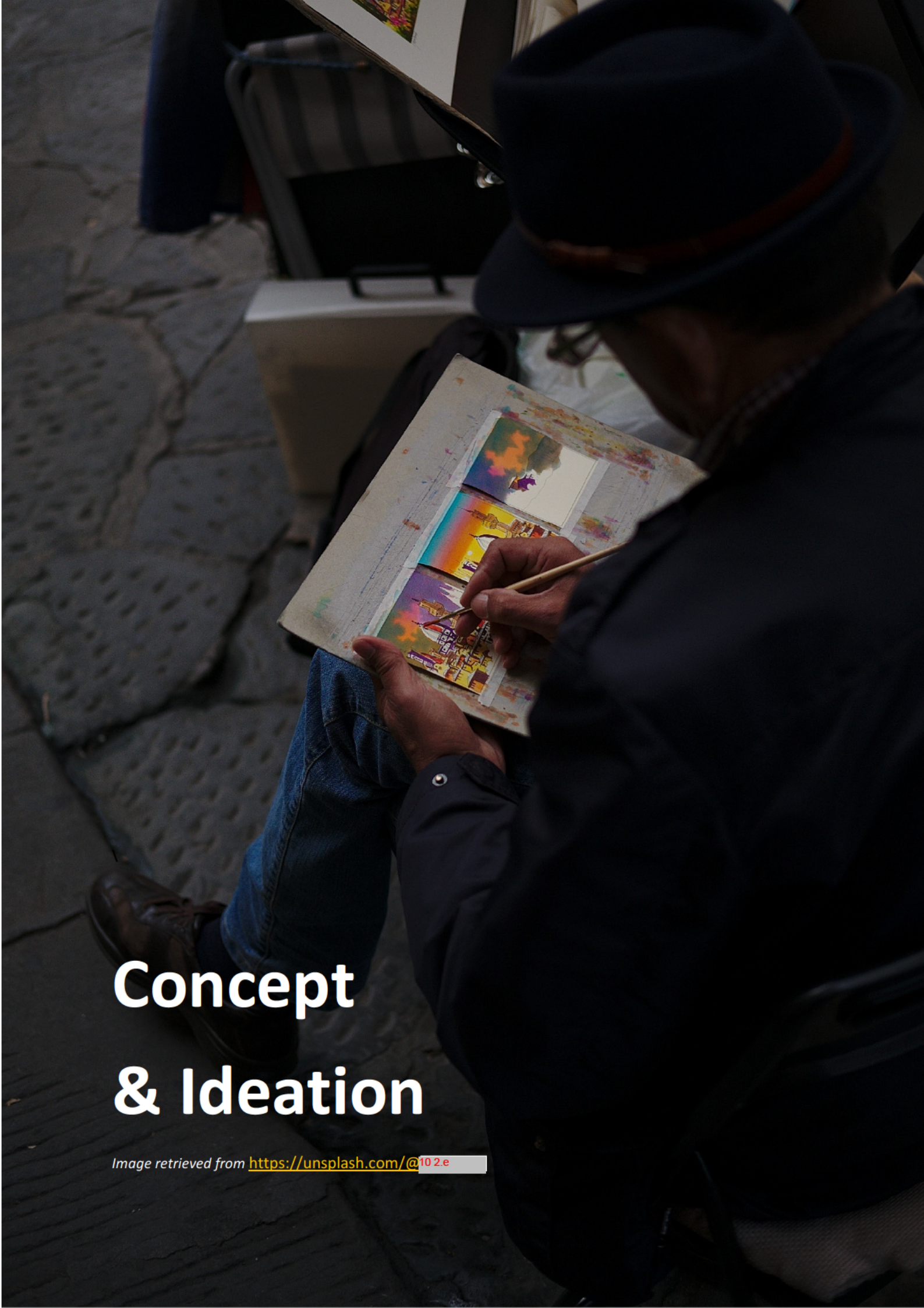The aboved mentioned method is a manner of prioritizing what is more important in

Must have

Should have

Could have

Would have

Design challenge

Design requirements and constraints

Reflection on the research

Concept
& Ideation

3. Concept phase

Reflection of the concept phase