Background Research

At least 3 areas of background research. This can include fundamental technologies, history, mechanics, manufacturing. etc. For each a 1 page summary with references is required. This can also include patents and prior art.

1. Fundamental Technologies

- Inertial mapping of underground pipe networks
    - https://geospatial.blogs.com/geospatial/2019/12/inertial-mapping-of-underground-pipe-networks-.html
    - The current easiest way to map underground pipes is map them before while the trenches are still exposed. This does not work for pipes installed via boring
        - Pipes applied this way can be detected via inentrial location, which can map pipe networks ranging from 30mm to 1500mm from up to 2 with a precision of 15cm. This system outputs a 3D model.
        - The Reduct DuctRunner is a inertial locator device the use inertial measurement sensors and battery power to run down a pipe, and record data on its location. This data can be exported to AutoCAD or google earth along with other formats
    - The most accurate way to find the location of existing underground infrastructure is to excavate the site and have it surveyed, this is cost and time intensive and now always possible.
    - Currently the best practice is to walk the site with electromagnetic wands (EMI) or ground penetrating radar (GPR) pushcarts.
        - There are reports of data being collected via GPR at speeds of 130km per hour
    - This report says that reality capture technology is being used commercial make models of the underground pipes
        - This is done by taking photos and measurements with a rig consisting of laser-scanners and photo cameras
- Other Good Source
    - https://geospatial.blogs.com/geospatial/2015/11/be-inspired-finalist-modeling-underground-utilities-in-3d-reduces-construction-time-and-costs.html
        - Alittle dated(2015) but talks about how these existing technologies are used for 3D mapping. It seem this is done by teams of subsurface engineers currently, if we could simplify their process we could make a better and easier to use service
    - https://www.geospatialworld.net/article/technologies-to-map-subsurface-infrastructure/
        - Indepth look at much of the same information stated above with historical examples. Also touches on some of the law surrounding subterranean work.

2. History

- Calling 811-Dig
    - The current process of obtaining information on underground utility pipes is to call 811-Dig.
    - 811-Dig is a service where homeowners or contractors have to dial the number ‘811’ before digging on any property to be made aware of any underground lines (e.g. pipes, cables and associated utilities) buried in the area.
    - This service is provided to prevent damage to underground lines potentially leading to disruption of services to the neighbouring area.
    - 811-Dig’s current process includes marking the area that the person wants to dig for construction and call 811 about the type of construction and the location. After 72 hours an employee of 811 will arrive and place markings on the location to identify the type of utility pipelines.
    - Utilities like gas, electric, telephone, cable television and private water companies are required to be a part of 811-Dig. This is only true for the state of Massachussets.
    - Some of the advantages of this process is that it is free; funded by utility members to promote public safety, the process of marking the construction zone is done within 72 hours.
    - Some of the disadvantages of this process is that 811-Dig offers tickets for construction which expire in 30 days and there are only some amount of member companies that are a part of 811-Dig, so non-member companies have to be notified separately before starting any construction.
    - Source: http://www.digsafe.com/index.php

3. Existing Solutions

- ARKI
    - ARKI provides the user the ability to develop 3D models of the construction.
    - These 3D models can then be viewed in a virtual reality or an augmented reality format. The user can view both scaled down versions and full scale models by using a tablet.
    - Features
        - The user can create their own 3D models using this software or can import an existing 3D model onto the device
        - The user can move and scale the model accurately in AR.
        - The application uses the system’s camera and LiDAR to create accurate renders of the 3D model in the real world.
        - This application also provides real-time visualization at any scale, allowing the user to view their model on-site.
    - Source: https://www.darfdesign.com/

- ARUtility
    - ARUtility is a company based in Michigan that provides a solution to view underground and aboveground assets in augmented reality.
    - ARUtilitie's solution is a mobile based application that tracks user location using GPS and shows the utilities in that area using the GPS data.
    - Features of ARUtility
        - The mobile application uses the GPS data and the camera to overlay an augmented reality version of utility pipelines on the users device.
        - Users can see the type of pipelines (which are color coded), the depth of the pipeline and can also see where they can mark which is indicated by dashed lines.
        - Users can also mark an area using the measurement tool built into the application. This feature also allows the user to take measurements of a particular area and mark it for construction.
        - Users can also add pipelines that were previously not visible and also update pipeline information through the application.The user can update information like material, pressure and voltage of the pipeline.
        - Architects can also upload their 3D models of buildings to visualize new construction before breaking the ground.
    - Images:

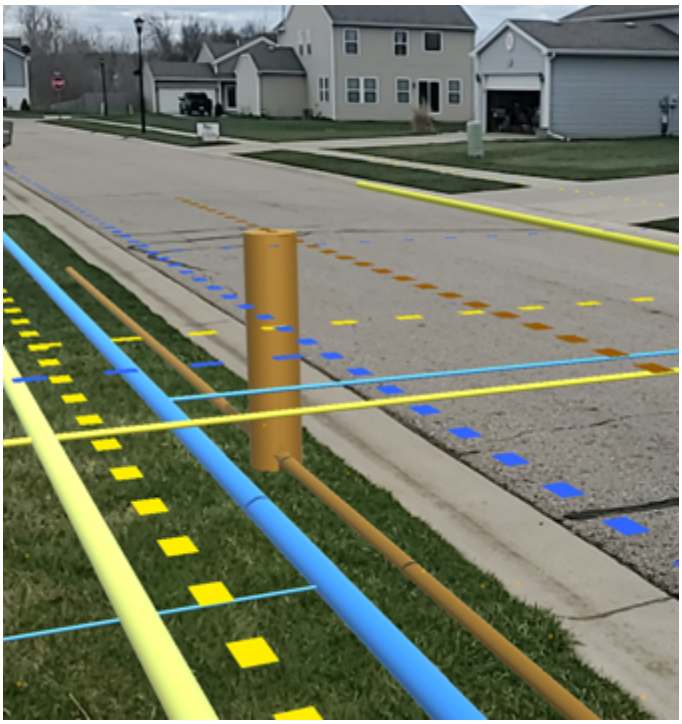

Image Source: https://www.arutility.com/images/arutilityview.png

    - Source: https://www.arutility.com/

Industry Research

Research should be conducted on any relevant industries that are important to the product and at least 3 competitors with the following information if known:

Company 1: 811 Dig - https://call811.com/Start-Here

1. **Company information**
    a. **Size:** 22 Employee
    b. **Revenue:** $22 million
    c. **Time on market:** Started in 2005
    d. **Location:** Primarily online with a location in every state
2. **Product offerings**
    a. **Summary of competitive product:** 811 Dig works on a “call-before-you-dig” process. It allows people to call and get assistance in marking buried utilities so that they are not affected while digging. It is required to call them when digging including anything froim a garden to a house.
    b. **Advantages:** 811-dig is located in every state and is a way to get all underground utilities marked. It is required to contact them at any time when digging.
    c. **Disadvantages:** Takes a few days to respond (72 hour minimum). Requires contractors to come to the location to mark.
3. **Summary of competition**
    a. **Why were they chosen:** 811-Dig is now a required number to be called when digging up anything. Therefor they are the number 1 competitor. They are required to be called because they are working with the government. Additionally, anyone is able to call them anywhere in the united states.
    b. **What are we most worried about:** We are worried that 811 - Dig will remain the chosen service do to it being an established company and also a required call. If we are able to make our product another way of being able to dig safley we will be able to excel.

Company 2: Blood Hound LLC - https://www.bhug.com/

4. **Company information**
    a. **Size:** 12 total employees
    b. **Revenue:** $1.21 million in sales

    c. **Time on market:** Started in 2017
    d. **Location:** Indiana Indianapolis
5. **Product offerings**
    a. **Summary of competitive product:** This is a private company that locates underground utilities, vacuum excavation, concrete scanning, and leak detection just to name a few of their services.
    b. **Advantages:** The advantage that this company has over us is that they offer a wider range of services and can do more than just see where the underground pipe and wires are.
    c. **Disadvantages:** Their device for checking underground wires are not as efficient as ours. Our product is just one device that can scan underground wires while they have a whole system that is harder to carry around and set up. Can take a while to schedule the service.
6. **Summary of competition**
    a. **Why were they chosen?** They were chosen because other than 811 dig companies liek these are the only one that check for underground cables/pipes.
    b. **What are we most worried about?** We are most worries about the wide range of services they provide, not just checking for underground utilities.

Company 1: Underground Surveying -
https://www.undergroundsurveying.com/services/utility-locating-services

7. **Company information**
    a. **Size:** 10 employees
    b. **Revenue:** $5 million
    c. **Time on market:** Started in 2005
    d. **Location:** Headquarters located in Brookfield, Connecticut
8. **Product offerings**
    a. **Summary of competitive product:** They offer utility locating, concrete imaging, leak detection and video inspection. Utility locating includes marking the location and depth of any underground utilities. Concrete imagine is when they find any potential obstructions embedded within concrete. Leak detection pinpoints the location of a water leak underground. Finally, Video inspection inspects the inside of pipes and searches for breaks, blockages or other problems.
    b. **Advantages:** Offers multiple services

    c. **Disadvantages:** Small company, takes time for a response, usually works with bigger companies rather than individual home owners.
9. **Summary of competition**
    a. **Why were they chosen:** They were chosen due to all of the services they offer. The variety off services makes them a very appealing company and therefore is a successful company.
    b. **What are we most worried about?** We are most worried about them provides additional services, while our product only checks for underground utilities.

Audience Research

A) Construction Teams:
    a) Goals: To utilize DigSight throughout all large scale projects for their source of data to save time, convenience, and materials in marking up places where they can safely build and utilize large scale equipment as well as what areas are structurally safe through DigSight rather than antiquated charts for data.
    b) Values: Time, convenience, effectiveness, cost, and safety. Perhaps contracting as well.
    c) Potential Frustrations: Time to learn and use the software with phones and AR/VR headsets as well as safety behind it on sight.
B) Gardeners, Plumbers, Electricians, and Local Exterior Designers:
    a) Goals: To utilize Digsight throughout small scale changes near households to markup where it is dangerous or not legal to dig up without having to call 811-Dig or digging up old landmark maps for data.
    b) Values: Time, convenience, effectiveness, cost, and safety.
    c) Potential Frustrations: The initial use of VR/AR in general and just overall user interface may be confusing at first and more work for them to be expected rather than just calling for someone else to do it but this will die down after several trial and errors.
C) Realtor and Home Inspection:
    a) Goals: To utilize DigSight to locate safety and hazardous conditions as well as to list markups to potential homeowners before or after purchase of household.
    b) Values: Effectiveness and Time
    c) Potential Frustrations: Delay in between whening showing the markups on Dightsight to showing it to homeowners.

Questions to ask Audience:

1) What would you like our user interface to include to make the DightSight experience more convenient?
2) What type of subscription based contract would you like to see to make the DightSight product more affordable>
3) What other applications would you like to use DigSight for rather than exterior mockups and designing?
4) Do you have any concerns for the safety of DightSight when using it on sight?
5) Do you have any recommendations on how we can make DightSight safer and more comfortable to use.
6) Are there any additional services/applications you would like to see us include in DigSight for more use?
7) Were there any software bugs and glitches that you've encountered with our system?
8) How was our tutorial on basic user interface? How could we improve this?
9) How was our packaging experience as a whole, was it nice and convenient to unpackage and use rightaway?
10) How was the customer service? Was there any additional improvements we could make to make you ask questions more conveniently and easily?