Real Time Welding Feedback

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Chapter 1

Introduction

1.1 POV Statement

Welders needs **real-time data feedback** because **it will enhance the welders' skills and reduce waste/time**.

1.2 Problem Statement

The current welding process often lacks real-time feedback and monitoring, which can result in welds with poor quality and durability. The lack of immediate feedback on weld characteristics such as arc length, electrode angle, and travel speed can lead to inefficiencies and costly errors. Traditional methods off providing feedback, such as visual inspection or external measuring devices, can be time-consuming, impractical, and expensive. The evidence of these issues can be seen in our observations and interviews with people in the field.[3] With the arc created during the welding process if you try to take a picture or record anything with a normal camera it will become distorted and unusable causing us to produce different methods. Therefore, the objective of this project is to develop a mobile application that connects to the main computer on the welder that handles the signals. That will then be passed to the users' headphones for real-time feedback. The application will provide audio signals to alert welders when there are deviations from the desired welding conditions, allowing them to make immediate adjustments to their welding techniques. The application will also have a database to store information about the welds, providing welders with a historical record of their welding work. Ultimately, the project aims to improve the efficiency and effectiveness of stick welding by providing real-time feedback to welders. The stakeholders for this project are the group members and our advisors. The users for this product would be new welders or welders that want to get better and know the soundness of their welds.

Chapter 2

Research

2.1 Observations

2.1.1 Observation 1

Sean Meals: The location I observed was the Gladwyne Fire Company at 1044 Black Rock Road in Gladwyne, Pennsylvania. The firehouse was rather large and had a kitchen, bunkroom, offices, garage bays that were home to the fire trucks, and a workshop. Particularly, I observed the workshop and saw the welding equipment which they use to fix equipment and apparatus. The people at this location in- cluded Fire Officers and firefighters. Most had a mechanical aptitude outside of firefighting and are responsible for maintaining and repairing all equipment. Some were dressed in uniform and others were in plain work clothes depending on who was "working" or on shift. The Fire Officers were in charge of assigning maintenance and repair activities to firefighters while they were on duty. During my visit, I observed and participated in welding a new bracket to store batteries for power tools. In order for the batteries to be safely secured inside the cab of the fire truck, a custom bracket was needed that could be affixed to an existing anchor point. One potential problem that I saw during my observation was the difficulty in trying to take photos while someone was actively welding. The arc created during welding is so bright that cameras are unable to focus properly. After bringing this problem up to other firefighters they said it was very normal. A possible solution in place was to take a photo through the viewing point of a welding mask. Figure 3 shows this problem as the image is extremely bright and unclear. A second potential problem that I saw during my observation was not being able to see my voltage and current values while I was welding. By design, they are only displayed on the welding machine itself and cannot be viewed from behind the welding mask. Since this is very common in the welding in- dustry most welders learn to adapt and weld without knowing this information in real-time and many firefighters agreed that they do the same. There are no solutions in place for this problem and an entirely new design would need to be implemented on the welding machine and in welding

masks. Figure 4 shows how far away the machine is when welding and how the voltage and current values are not even viewable based on the orientation of the machine. The third potential problem I saw during my observation was the amount of splatter that accumulated on the metal being welded. This splatter occurs normally as a result of welding but is going to provide lots of interference and sensor compati- bility issues during our project. The firefighters explained that no real solutions exist for this problem except for grinding the splatter away with power tools after the weld is completed. The splatter can be seen in a test weld done in Figure 5. Yes, I experienced all three of the problems firsthand. The first problem related to the photos was very frustrating at first and made it difficult to document. This is going to pose a significant issue in our project as we were planning to use image recognition to collect data. The second problem with the voltage and current values was something that I was prepared for and had prior knowledge about so I was expecting that to happen. The third problem with the splatter was something that I had encountered for the first time. I was able to talk with the firefighters about all three of the problems to hear their input and talk about solutions. They all provided me with great explanations of why the problems occur in the first place and what can be done to mitigate them. For example, we talked about how the splatter on the metal can be reduced if it is shielded or if you lower the voltage and current. They did not mention any other prob- lems not immediately visible during my visit. Yes, I was able to observe all the problems and ask follow-up questions about them right after they occurred.

2.1.2 Observation 2

Alex Rhodes This is my grandpa's machine shop in New Castle, PA my home town. This shop focuses on machining new feed screws for industrial uses and the maintenance of these parts. The maintenance and manufacturing of this part is comprised mostly of welding and re-welding the threads of the screws. This is done by an automated welder that will be shown in the pictures. The two people that I talked to was my grandpa, David Wilson who is the owner and one of his welders, John. My grandpa looks like a old man he used to work in the shop everyday but now he is really just supervising so he has a lot of knowledge on the subject. John on the other hand is one of his newer employees he is a younger guy and his main job is to weld the new threads this is done by him sitting at the machine adjusting its movements and other parameters to get a successful weld. The first potential problem that I found during the day was during the welding John was really just making the adjustments based on feel and experience and not really any data. From the temperature of the metals to the amount of current is being put through the welder. This could be a problem because if the welder is not moving in the right location or the current is too high then the weld could be compromise. This did not happen during my time there but I was told about it being one of the biggest issues. The second potential problem that I saw was the arc being put off was so bright that it was hard to make these decisions that are needed to have a good weld. Currently

John is just sitting behind a piece of wood that has a little cutout with the film needed to look at the arc. This problem is something that all welders deal with but there has not been really any solutions on the market to view your welding space better to control the arc better. The last problem that I saw during my time in the shop was The lack of standardization in the welding field. Yes there are big welding companies that create standard welders that work for most situations but for this one in particular it is all custom tooling. This is not really a problem because they have the people on staff that made the equipment but this could cause us problems for our project. From my talking with the welders it is really just a learning curve for them so it is not that big of a issue but for someone wanting to make a new product will have to think about this during the design. I experienced a couple of the problems first hand. I saw John having to change the settings of the welder a lot to keep a good weld. I did not try changing the settings because he was working on a customers feed screw. Th problem that was easy to experience was not having the best view of the arc as it is welding. I looked through the window and all you really see is a glowing spot. It is hard to see the metal and the pooling that occurs during the weld. John said he has gotten used to looking through it but I feel like it can be improved.

2.1.3 Observation 3

Timothy Hoo Location: Berks Career and Technology Center

Day and Time:3/17/23

Duration: from 4:30pm-10:00pm

Location

Describe the location you observed. The location we observed was a Berks Career and Technology Center, it was a welding center where they held multiple stations to weld and teach students how to do the different welding. Furthermore, there were also other tools they could practice with such as metal cutters and plasma cutters for the metal they are working on. The people we say at the site were both students learning how to weld and teachers who were guiding them on how to weld. The students there looked to be around our early to mid twenties, while the teachers felt like senior citizen so around the age of 65 and up. The students seeded to be working on a project while the teachers were both supervising them and showing us around the workshop.

Potential Problems

One of the main problems we faced and the teachers described having were not having enough info about what they are welding when they are welding. This can range from the temperature of the metal when welding or the arc length while welding. This will help with the consistency of welding and help improvement faster. Another problem that was described to us was that teachers would also want more information also after the weld is done. Such as how consistent

the the student was when welding so they don't have to do an x-ray or ultrasound on the metal to truly see how good the weld was, which would also be good in real world for the same reason. The last problem we saw was there should also be a prep system so that students having something to follow or there should be something to compare to so people know where to improve in comparison to what they wanted to do with the weld.

Experiences
So during the visit to the shop our advisor allowed us to try the three different type of welding. While welding we experienced the problem first hand of both not having the information readily available and not setting a pre-information to help out. This was very transparent when we were doing the stick welding where it was the hardest to complete and needed the most information to help complete as a new person. The reason why we need the information I realized is because the mask that you wear to block the light and rays from welding really inhibits you from seeing anything so its hard to keep the weld straight and consistent. Some other problems that the teachers told us were they don't have enough feedback information to know whether sometimes the weld is good or not unless they do an x-ray or and ultrasound of the weld which is both costly and timely for them to complete.

2.1.4 Observation 4

Rafael Guerrero

This location was in a car transmission and torque converters shop called Hugo's Transmissions in East LA. The welding is done closer to the back of the inside of the shop where the welding equipment is held. The welding set up is two tables, one on each side of the welding machine, with the clamps curled around to a hook where it can safely be hung and no one touches it even when it is off other than himself. That area is then also has an orange curtain in order to make sure that onlookers from different angles do not look at the bright light directly if they are looking in that direction for him. My father was the one who was there as he is the only employee of his business and the only one in the shop that knows how to weld. He had the traditional mechanic jumpsuit on, but when he begins to weld, he has to have a leather jacket on that covers his chest, both arms, and neck, along with a mask visor to block the bright light. He also has on a plastic apron with a leather strap in order to protect his lower body. He showed me how he welds the torque converters shut and also how to weld the metals together in order to create a stronger resistant clutch that goes inside the torque converter to help it function better. I did not experience the problems first hand as my father does not let me weld since it can damage my eyes. However, I was provided googles and was able to see the way he was welding shut the torque converters. It was fun to see and understand how welding works in a specific way for these torque converters. For

any problem he encountered he was able to fix with a quick thinking solution or by methods he learned. The ventilation system was a quick solution using fans to have better air flow. However, for other problems, he already had those solutions. He agreed with having an app to help figure out welds before they are over done will be an amazing idea. It will save time and material. Also, the angle for him is set to ensure that there the same welds most of the time so he does not have that angle issue like other welders may have but thinks that is a great issue to try to fix for it does affect welds a lot.

2.2 Interviews

2.2.1 Interview 1

Sean Meals: After introducing ourselves I asked Adam my first question, which was "Does your company have any protocols in place to help mitigate waste during the construction process? If so, can you tell me about them?" He responded by indicating it depends on who orders the material but in most cases, if there is excess material that is ordered it can be sent to another job site, it could be recycled if necessary, or it can be returned to the vendor to help cut down on waste. Based on Adam's response it seemed like his company had many safe- guards in place to help mitigate waste but it was still present in some aspects. Next, I asked "If skilled trade personnel were given more resources in the field to help them with efficiency could this benefit the overall schedule of the project and reduce construction time?" Adam's response indicated that there is always room for improvement in the construction field to help with efficiency. Increas- ing efficiency would help make a project go faster and yield more income for the company. He followed up by asking me if I knew of any technology that already existed with regard to welding. I responded by giving him insight into some of the things I have been researching such as using thermal imaging and lasers to obtain real-time data acquisition. I explained some of the struggles related to this technology as he was curious about our project. Adam followed up by saying he has taken part in some demos where companies come out to their construction sites and test or demo technology. This made me curious and wonder if we could potentially test the project in the field with his company once we get a functioning prototype. I asked my third question "How can waste reduction during the welding process help benefit your company financially"? Adam described how material that is not properly managed can be risky and lead to deficits. He described waste directly related to stick welding when usually a quarter of the rod is unused as you can only get so close to the electrode until the heat becomes too intense. He gave advice saying that we should look into cost-effective ways to recycle this waste instead of discarding it like most job sites. I followed up by saying how calculating the resistance of the rod could help the welder know how much of the rod was left without physically having to stop welding to look at the rod. Adam really seemed to like this idea. I asked Adam about issues with over-ordering material and he

described the software system they had at the company and how it could be improved upon. I asked Adam about what technology they had in the field with regard to con- struction tracking. This helped me lead into how we could track weld quality and efficiency through current software. He responded indicating how they use iPads in order to make changes to blueprints immediately and so that everyone would be notified and kept up to date. I then brought up how we could com- bine some of the software he is using already with real-time data acquisition for welding. Adam responded by saying his company is slowly moving down that path and that there is a need for more innovation. I then brought up a hypothetical idea where we could combine the software that Adam is already using in the field and add some things that would make his job easier on the management side. For instance, trade personnel in the field could take a photo of their weld and the data acquisition system we design could verify that weld and say immediately say pass or fail. This way everyone can see in one spot if something needs to be changed or fixed. Adam thought this would be an excellent implementation. One of my final questions to Adam was "how do you track your costs for con- struction projects." I was trying to relate all aspects of efficiency to one area. He explained their "percent complete" system of reporting and he gave me a detailed response on how they can predict their schedule based on input data such as crew size and material usage. We discussed the efficiency of workers and how that could lead to a project being under or over budget based on labor costs. Other Notes: After the interview ended Adam described how he would be in- terested in prototyping our design out in the field with their team of welders to help get feedback.

2.2.2 Interview 2

Sean Meals: Jonathan is a mechanical engineer currently employed at Boeing. He is working on laser-assisted gas metal arc welding for aircraft manufacturing. His main goal is to help make the welding process more efficient and increase overall quality. To commence the interview, Jonathan talked about conventional gas metal arc welding that is used today in the aircraft industry. He mentioned that this type of welding is most common in robotic welding. I asked my first question, "Can you explain the difference between gas metal arc welding and hybrid laser- assisted gas metal arc welding?" Jonathan proceeded to answer by explaining how the process worked, mentioning how the electrode is fed through the nozzle of the welding machine until it creates an arc with the metal. After the arc is created, the electrode melts into the fusion zone. Gas is used to shield the metal so oxidation does not occur and to protect the metal from impurities. He continued into the benefits of gas metal arc welding by describing it can be used for ferrous and nonferrous metals. He said it is most commonly used for very long welds and has very minimal post-weld cleaning due to the gas. Next, he discussed some of the negative effects of gas metal arc welding by describing how surface contaminants can cause cracking or improper bead ap- pearances. He discussed how wind can cause many issues in the field since the shielding gas can be blown away and potentially lead to issues. After discussing gas

metal arc welding Jonathan switched topics to laser beam- assisted gas metal arc welding. He said the most important difference between the two types was that laser beam welding does not have any filler metal. Rather it fuses the two metals together into one. He continued into the benefits of laser beam welding by saying it can be used for a variety of materials and has deep penetration. I asked him a follow-up question about which type of welding pro- vided better quality welds. He remarked that laser beam welding outperforms conventional gas metal arc welding almost every time in experimentation. He then said that the speed of laser beam welding is usually much higher than conventional gas metal arc welding since it is usually automated. Then I asked, "What are some of the safety hazards that a user may face when undergoing laser-assisted gas metal arc welding?" Jonathan responded by say- ing the UV rays produced from welding can cause harm to human eyes and the effects of electromagnetic radiation on the human body are still being studied today. He described how the laser itself can pose risks to humans if it comes into contact with the skin. I followed up by asking what effects laser beam welding has on human skin. Jonathan responded by saying it can cause severe burns and if reflected into the eyes could cause immediate blindness. I asked "What are the economics of laser-assisted gas metal arc welding? Is it more efficient than conventional gas metal arc welding and can you break down the cost difference"? I learned from Jonathan that laser beam welding is almost double the cost of conventional gas-metal arc welding. He continued by saying how maintenance costs are extremely high as only a select group of technicians know how to repair this equipment and parts are not necessarily easy to find. Many times parts have to be custom made and this is where costs can become very high. He also described how since the power consumption of the laser is so great it can lead to higher energy costs. Jonathan then talked about how rapid cooling plays a major role in laser beam welding. He said high heat in a relatively smaller area causes the heat to trans- fer rather quickly to the base material. This can lead to defects such as melting, cracking, and warping. After this, I reiterated my first question and asked John to talk about hybrid laser-assisted gas metal arcing welding. So far he had only discussed gas metal arc welding and laser beam welding. At this point, he had not talked about the "hybrid" part of the process. Jonathan discussed the combination by drawing an image on a piece of paper. He did not let me take a photograph of the image so I will try to describe it verbally the best I can. The image consisted of a welding nozzle feeding the electrode onto a base metal. Jonathan circled the fusion zone and then drew a line from the fusion zone to the top of the paper. I asked him what that line represented and responded by saying it was the laser beam. The point he was trying to convey to me was that the "hybrid" referred to combining conventional gas metal arc welding and laser beam welding. This meant the weld would still be done with a filler metal but the laser would to guided just ahead of where the weld was happening to help heat up the metal and begin the weld. Then the electrode would pass over where the laser beam had just been and finish the weld. I then asked Jonathan why this process was better than just laser beam welding. He said it provided much deeper penetration since the temperature was higher but

it didn't cause the base metal to heat up as fast. He then talked about how the speed of the hybrid process was much faster than conventional gas metal arc welding. He gave me some statistical data and said that gas metal arc welding travel speeds average around 0.95m/min while the hybrid process averaged 5m/min. This clearly shows that the hybrid process is much more efficient as it has higher travel speeds and deeper penetration. I then asked about the quality of each process. Jonathan said there is much less distortion of the base material due to the precision accuracy of the laser. Other Notes: Jonathan showed me photographs of the laser beam welding machine that he has access to at Boeing. He also demonstrated videos of a prototype hybrid machine that he is currently working on.

2.2.3 Interview 3

Student Name Alex Rhodes **Student Name:**
Alex Rhodes
Interviwee Name:
Dr. Kulkarni
Interview Location:
Tolentine 408
Interview date and time:
April 3, 2023 at 3pm
Duration of interview:
10 minutes
Write at least 3 planned, open-ended questions to bring to your interview:

1. Question 1-What programming languages and frameworks would you recommend for this project?

2. Question 2-Do you know about the Bluetooth standard? Steps Involved in using it? Common challenges faced? Testing and Debugging?

3. Question 3-What advice would you give to a team working on this project with limited real world coding experience?

Notes
We talked about the steps needed to create something like we are thinking about doing. From the coding languages being different for each sensor it will be helpful to find documentation for each one. Most the time he said that each sensor will just feed the raw data and we will have to find the code to ingest that data into usable data. The conversation the switched to my next question about the Bluetooth protocol. I have not done anything with this yet so he gave me a good baseline to get started with that and places to find resources. Finally we got into our last question about organizing our work and using our time well. Since we are all new to real work applications of what we have been learning he really pushed time management. For example we could get a cheap 5 dollar

sensor but have to put 20 hours of work to get it functional or we could get the 100 dollar one that works instantly. Since our time is worth more than that price difference. Overall, I think this was a good interview and covered a lot even though I did not meet the 15 minutes minimum I got all the questions and follow ups answered.

2.2.4 Interview 4

Student Name:
Alex Rhodes
Interviwee Name:
Jason Keeley
Interview Location:
CEER 009
Interview date and time:
April 12, 2023 1 PM
Duration of interview:
20 minutes
Write at least 3 planned, open-ended questions to bring to your interview:

1. Question 1-What are some of the most common issues you encounter when stick welding and how do you address them?

2. Question 2-In your experience what are the most important factors that contribute to successful stick welding and how do you optimize these factors?

3. Question 3-How do you currently track and document your stick welding processes and results? Are there any areas where you think improvements could be made?

4. Question 4-In what ways do you think our project could potentially improve the stick welding process. What specific features or capabilities would you like to see in a new welding solution?

5. Question 5-How important is welding quality and consistency in your work and how do you measure your success currently?

Notes
We starting this interview getting his take on the challenges and issues that he faces when stick welding. He brought up a good point that there is variability in the condition of the stick itself and that can just ruin the weld. We have not thought of this before so it could be valuable to look into that. For the next question I asked him about the most important factors in welding. He told me to be prepared and plan ahead. This means knowing the welding material and

the setting to put on the welder. Currently you have to use a website to get this info if it is unknown to you. This could easily be bought into the computer and our app. Another thing that he said was welds don't really get tracked or testing just gets send out currently. So with our real time feedback that should be enhanced greatly. For the final two questions he just reiterated what was said before and added some more context to it. The recorded part of the interview was only about 9 minutes but after I stopped we went around his machine shop on campus talking about some more ideas for another 10 minutes.

2.2.5 Interview 5

Rafael Guerrero

He has been welding for a bit over 6 years, not professionally and usually has it spinning on its own wheel so kind of like automatic welding. He just wants to clear up that he only welds when it is necessary but has done it often amount of times to have a basic foundation of this angle and temperature are important factors. There are different items need different temperature also affected by what gas is being used. The temperature allows for the weld to be completed and no pores opened while the angle makes sure it is equivalent throughout both are very important. He explained that steel is used in torque converter, more specifically 8620 steel. Steel is a really good material that is not difficult and stays strong. Aluminum is a difficult material and sometimes has to weld it for a part in the reactor arc clutch to keep the metal in place. He rarely does it but does it, however aluminum is not recommended to weld. Mentions different types of steel to weld, since for torque converter it is essential to have a good weld. It is necessary since it will be placed in a car and don't want to have it stop working. A bad weld can cause fluid to leak and then the converter to cause damage to the transmission. The benefits of knowing there is a bad weld is that there is less waste, less time to re-weld, less material being used and very beneficial.

2.2.6 Interview 6

Rafael Guerrero

He states that you have to know the material and it's thickness to help know what temperature to be at, but typically 45 degree angle. The different angles have the probability of causing materials to layer itself causing ineffective welds. We have to clean the surfaces or we run the risk of a pore that can cause breaking. He then gives the example of a bucket and can have a leak due to these pores. He talks about the accessibility of an app but some concerns on the device it would be on since most hardware type shops have bulky durable devices. He suggested examples of MatCo and Snappon tools. A scanner function would be beneficial along with a user friendly interface. Never stop at different points and you have to see out the weld to the end, and he emphasizes the fact to

see out the weld. If you stop then you would have to start the weld all over. The use of a grinder to take off the metal and then clean the surfaces all over again, however the weld may still be defective since it would be on top of the old mistake and with a created pore it makes a poor weld.

2.2.7 Interview 7

Student Name: Timothy Hoo

Interviwee Name: Kyle Juretus

Interview Location:His Office

Interview date and time:4/12/2023 1:15pm

Duration of interview:16 min

Write at least 3 planned, open-ended questions to bring to your interview:

1. What Micro controller would you recommend in this situation and why?
2. What difficulties do you see arising trying to collect and compute all the data a in a timely manner?
3. What seems the most feasible to give feedback to the person with the given parameters of a welder and a micro controller?

Notes
After asking some of the questions about what micro controller should be used, he recommended using a blue pill or a small raspberry pi for a micro controller. Furthermore, he said that we should first work on connecting with a Bluetooth modulation and focus on them working together. He then said that the vibration was the most viable for the feedback for people and that adding the more sensors shouldn't be added difficulty. Some of the other follow up questions I asked were what were the time frame he would give him self for the coding part of the project and he recommend as much time as possible but only the focus are the essentials. Furthermore, I think the biggest thing he recommended is to not focus too much on the size too much with the limited time but instead focus on making sure it works and that if it does then describe at the end how to shrink it with a custom pcb if possible.

2.2.8 Interview 8

Student Name:Timothy Hoo

Interviwee Name:Joey LaMorte

Interview Location:Toletine

Interview date and time:3:30

Duration of interview:

Write at least 3 planned, open-ended questions to bring to your interview:

1. What was the biggest issue when welding?
2. What do you think would be the most helpful when welding?
3. Where would you want the device to be the least inconvenient for you?

Notes
The items in the setup took the longest, the right voltage was very important and how long to hold the welder to know how long. I simulation would have been helpful. vibration, sound, sight is said how he ranked what be useful to him. He thinks that the device we are making would help him improve quickly and would definitely give it a try if he could. It was also insightful what the biggest fears of new welders are which were getting electrocuted from the mig gun and was interesting of the precautions of watching YouTube video being his guide. This gives me insight to look at the Youtube to try and get data to tell people who are new welding what they are getting into and what the information we are giving and what they mean on how to get better at welding.

Extra Key Notes
Learning from someone who has only welded the first time gave a good perspective of people who we are mainly catering this device to and how to help these people the most. This also helps give a good idea to what features we should have toggleable for more of experts and how we might want to give them different options of how they get the feedback response.

2.3 Literature Review

2.3.1 Title of Article: Weld quality assessment based on arc sensing for robotic welding

Student Name Timothy Hoo
Author(s): Tomasz Marek Lubecki; Fengjun Bai
Journal/Publisher: IEEE
Year: 2015

Summary: In this article the authors experimented with machines on how develop robots to take in real time data while welding mainly TIG and MIG to determine whether the weld is good and hold or have issues. They trials with around 4000 bots and measured mainly the current change and voltage change to determine what should they expect from good and bad welds and why they happen. Next they put threshold values to check when the bot would go above or below these values and determine where the bot made a poor weld and can pinpoint where to check and not make robots more consistent when welding with the new data.
Key Takeaways:

1. Shows the possibility that data such as voltage change and current change can determine a good and bad weld
2. Demonstrates that since the information can be transmitted to a robot we can possibly to it to a human
3. Tells us what steps to take to see how good our product could be in comparison

CRAAP: The article is relatively current only coming out in 2015 and using modern technology to determining their results. It's relevant to what we are working on because we are also trying to get feedback data from welding such as them so its a good starting point for us. The authority comes from that it was published in IEEE International Conference on Advanced Intelligent Mechatronics (AIM) which should be both an authoritative and accurate publisher that should be trusted. The purpose of this article is to help us determine how to get relevent data from the feedback that should be told to the welder so he knows what to do to improve his weld while welding. **In Text Citation:** [7]

2.3.2 Title of Article: Real-time Inspection Method For Laser Welding Process

Student Name: Sean Meals
Author(s): Hee-Shin Kang, Ji Whan Noh, Kyung Han Kim
Journal/Publisher: IEEE
Year: 2012
Summary: This article focuses on a study conducted to measure the quality of laser welding. Specific parameters are given, such as the power consumption of the laser and the specific industrial welding robot used. The authors describe the laser welding system and argue that it increases the processing speed and improves overall efficiency. To defend this claim they observed the shape of weld pools and beads using UV and IR sensors. Finally, a full analysis of the test results are given. I learned from this article the industrial applications of robotic welding and how real time sensing data is used to make them more efficient.
Key Takeaways:

1. Illustrates the types of sensors used in order to capture real-time data such as UV and IR

2. Measuring plasma intensity in order to determine tensile strength

3. Using signals to measure temperature instead of using conventional temperature acquisition devices

CRAAP: This article was published in 2012 which may seem dated but in the realm of welding, there hasn't been much innovation. Therefore it is current by today's standards. It is relevant because it relates to a study on monitoring weld quality, which is one part of the project our team needs to master. This article is from the IEEE therefore it comes from good authority and is proven to be accurate as it goes through multiple peer reviews. The purpose of this resource is to provide us with specific quality tests that can be performed in order to test the accuracy of our prototype.
In Text Citation: [4]

2.3.3 Title of Article: A Study on Measuring System of Submerged Arc welding for Panel Butt Joint in Shipyard

Student Name: Sean Meals
Author(s): MoonYoung Chung, SungHoon Ko, Hyeong Soon Moon, JinWoo Choi
Journal/Publisher: IEEE
Year: 2013
Summary: This article focuses on submerged arc welding and discusses how the error between measured and actual data values can be problematic. This error causes the weld quality to diminish and the weld cannot be guaranteed. To overcome this problem the authors write how they designed a new system to accurately account for current, voltage, and speed. In this new design if an error occurred the onsite workers could correct the problem immediately after it occurred to increase quality.
Key Takeaways:

1. The need for accuracy from sensors in order to determine present conditions

2. Having the ability to determine weld defects as they occur is crucial

3. There is large error in existing systems on the market

CRAAP: This article is from 2013 so it is somewhat current. It is relevant because it presents information that most likely would have been overlooked in our project given the time constraints. A small error in measured data versus the actual data can lead to inaccuracies that risk the quality of the weld. The article originates from IEEE therefore its authority can be trusted and it is

accurate since the article must pass through peer review. The purpose of this resource was to draw attention to the need for accuracy when researching and designing our sensors in order to have a good outcome for our project.
In Text Citation: [**Chung2013AShipyard**]

2.3.4 Title of Article: Experimental Research on Welding Defect Detection Based on Thermal Imaging

Student Name: Sean Meals
Author(s): Mengmeng Li, Tao Ma, Ding Yan, Handing Liu, Hongliang Wang
Journal/Publisher: IEEE
Year: 2022
Summary: This article discusses how thermal imagining can be utilized in order to determine the quality of a weld. Particularly it discusses how a weldment can be photographed immediately after it was welded to determine areas that may pose a risk for discontinuities. It goes into detail on how areas with a lower temperature are specific cases when debris may have entered the weld.
Key Takeaways:

1. The information provided by temperature readings on welds can help determine the quality
2. This is a non-destructive way of testing welds
3. Image processing is still required to flag discontinuities

CRAAP: This article is from 2022 so it is very current. It is relevant because it provides a way for nondestructive quality testing and can be redesigned to provide that information in real time. It is published by the IEEE so it comes from good authority and can be considered accurate as it undergoes peer review. Its purpose is to provide insight into different types of procedures that exist in order to test weld quality by utilizing temperature readings from thermal imaging cameras.
In Text Citation: [6]

2.3.5 Title of Article: Evaluating technology of spot weld quality for coated high strength steel sheet based on ultrasonic guide wave

Student Name: Sean Meals
Author(s): Zhenhua Chen, Yaowu Shi, Haiyan Zhao
Journal/Publisher: IEEE
Year: 2008
Summary: This article discusses how existing welding parameters can lead to poor quality such as in splatter or sticking the weld. The authors investigate using ultrasonic techniques in order to perform nondestructive welding tests. They mainly focus on spot welding under certain parameters such as the metals

being coated in zinc and using a lamb wave and measuring its reflection or transmission.
Key Takeaways:

1. Ultrasound is relatively safer than performing x-ray analysis in field applications
2. Relates to current coursework in electromagnetics therefore most of the information is understandable
3. Specific parameters are required for this analysis such as the metals being coated in zinc

CRAAP: This article is not very current as it was published in 2008. It is relevant because it focus on ultrasonic and nondestructive weld testing that we may need to utilize for the project. It is published by the IEEE therefore it comes from good authority and is accurate as it went under peer review. It's purpose is to provide insight into ultrasonic testing and its relation to the welding industry.
In Text Citation: [12]

2.3.6 Title of Article: Adaptive Control on Wire Feeding in Robot Arc Welding System

Student Name Timothy Hoo
Author(s): H.B. Chen; T. Lin; S.B. Chen; J.F. Wang; J.Q. Jia; H. Zhang
Journal/Publisher: IEEE
Year: 2008
Summary: In this article the authors experimented with machines in completing tig welding. From their experiments they collected data while the robot was completing the weld and realized that one of the important aspects was the feed speed of the metal for the weld. With this info they took outside data around the weld and was able to identify what speed to feed the metal to fix the weld automatically for the weld so that is stays consistent.
Key Takeaways:

1. Can give automated help to humans instead of feeding information to them
2. Gives another solution on what to do with the data and how we could change another aspect of welding
3. Gives another data point that we should pay attention to and what data is important when welding.

CRAAP: This was published within the last twenty years so it is current, it's relevant because it has to with welding and what data to collect and how to use it. The authority comes from the IEEE which we should trust with accuracy since they go over the reports thoroughly. Finally the purpose of using is that

its gives new ideas of how to solve the problem and more data on what we should collect.
In Text Citation: [3]

2.3.7 Title of Article: Development of Travel speed detection method in welding simulator using augmented reality

Student Name Alex Rhodes
Author(s): Ario Sunar Baskoro; Irwan Haryanto
Journal/Publisher: IEEE
Year: 2015
Summary: This paper is about the development of a travel speed detection method for a welding simulator using augmented reality. Learning to weld can be very expensive but with the proposed welding simulator makes it easier and cheaper. They conducted different experiments with different light sources and tracking speed to find the best combination and their accuracy's. In their finding they decided that 450 lux lighting gave the best results. In their fixed data mode, the program saves data of the main tracker in temporary storage. Turning on this mode made it more accurate as well. Overall, this paper presents an interesting way to track the travel speed of the weld tip by using existing technology in ARKIT and using augmented reality.
Key Takeaways:

1. Shows the possibility of using tracking markers and cameras to get the location data of the welder for our detection
2. Talks about some of the existing technology and what they are currently doing with the products on the market
3. Gives us a good start to our tracking by taking their findings and adding to them to create of design

CRAAP: The article is pretty current as it came out of a conference in 2015 and is using some current technologies like ARKIT. It is relevant to what we are working on because in our project we would like to have real time tracking of fine movements of the weld tip to allow us to guide the welder. The authority for this paper comes it being published by IEEE and came from a conference in 2015 the ICACSIS. This means that the article should be authoritative and accurate. The purpose of this article is giving us the basic understanding of how to track display data on the location of the welding tip. **In Text Citation:** [2]

2.3.8 Title of Article: Model based feedback control of gas tungsten arc welding - An experimental study

Student Name Timothy Hoo
Author(s): Fredrik Sikström; Anna-Karin Christiansson; Bengt Lennartson

Journal/Publisher: IEEE
Year: 2015
Summary: In this article the authors experimented with simulations and to try and give an example before performing the real weld. They discovered by simulating the weld before completing the actual weld has turned out with better results since they can predict the process and answer the critical issues that might appear during the weld.
Key Takeaways:

1. Gives an idea of instead of real time we can predict
2. Demonstrates that welds are predictable
3. Allows us to compare a simulation to when welding to they can correct it with reference to the simulation

CRAAP: This was published within the last ten years so it is current, it's relevant because it has to with welding and what data to collect and how to use it. The authority comes from the IEEE which we should trust with accuracy since they go over the reports thoroughly. Finally the purpose of using is that its gives new ideas of how to solve the problem and more data on what we should collect.
In Text Citation: [9]

2.3.9 Title of Article: An embedded Electric Meter Based on Bluetooth Data Acquisition System

Student Name Alex Rhodes
Author(s): Peng Xuange; Xiao Ying
Journal/Publisher: 2010 Second International Workshop on Education Technology and Computer Science
Year: 2010
Summary: This article describes the design of an embedded electric meter based on Bluetooth data acquisition system. The goal for this design is to reduce complexity that tradition cable-based data systems. They used standard arm chips that have its own Bluetooth chip built in. They built in the correct measures to protect the chip from the effects of ESD before it connects. The major difference between this Bluetooth data acquisition and other collection methods is that it realizes the data transmission after the A/D conversation. This makes the system simpler and more resistance to interfere. The authors provide a lot of data comparing their method to other common methods.
Key Takeaways:

1. Gives us ideas on how to handle our Bluetooth transmission in an area with a lot of interference.
2. Gives us ideas on when is it best to collect our current and voltage data
3. Let us understand better the plus and minus to wireless data transmission

CRAAP: This article is coming up on 13 years old as it was published in 2010 which is not the most current. However with it still discussing current technologies it is still relevant today and for our project. The authority for this paper is from it being published by IEEE and discussed during a conference in 2010 in China. This means that this paper should be accurate as well. The purpose of this article was to research new ways to transmit data by a wireless and reliable way. **In Text Citation:** [8]

2.3.10 Title of Article: Weld Quality Inspection Based on Online Measured Indentation From Servo Encoder in Resistance Spot Welding

Student Name Timothy Hoo
Author(s): Lai Xinmin; Zhang Xiaoyun; Zhang Yansong; Chen Guanlong
Journal/Publisher: IEEE
Year: 2007
Summary: In this article the authors experimented with a huge data set and where they have a recording device of when a person completes a good weld and a bad weld. From this data they then see what was happening during the weld and extrapolate the data and create a range for the data of what is a good weld and what is a bad weld. From this they can complete another experiment where they have the people complete welds and only using the data to determine the good welds and the bad welds if they were or weren't in the given ranges.
Key Takeaways:

1. Gives idea of how to collect data
2. Show how to test the data and what tests to confirm our information
3. Demonstrates we can get data online to help us complete data sets

CRAAP: This was published within the last twenty years so it is current, it's relevant because it has to with welding and what data to collect and how to use it. The authority comes from the IEEE which we should trust with accuracy since they go over the reports thoroughly. Finally the purpose of using is that its gives new ideas of how to solve the problem and more data on what we should collect.
In Text Citation: [11]

2.3.11 Title of Article: Influence of temperature variation on the accuracy of DC voltage measuring device

Student Name Alex Rhodes
Author(s): Xie Tingting; Yang Zhongzhou; Feng Jianhua; Wang Lu
Journal/Publisher: 2017 4th International Conference on Electric Power Equipment - Switching Technology (ICEPE-ST)
Year: 2017

Summary: This paper discusses the importance of voltage measurement devices in DC transmission systems. These devices are installed in the transmission lines to get a reading of the voltage that is sent to protection devices. The main part of this paper looks at the impact of temperature variation on the accuracy of the voltage reading. It suggests that internally generated heat of the voltage in the cable. This could change how the voltage is being read. It can cause changes in the ratio of the voltage divider and affect the accuracy of the measurement device. This paper presents suggestions on the ratio test and how the national standards should be.
Key Takeaways:

1. Even though this paper is on electric transmission the measuring of voltage will be the same and with us handling high voltages it can get hot
2. gave us a good background in voltage measurements
3. let us know what to do when we come across these issues

CRAAP: This article is from 2017 and talks about current technology. It is relevant because of the voltage measurement and the issues that could occur and we are doing that in our project. This article has authority because it was published in ICEPE-ST a big conference on electric power equipment. This also means it is accurate because others have cited it as well. The purpose of this article was to address the variation in temperature can change your voltage readings. **In Text Citation:** [10]

2.3.12 Title of Article: Fusion of thermal imagery and LiDAR data for generating TBIM models

Student Name Alex Rhodes
Author(s): A. Adan; T. Prado; S.A. Prieto; B. Quintana
Journal/Publisher: 2017 IEEE SENSORS
Year: 2017
Summary: This paper proposes the combination of 3 different types of sensors to make a comprehensive 3d map of buildings. The three sensors are a RGB camera, A FLIR thermal camera, and a 3d laser scanner or LiDAR sensor. This created this sensor suite to map out building more efficiently and more effectively with more data than ever. They call this model the TBIM or (Thermal Building Information Model). They then went through the calibration process that you have to do to get all the sensors aligned correctly. After that they showed images of the corresponding data of a room. They are currently testing more in larger scenarios.
Key Takeaways:

1. The ability to make a fusion of different image technology to get better data
2. Even though it is for room purposes that can be scaled down for our purposes

3. You can get a lot of good data from this fusion

CRAAP: This article is from 2017 and is talking about cutting edge technology still today so that makes it current. This is relevant for the project because we would be taking both lidar and thermal images so with fusing then it could just be better. This article has authority because it was published in IEEE sensors meaning it has been checked. This is also accurate for the same reason and has been cited 6 times meaning people have agreed with their findings. The purpose of this article was to talk about the fusion of 3 sensor technologies to create a whole room depth map with thermal data. **In Text Citation:** [1]

2.3.13 Title of Article: Effects of Welding Time and Welding Current to Weld Nugget and Shear Load on Electrical Resistance Spot Welding of Cold Rolled Sheet for Body Construction

Student Name Rafael Guerrero
Author(s): Ario Sunar Baskoro, M. Rizky Trianda, Jos Istiyanto, Sugeng Supriyadi, Danardono A. Sumarsono, Gandjar Kiswanto
Journal/Publisher: IEEE
Year: 2014
Summary: This article talks about how welding time and current have an impact on an electrical resistance spot welding used in body construction. These investigators did a series of expiriments trying to determine the effects of different parameters on the formed weld nugget. The concluding finding was that increasing weld time and current has the probability to enhance the formation but the optimal combination of time and current has a higher shear load. This optimization can then be used in body construction later in time.
Key Takeaways:

1. 1) Welding current and time are critical parameters that has an effect on the quality of welding.
2. 2) The higher the welding current and time has the result of a higher nugget size and strength of the weld.
3. 3) The parameters being controllable allow for stronger weld joints for body construction.

CRAAP: This article is from 2014 talking about how different parameters affect the weld nuggets which always happens in welding so it is still current. The relevancy for the project is that we are considering these same parameters so having past work will be extremely helpful. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to talk about how the time and current impacts the weld and what are the optimal parameters.
In Text Citation: [**IEEE2014**]

2.3.14 Title of Article: Research of Intelligent Welding Control System of Swing Arc Narrow Gap

Student Name Rafael Guerrero
Author(s): Xin Yanggui, Zheng Shida, Gao Shiyi*, Xu Wanghui, Li Su
Journal/Publisher: IEEE
Year: 2021
Summary: This article talks about how there is some type of intelligence welding control system that narrows the arc gap. This process combines swing arc and narrow gap welding techniques with the goal of having a greater efficiency and quality. There are hardware and software parts that shows how implementation can adjust the parameters in real time. They found that the control system is effectively control the swing arc narrow gap and improved it.
Key Takeaways:

1. 1) The intelligent system for swing arc narrow gap can be improved through quality and efficiency.
2. 2) This system has real time sensor data to improve welding.
3. 3) This has potential to be used in large-scale applications.

CRAAP: This article is from 2021 talking about how intelligence welding systems allow for a better efficiency and quality of welding. The relevancy for the project is that we are need a real time sensor finding and that is what this has completed. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to talk about how the algorithm and real time data can result in welding outcomes.
In Text Citation: [5]

2.3.15 Title of Article: Detection and Classification of Weld Defects in Industrial Radiography with Use of Advanced AI Methods

Student Name Rafael Guerrero
Author(s): Ryszard SIKORA, Piotr BANIUKIEWICZ, Tomasz CHADY, Przemysław ŁOPATO, Bogdan PIEKARCZYK, Grzegorz PSUJ, Bogdan GRZYWACZ, Leszek MISZTAL
Journal/Publisher: IEEE
Year: 2013
Summary: This article talks about how AI systems have a detection and classification of the defects in the weld using radiography. The author then talks about how the combination of this AI with industrial radiography will help detect defects by an increasing accuracy of 90 percent. This has potential to be an autoamted inspection procedure. This improve quality control and reduce cost and time.
Key Takeaways:

1. 1) Developing AI has algorithms that can show the defects in welds through industrial radiography.

2. 2) This AI system achieved 90 percent accuracy rate

3. 3) The weld defect detection can improve quality and reduce cost.

CRAAP: This article is from 2013 talking about how artificial intelligence can help detect defection in welds. The relevancy for the project is that we need to find a way to use advanced technology to find the real time data of this exact problem. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to propose AI methods in combination with industrial radiography can detect weld defects to improve quality.
In Text Citation: [**IEEE2013**]

2.3.16 Title of Article: Parameterized Study of High-Frequency Welding System

Student Name Rafael Guerrero
Author(s): Ilona Iatcheva, Rumena Stancheva, Nikolina Petkova
Journal/Publisher: IEEE
Year: 2018
Summary: This article talks about how high frequency welding systems is used in making steel pipes. The welding parametes are frequency, voltage, and current to have the best quality. The optimization of the high frequency welding process leads to improving quality and efficiency.
Key Takeaways:

1. 1) The frequency and current are the key parameters that affect the quality of steel piped welding.

2. 2) The weld speed in high frequency welding can be by increasing welding frequency improves the welding speed.

3. 3) Improvements in welding quality and efficiency on steel pipes can be by optimizing the high frequency welding.

CRAAP: This article is from 2018 talking about how high frequency welding can be affected by certain parameters. The relevancy for the project is that we need to find real time data of these exact parameters so looking deeper in this can be helpful. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to show how parameter studying can improve welding quality and efficiency through optimizing of welding.

Figure 2.1: Observation 1

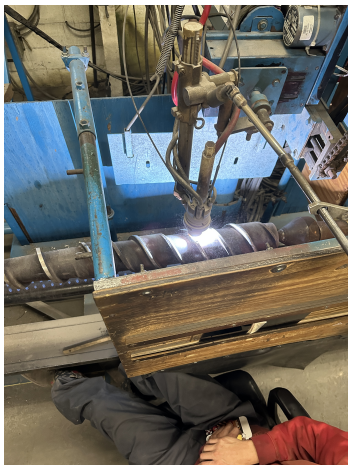


Figure 2.2: This is a view of the automated welder working

Figure 2.3: This is the VR Welding Station

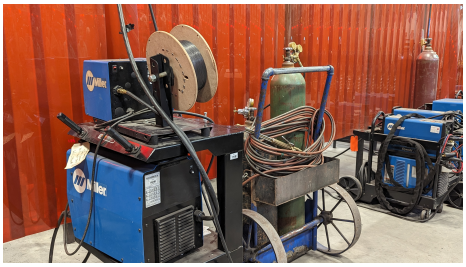


Figure 2.4: This is the plasma cutter next to a Tig and Mig Welder

Figure 2.5: These are the stations for Mig and Stick and where the students work

Chapter 3

Brainstorming

3.1 Three Best Ideas

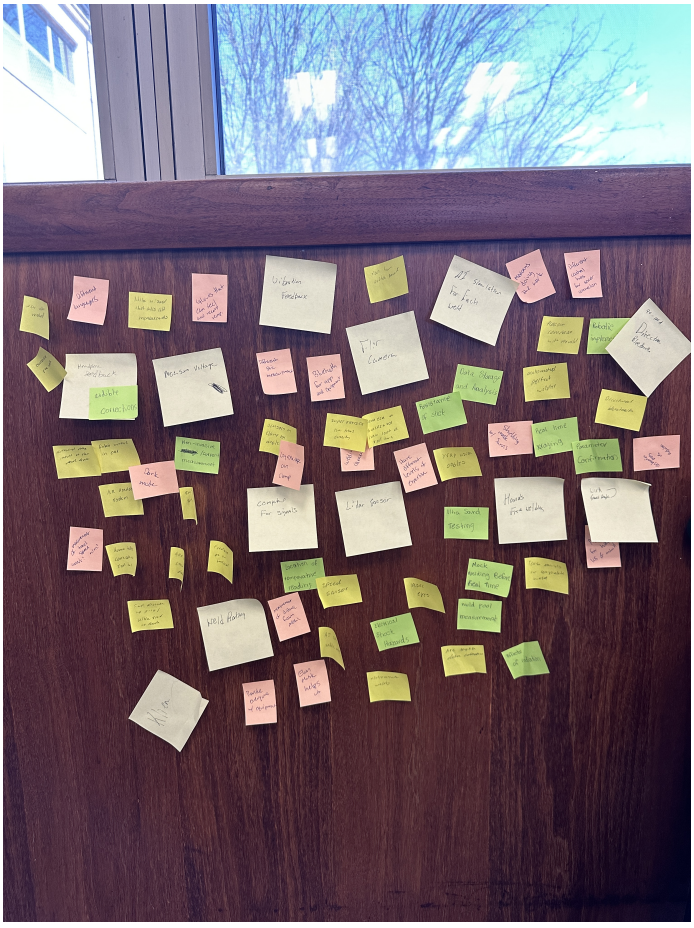


Figure 3.1: Post it ideas

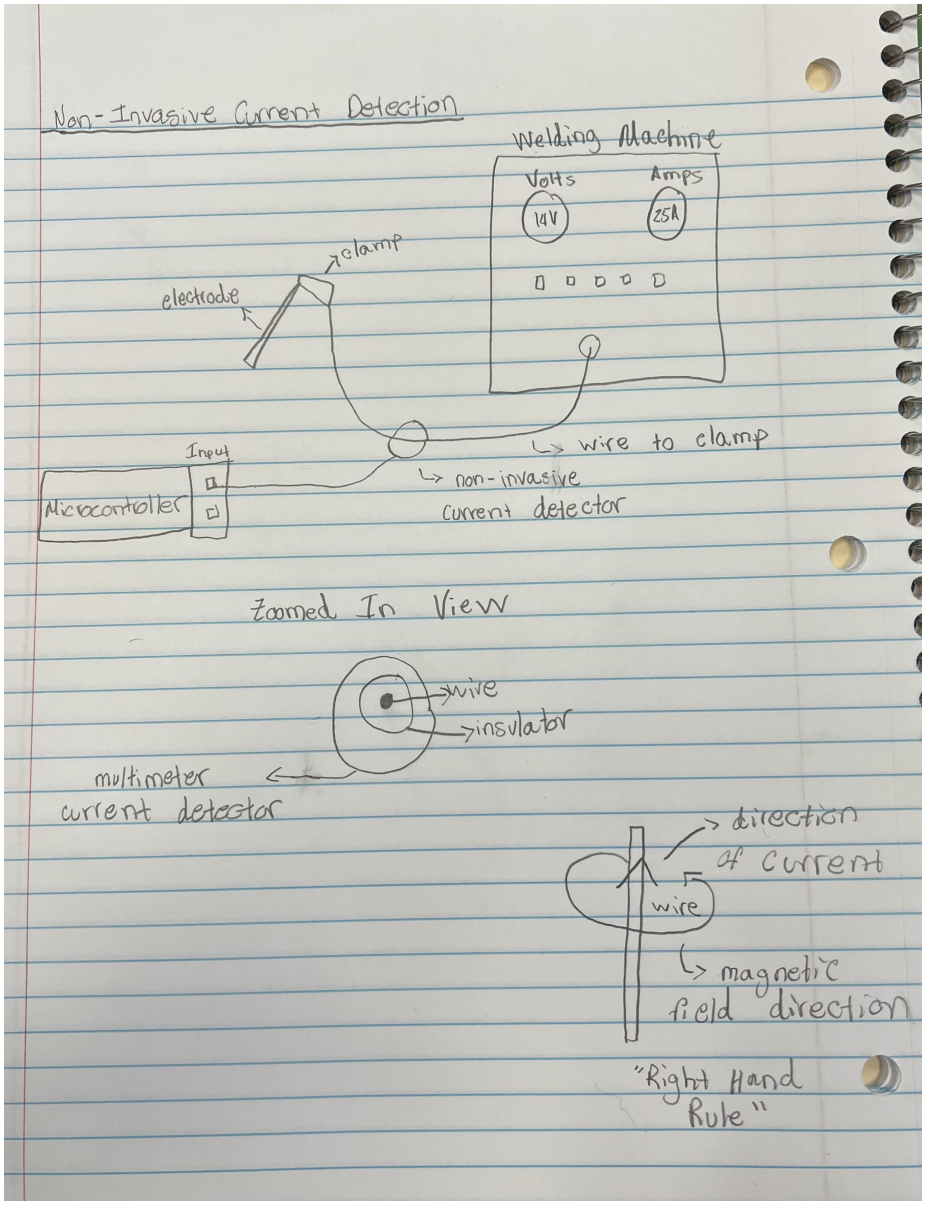


Figure 3.2: This photo shows how we will implement current detection on existing welding machines. Using the direction of the current, we can determine the direction of the magnetic field. Then we can place a multi-meter sensor over the wire to determine the current. This allows our design to be implemented on existing machines without alterations.

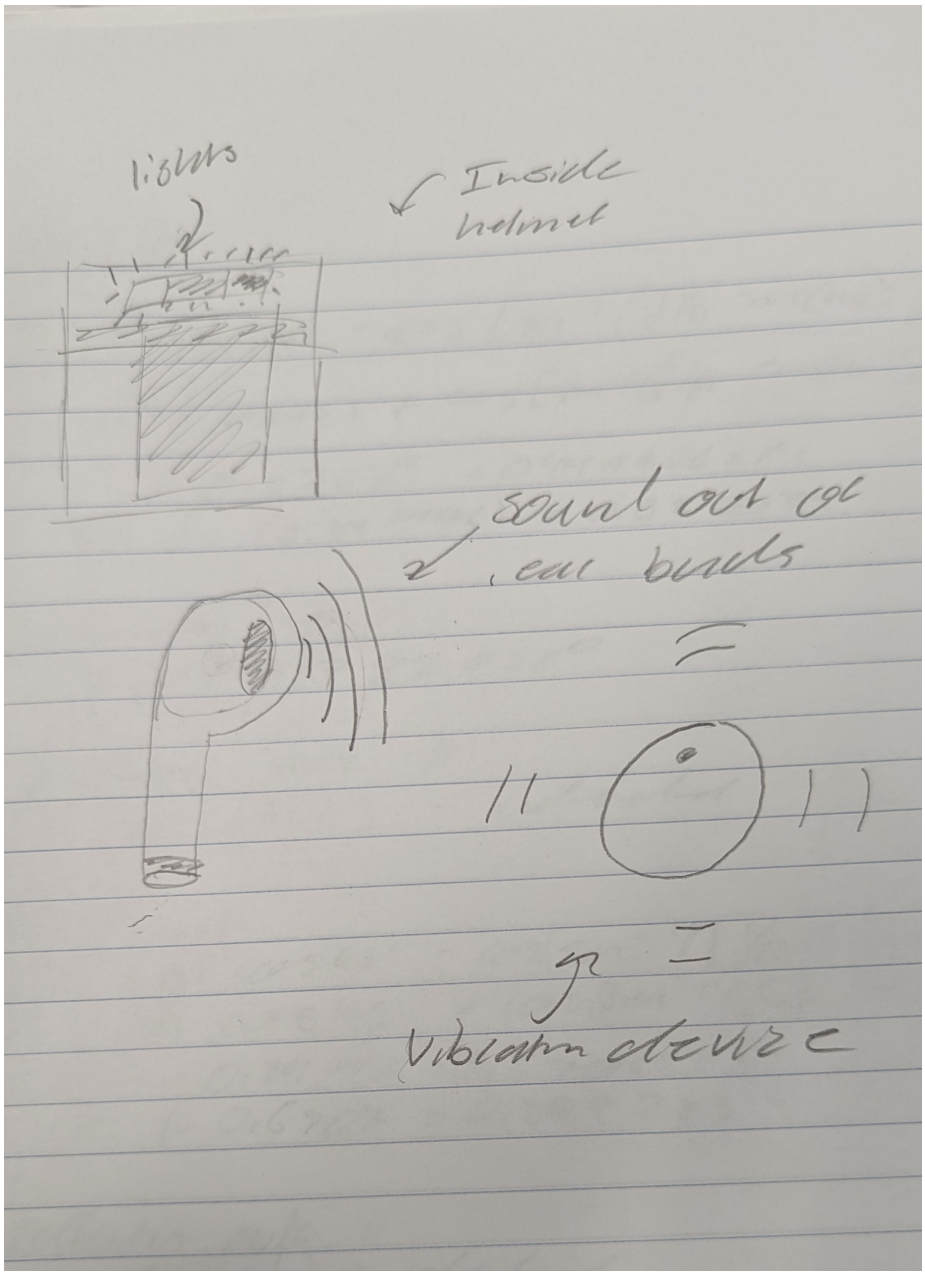


Figure 3.3: This image shows different ways to implement a way to give a feedback response to the welder while they are welding without them being too distracted from welding. This can be seen with the top left image of us putting in different light to determine different meaning such as red being to stop, or green to go faster. The other image in the middle is an earbud which is to represent the option of sound to give the feedback. With the different tones or spatial sounds such a left ear sound meaning something different than the right ear. The last part at the bottom is a vibration device which could be on like the Welder's leg which would have different speeds to portray different information.

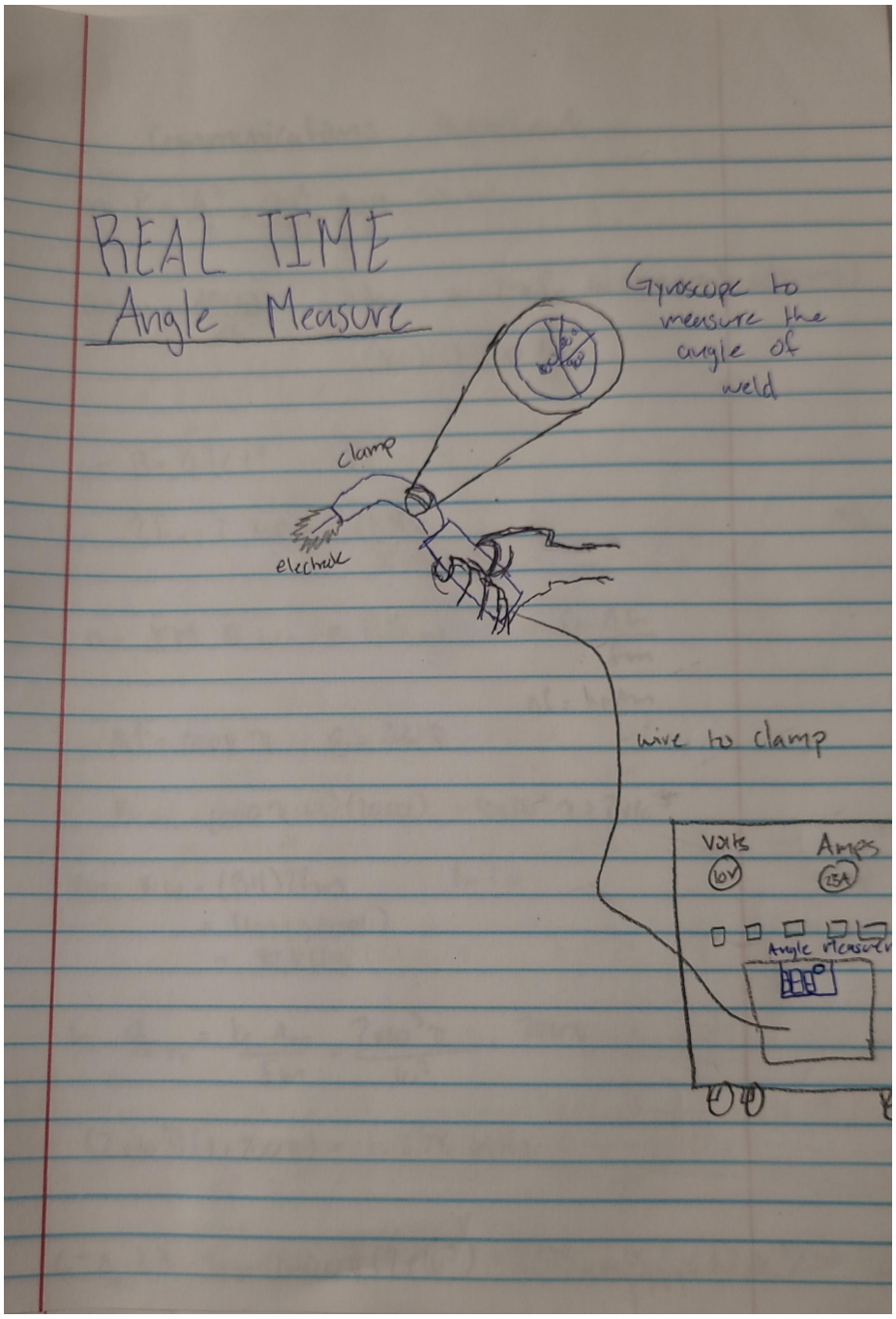


Figure 3.4: This photo demonstrates the implementation of a gyroscope on existing welding machines old clamp versions. These new clamps will be able to display the angle of the weld being done on a monitor in the front of the machine. The only component required for this is some sort of microchip that can read the data and transform it into a visible measurement.

Chapter 4

Proposed Solution

4.1 Constraints and Criteria

1. Constraint 1: Easy to use for anyone
2. Constraint 2: Can be used on any type of welding machine
3. Constraint 3: Not invasive to the Welder
4. Constraint 4: Quickly accessible
5. Criteria 1 : Must provide accurate data to user
6. Criteria 2 : Must enhance welders skill faster than normal

4.2 Decision Matrix

4.3 Solution Description

Our solution includes a measuring device that detects the magnetic field strength. This would allow us to detect voltage and current on any type of welding machine regardless of manufacturer. Since this type of detection is noninvasive it can be easy to use for anyone. This solution does not affect the welder since there are no extra steps that would make the process complex. Using magnetic field strength to detect current is widely used in industry and provides accurate results within a certain range. Welders' skills will improve since the real-time data provided can allow them to make adjustments and correct errors as they happen. All of the examples and descriptions provided allowed us to decide that this would be the best solution. Based upon our results from the decision matrix, this solution ranked the highest compared to our hard-wired solution and creating a whole new wiring harness.

Solutions	Easy to use for anyone	Can be used on any type of welding machine	Not invasive to the Welder	Quickly accessible	Must provide accurate data to user	Must enhance welders skill faster than normal	Total
Hard wire Voltage and Current Detection	3	3	4	2	Y	Y	12
Magnetic Field Measurement	5	5	5	4	Y	Y	19
Create a whole new harness	1	4	4	4	Y	Y	13

Key: Constraints ranked 1-5
Criteria N=no, Y=yes

Figure 4.1: We looked at different methods to measure the current and voltage off the welder

4.4 Subsystem 1

4.5 Subsystem 2

4.6 Subsystem 3

4.7 Subsystem 4

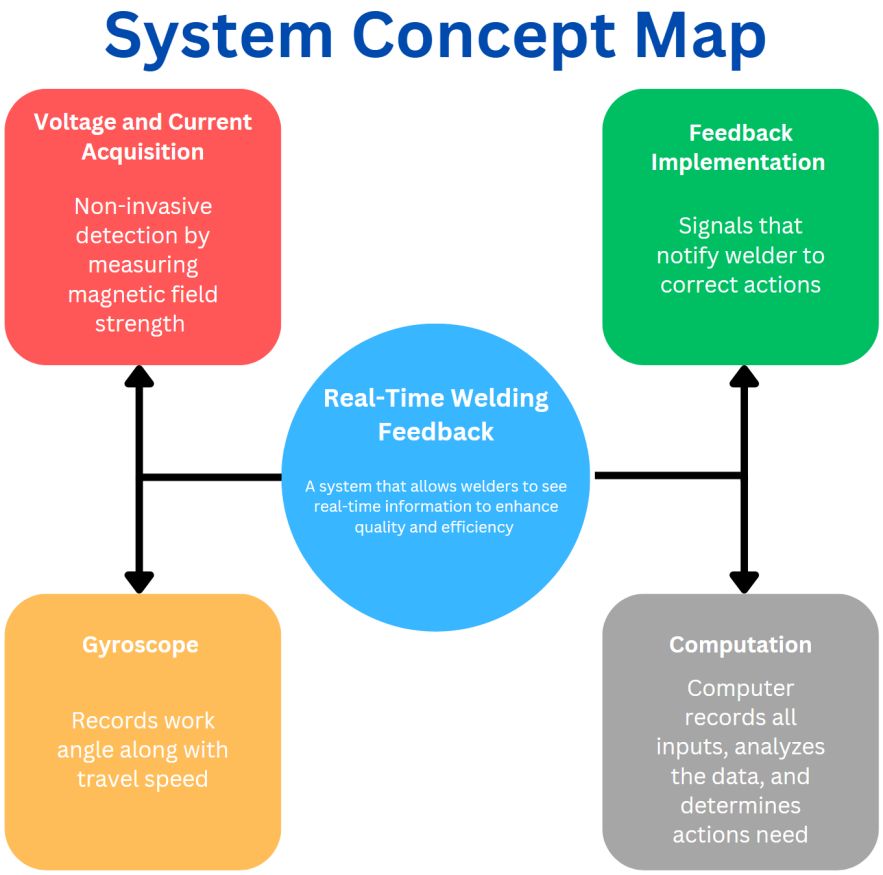


Figure 4.2: Real-Time Welding System Diagram

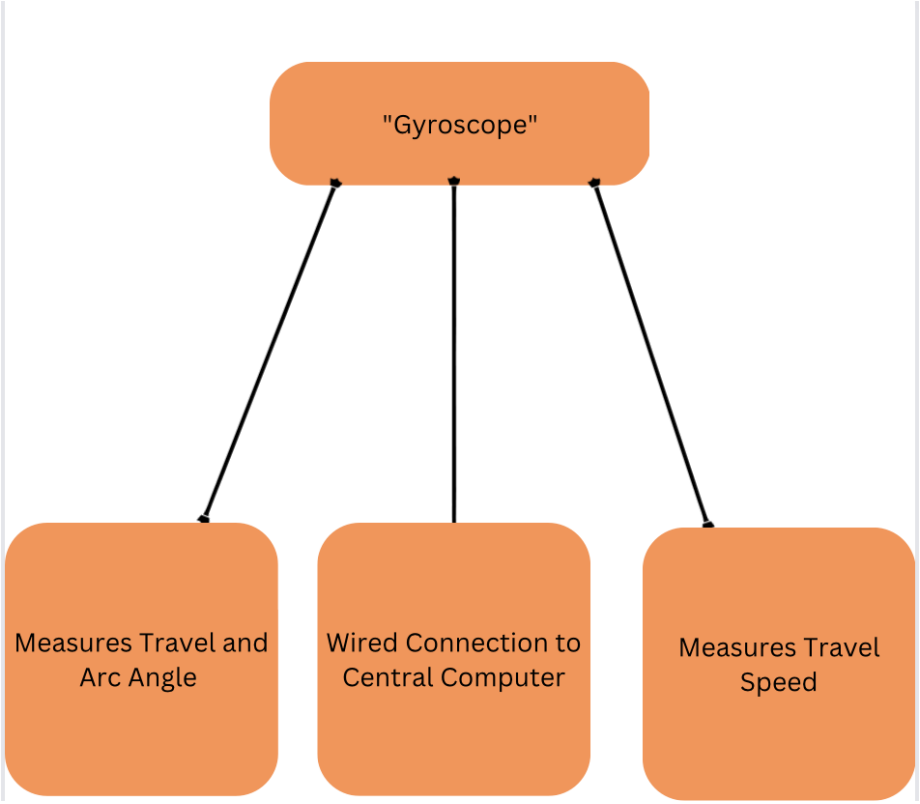


Figure 4.3: Gyroscope Subsystem Diagram

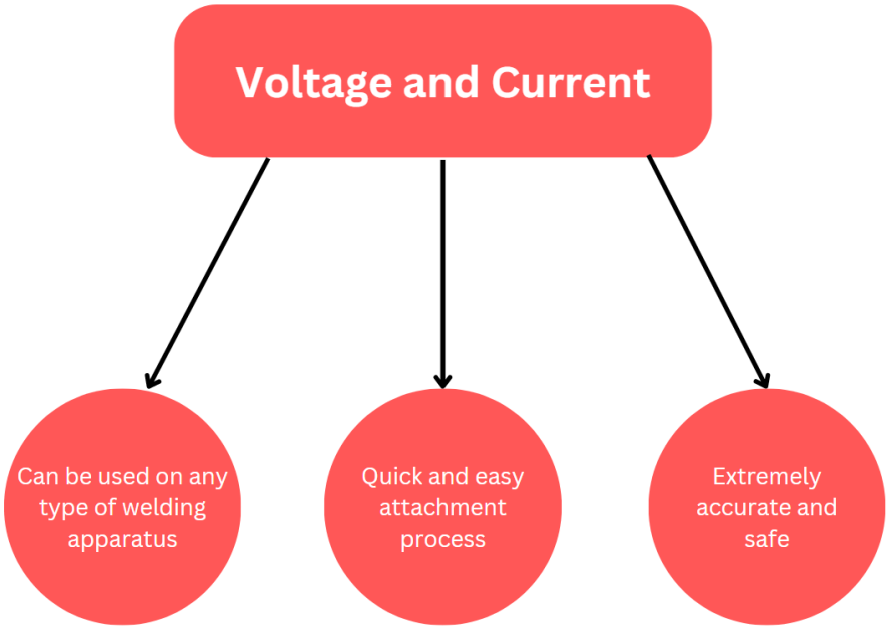


Figure 4.4: Voltage and Current Subsystem Diagram

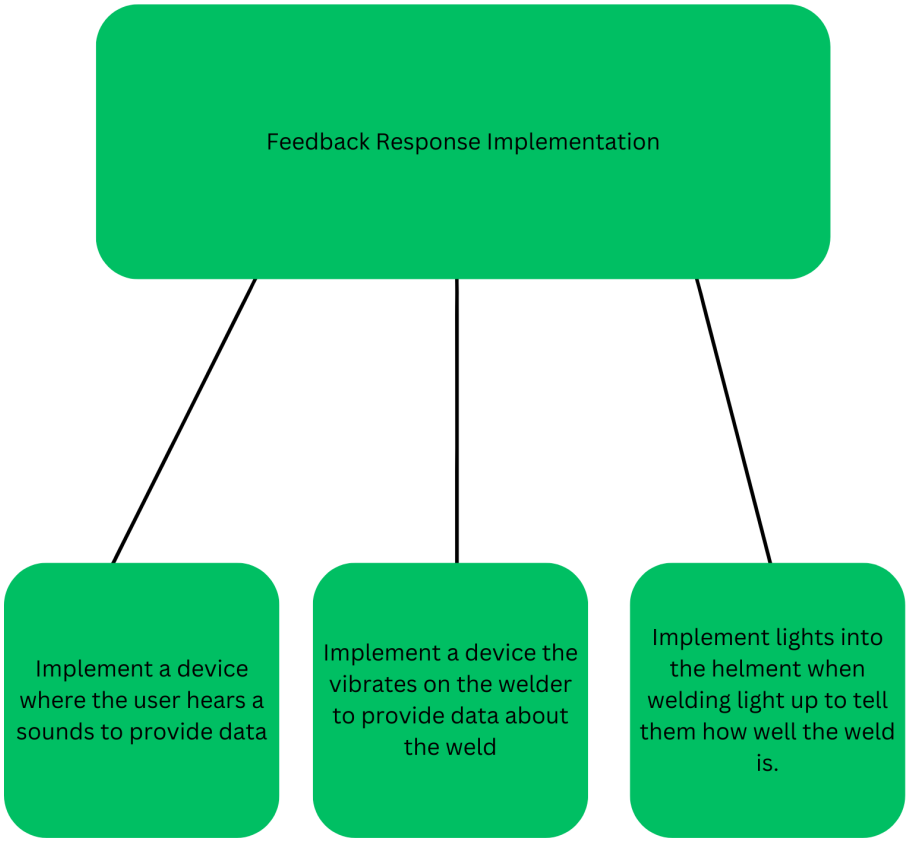


Figure 4.5: Feedback Implementation

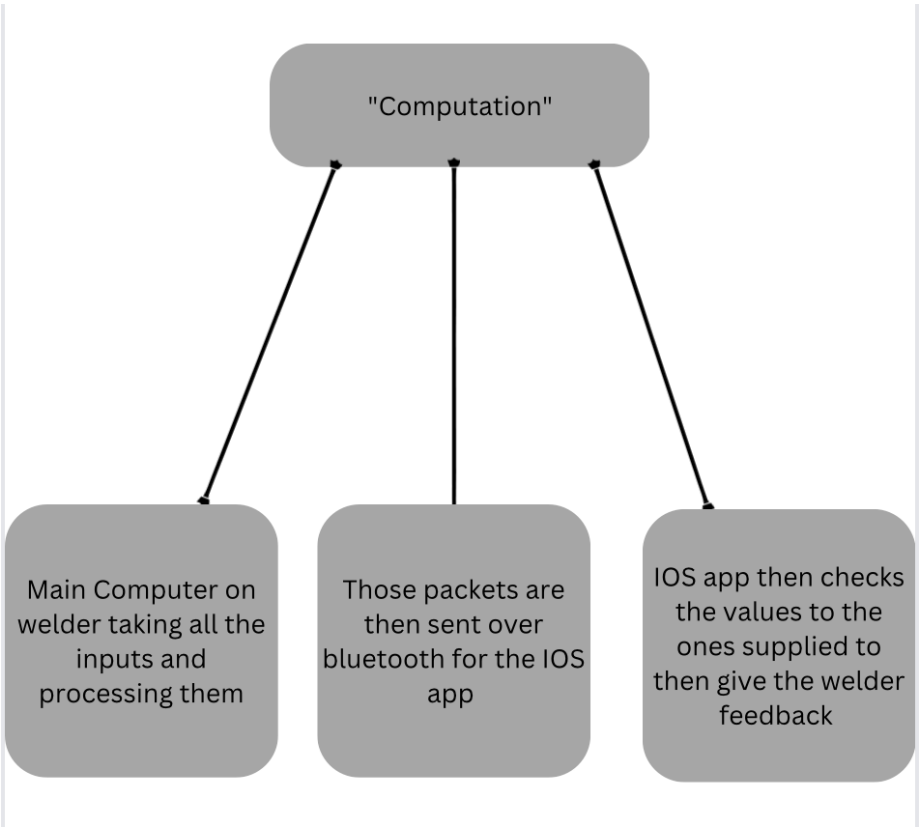


Figure 4.6: Computation for signal processing

Chapter 5

Project Management

5.1 Personnel

Sean Meals has expertise in power systems, specifically in protection and controls. He has previous experience in high-voltage system upgrades to substations and has created associated one-line diagrams, cable schedules, conduit plans, and schematics. He will be in charge of obtaining the voltage and current data for this project. This entails identifying the correct sensors and implementing these sensors into existing welding equipment in a non-invasive manner. His background in power systems will help him champion this section of the project since it relates to obtaining precise voltage and current measurements throughout a high-voltage system.

Rafael Guerrero has an expertise in control systems and mathematics. He has previous experiences in proving mathematical theories and calculating different values through different axis. The precision of the gyroscope to define the perfect angle to weld has to be calculated and proved. These calculations would be vital since the angle of a weld is one of the most important variables that factor into welding. This means that I will be championing the tasks of the gyroscope and answer the questions of what sensor has to be used in order to have the most accurate data.

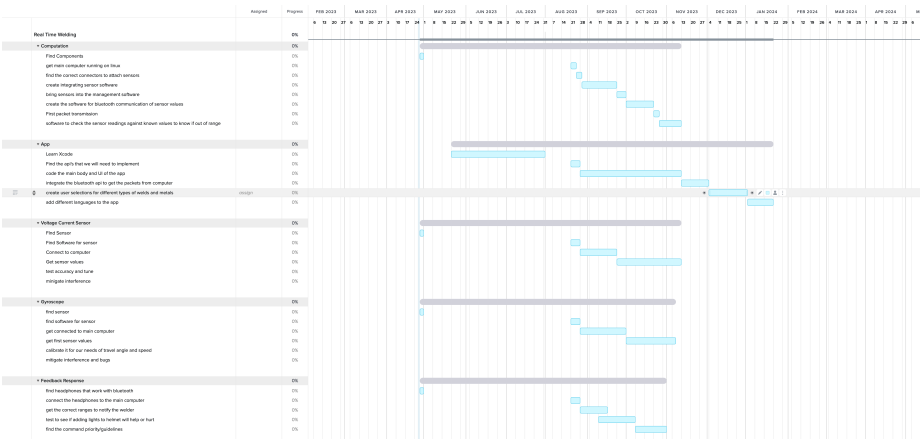
Timothy Hoo with expertise in both control systems and coding with micro controllers. Some of my previous experiences contain participating and winning sumo bot, this entailed me working with an Arduino and coding what the bot needs to do to win. These skills will be useful when using micro controllers to sample data and calculate the information for the welding feedback. Furthermore, I have done research with Professor Juretus where I am coding for cybersecurity. This base line knowledge of coding will help us code the app's fundamentals and the basics processes and how to run properly. I will championing the tasks of the feedback response and how the some of the peripherals of the micro controller talks back to the app.

Alex Rhodes is the team captain of this group. He has an expertise in

programming and system interfaces. Has has had a lot of experience in signal processing and computer architecture. He has also worked in many different languages allowing him to adapt and learn new languages faster. These skills will be useful for the computation and the app development. With that being said he can also work on some of the physical aspects of the design. He has previously worked on the Formula SAE team designing the pedals for the car. This will allow him to build the brackets to attach sensors and build the enclosure for the computer.

5.2 Gantt Chart

Links:
Trello Board



Gantt Charts are typically too large and cumbersome to include as an image in reports. I recommend including a landscape screenshot of your gantt chart **and** entering a list of tasks with due dates.

- Item 1: Find Components (Apr 27-Apr 27)
- Item 2: Find Sensor(Apr 27-Apr 28
- Item 3: Find Software for sensor(Aug 21-Aug 25)
- Item 4: Connect to computer(Aug 28-Sep 22)
- Item 5: Get sensor values(Sep 25-Nov 10)
- Item 6: Get main computer running on Linux (Aug 21-Aug 23)
- Item 7: Find the correct connectors to attach sensors(Aug 24-Aug 28)

- Item 8: Create integrating sensor software(Aug 29-Sep 22)
- Item 9: Bring sensors into the management software(Sep 25-Sep 29)
- Item 10: Create the software for Bluetooth communication of sensor values(Oct 2-Oct 20)
- Item 11: First packet transmission(Oct 23-Oct 25)
- Item 12: Software to check the sensor readings against known values to know if out of range(Oct 26-Nov 10)
- Item 13:Learn Xcode(May 22-Jul 31)
- Item 14: Find the api's that we will need to implement(Aug 21-Aug 25)
- Item 15: Code the main body and UI of the app(Aug 28-Nov 10)
- Item 16:Integrate the bluetooth api to get the packets from computer(Nov 13-Dec 1)
- Item 17: Create user selections for different types of welds and metals (Dec 4 - Jan 1)
- Item 18: Add different languages to the app (Jan 2 - Jan 19)
- Item 19: Find sensor (Apr 27 - Apr 28)
- Item 20: Find software and sensor (Aug 21 - Aug 25)
- Item 21: Get connected to main computer (Aug 28 - Sep 29)
- Item 22: Get first sensor values (Oct 2 - Nov 7)
- Item 23: Calibrate it for our needs to travel angle and travel (Nov 8 - Dec 8)
- Item 24: Mitigate interference and bugs (Dec 11 - Jan 12)
- Item 25: Mitigate interference (Dec 11 - Jan 19)
- Item 26: Find headphones that work with Bluetooth (Apr 27 - Apr 28)
- Item 27: Connect the headphones to the main computer (Aug 21 - Aug 25)
- Item 28: Get the correct ranges to notify the welder (Aug 28 - Sept 15)
- Item 29: Test to see if adding lights to helmet will help or hurt (Sept 11 - Oct 6)
- Item 30: Find the command priority/guidelines (Oct 9 - Oct 31)
- Item 31: Test Accuracy and Tune (Nov 13 - Dec 8)

5.3 Materials and Tools

5.3.1 Materials

1. Steel: For testing of the sensors and calibrating
2. Flux sticks: needed for stick welding
3. Screws: Needed to assemble the systems
4. Wire: This will be needed to connect all the sensors to the Arduino
5. Wireless earbuds: To give feedback response to the welder on what he should do to improve his weld
6. Arduino Mega: For the input of sensors and management software that packs up the Bluetooth packets for transmission to the iOS app
7. Gyroscope Sensor: This sensor will be attached to the handle of the welding clamp to measure travel motion.
8. Commercial 400A AC/DC Clamp Meter- this will be used to measure the current and voltage going through the lines
9. Welding Jackets and Gloves- will be needed for our protection
10. Auto Tinting welding helmet- will help us be able to start the weld since we are beginners
11. Bluetooth Add-on Card: This will give the Arduino Bluetooth capability for transfer to ios app

5.3.2 Tools

1. Unity Student Plan: This is used to help create the app on a windows device and not purchase a macbook to help
2. Xcode: The code to used to program the app for the background to complete the calculations
3. git repository - needed to be able to collaborate on the code
4. Apple Developer Account- this will be needed to create our app and test it
5. Welder: to practice and see how we how to model our project off of

5.3.3 Budget

Item	**Manufacturer**	**Cost per Unit**	**Num. Units**	**Total Cost**
Steel	Joe	0	-	-
Flux Sticks	On Campus and Joe	0	-	-
Screws	On Campus	0	-	-
Wire	On Campus	0	-	-
Wireless Earbuds	JBL-California, US	29.99	1	29.99
Arduino Mega	Arduino-Italy	48.20	1	48.20
Gyroscope	Adafruit-New York, NY	17.95	1	17.95
Clamp Meter	Aicevoos-Wuhan, China	39.99	1	39.99
Welding Jacket and Gloves	Joe	0	-	-
Auto Tinting Helmet	Joe	0	-	-
Unity	Unity-California, US	0	-	-
Xcode	Apple-California, US	0	-	-
Apple Development Account	Apple- California, US	0	-	-
Welder	On Campus	0	-	-
Bluetooth Add-on Card	DSD Tech-Wisconsin, US	9.99	1	9.99
Final Total				$ 146.12

Links:
JBL Wireless Headphones
Unity Student Software
Arduino board
Gyroscope
Current Clamp
Steel Testing
Welding Jacket
Welding Gloves
Auto Tinting Helmet
Xcode
Apple Student Developer Account

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Appendix A

Appendix

Location: Berks Career and Technology Center

Day and Time:3/17/23

Duration: from 4:30pm-10:00pm

Location
Describe the location you observed. The location we observed was a Berks Career and Technology Center, it was a welding center where they held multiple stations to weld and teach students how to do the different welding. Furthermore, there were also other tools they could practice with such as metal cutters and plasma cutters for the metal they are working on. The people we say at the site were both students learning how to weld and teachers who were guiding them on how to weld. The students there looked to be around our early to mid twenties, while the teachers felt like senior citizen so around the age of 65 and up. The students seeded to be working on a project while the teachers were both supervising them and showing us around the workshop.

Figure A.1: This is the VR Welding Station

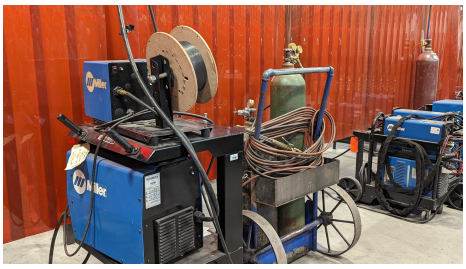

Figure A.2: This is the plasma cutter next to a Tig and Mig Welder

Figure A.3: These are the stations for Mig and Stick and where the students work

Potential Problems

One of the main problems we faced and the teachers described having were not having enough info about what they are welding when they are welding. This can range from the temperature of the metal when welding or the arc length while welding. This will help with the consistency of welding and help improvement faster. Another problem that was described to us was that teachers would also want more information also after the weld is done. Such as how consistent the the student was when welding so they don't have to do an x-ray or ultrasound on the metal to truly see how good the weld was, which would also be good in real world for the same reason. The last problem we saw was there should also be a prep system so that students having something to follow or there should be something to compare to so people know where to improve in comparison to what they wanted to do with the weld.

Experiences

So during the visit to the shop our advisor allowed us to try the three different type of welding. While welding we experienced the problem first hand of both not having the information readily available and not setting a pre-information to help out. This was very transparent when we were doing the stick welding where it was the hardest to complete and needed the most information to help complete as a new person. The reason why

we need the information I realized is because the mask that you wear to block the light and rays from welding really inhibits you from seeing anything so its hard to keep the weld straight and consistent. Some other problems that the teachers told us were they don't have enough feedback information to know whether sometimes the weld is good or not unless they do an x-ray or and ultrasound of the weld which is both costly and timely for them to complete.

Location: Precision Feed screws Inc

Day and Time: March 6, 10 am

Duration: 2 hours

Location
This is my grandpa's machine shop in New Castle, PA my home town. This shop focuses on machining new feed screws for industrial uses and the maintenance of these parts. The maintenance and manufacturing of this part is comprised mostly of welding and re-welding the threads of the screws. This is done by an automated welder that will be shown in the pictures.

Who The two people that I talked to was my grandpa, David Wilson who is the owner and one of his welders, John. My grandpa looks like a old man he used to work in the shop everyday but now he is really just supervising so he has a lot of knowledge on the subject. John on the other hand is one of his newer employees he is a younger guy and his main job is to weld the new threads this is done by him sitting at the machine adjusting its movements and other parameters to get a successful weld.

Potential Problems
The first potential problem that I found during the day was during the welding John was really just making the adjustments based on feel and experience and not really any data. From the temperature of the metals to the amount of current is being put through the welder. This could be a problem because if the welder is not moving in the right location or the current is too high then the weld could be compromise. This did not happen during my time there but I was told about it being one of the biggest issues. The second potential problem that I saw was the arc being put off was so bright that it was hard to make these decisions that are needed to have a good weld. Currently John is just sitting behind a piece of wood that has a little cutout with the film needed to look at the arc. This problem is something that all welders deal with but there has not been really any solutions on the market to view your welding space better to control the arc better. The last problem that I saw during my time in the shop was The lack of standardization in the welding field. Yes there are

big welding companies that create standard welders that work for most situations but for this one in particular it is all custom tooling. This is not really a problem because they have the people on staff that made the equipment but this could cause us problems for our project. From my talking with the welders it is really just a learning curve for them so it is not that big of a issue but for someone wanting to make a new product will have to think about this during the design.

Experiences
I experienced a couple of the problems first hand. I saw John having to change the settings of the welder a lot to keep a good weld. I did not try changing the settings because he was working on a customers feed screw. Th problem that was easy to experience was not having the best view of the arc as it is welding. I looked through the window and all you really see is a glowing spot. It is hard to see the metal and the pooling that occurs during the weld. John said he has gotten used to looking through it but I feel like it can be improved.

Other
This type of welding is not really the main focus of this project since it is a plasma weld and we are looking into stick welding. Other than that a lot of the issues will be the same.

A.1 Interviews

A.2 Interview 1

Student Name: Timothy Hoo

Interviwee Name: Kyle Juretus

Interview Location:His Office

Interview date and time:4/12/2023 1:15pm

Duration of interview:16 min

Write at least 3 planned, open-ended questions to bring to your interview:

(a) What Micro controller would you recommend in this situation and why?

(b) What difficulties do you see arising trying to collect and compute all the data a in a timely manner?

(c) What seems the most feasible to give feedback to the person with the given parameters of a welder and a micro controller?

Notes
After asking some of the questions about what micro controller should be used, he recommended using a blue pill or a small raspberry pi for a micro controller. Furthermore, he said that we should first work on connecting with a Bluetooth modulation and focus on them working together. He then said that the vibration was the most viable for the feedback for people and that adding the more sensors shouldn't be added difficulty. Some of the other follow up questions I asked were what were the time frame he would give him self for the coding part of the project and he recommend as much time as possible but only the focus are the essentials. Furthermore, I think the biggest thing he recommended is to not focus too much on the size too much with the limited time but instead focus on making sure it works and that if it does then describe at the end how to shrink it with a custom pcb if possible.

Location: East Los Angeles, CA

Day and Time: March 30th 3:00 pm

Duration: About an hour or so, but have been there multiple times before

Location
This location was in a car transmission and torque converters shop called Hugo's Transmissions in East LA. The welding is done closer to the back of the inside of the shop where the welding equipment is held. The welding set up is two tables, one on each side of the welding machine, with the clamps curled around to a hook where it can safely be hung and no one touches it even when it is off other than himself. That area is then also has an orange curtain in order to make sure that onlookers from different angles do not look at the bright light directly if they are looking in that direction for him.

My father was the one who was there as he is the only employee of his business and the only one in the shop that knows how to weld. He had the traditional mechanic jumpsuit on, but when he begins to weld, he has to have a leather jacket on that covers his chest, both arms, and neck, along with a mask visor to block the bright light. He also has on a plastic apron with a leather strap in order to protect his lower body. He showed me how he welds the torque converters shut and also how to weld the metals together in order to create a stronger resistant clutch that goes inside the torque converter to help it function better.

Potential Problems
The three potential problems that he had where: 1) There may be an excess use of material that it just ends up turning into unnecessary waste. This is because there are times were the weld does not stay consistent so he has to redo the weld over and over a few times. There was nothing he can do but check it in water to make sure the weld is consistent and there are no cracks or chips in it. 2) Since he does work by himself, he has to check that the weld is complete since an incomplete weld can cause harm to the driver if the torque converter end up malfunctioning. This means he has to spend cautious time on it meaning that if the weld is incomplete he has a waste of time. 3) He needs a better ventilation system since it is mainly fans blowing out the air and a vacuum above in order to pull the air out from that spot to the outside. His reaction to this was that he always has worked in conditions like this or worse when he used to work for someone else. In order to fix this he made sure there was proper ventilation in the shop by also ensuring the fans will be a boost.

Experiences
I did not experience the problems first hand as my father does not let me weld since it can damage my eyes. However, I was provided googles and was able to see the way he was welding shut the torque converters. It was fun to see and understand how welding works in a specific way for these torque converters. For any problem he encountered he was able to fix with a quick thinking solution or by methods he learned. The ventilation system was a quick solution using fans to have better air flow. However, for other problems, he already had those solutions.

Other
He agreed with having an app to help figure out welds before they are over done will be an amazing idea. It will save time and material. Also, the angle for him is set to ensure that there the same welds most of the time so he does not have that angle issue like other welders may have but thinks that is a great issue to try to fix for it does affect welds a lot.

Assignment 6: Observations Sean Meals March 30, 2023

Location: Gladwyne Fire Company

Day and Time: Wednesday, March 15, 2023 (5:00 pm)

Duration: 4 hours

Location
The location I observed was the Gladwyne Fire Company at 1044 Black Rock Road in Gladwyne, Pennsylvania. The firehouse was rather large and had a kitchen, bunkroom, offices, garage bays that were home to the fire trucks, and a workshop. Particularly, I observed the workshop and saw the welding equipment which they use to fix equipment and apparatus.

The people at this location included Fire Officers and firefighters. Most had a mechanical aptitude outside of firefighting and are responsible for maintaining and repairing all equipment. Some were dressed in uniform and others were in plain work clothes depending on who was "working" or on shift. The Fire Officers were in charge of assigning maintenance and repair activities to firefighters while they were on duty. During my visit, I observed and participated in welding a new bracket to store batteries for power tools. In order for the batteries to be safely secured inside the cab of the fire truck, a custom bracket was needed that could be affixed to an existing anchor point.

Potential Problems

One potential problem that I saw during my observation was the difficulty in trying to take photos while someone was actively welding. The arc created during welding is so bright that cameras are unable to focus properly. After bringing this problem up to other firefighters they said it was very normal. A possible solution in place was to take a photo through the viewing point of a welding mask. Figure 3 shows this problem as the image is extremely bright and unclear. A second potential problem that I saw during my observation was not being able to see my voltage and current values while I was welding. By design, they are only displayed on the welding machine itself and cannot be viewed from behind the welding mask. Since this is very common in the welding industry most welders learn to adapt and weld without knowing this information in real-time and many firefighters agreed that they do the same. There are no solutions in place for this problem and an entirely new design would need to be implemented on the welding machine and in welding masks. Figure 4 shows how far away the machine is when welding and how the voltage and current values are not even viewable based on the orientation of the machine. The third potential problem I saw during my observation was the amount of splatter that accumulated on the metal being welded. This splatter occurs normally as a result of welding but is going to provide lots of interference and sensor compatibility issues during our project. The firefighters explained that no real solutions exist for this problem except for grinding the splatter away with power tools after the weld is completed. The splatter can be seen in a test weld done in Figure 5.

Experiences

Yes, I experienced all three of the problems firsthand. The first problem related to the photos was very frustrating at first and made it difficult to document. This is going to pose a significant issue in our project as we were planning to use image recognition to collect data. The second problem with the voltage and current values was something that I was

prepared for and had prior knowledge about so I was expecting that to happen. The third problem with the splatter was something that I had encountered for the first time. I was able to talk with the firefighters about all three of the problems to hear their input and talk about solutions. They all provided me with great explanations of why the problems occur in the first place and what can be done to mitigate them. For example, we talked about how the splatter on the metal can be reduced if it is shielded or if you lower the voltage and current. They did not mention any other problems not immediately visible during my visit. Yes, I was able to observe all the problems and ask follow-up questions about them right after they occurred.

Other
The firehouse has a Dalmatian named Rowdy. The workshop did not have any ventilation systems installed to mitigate welding fumes. The firehouse welding machine is a flux-core machine.

A.3 Interview 2

Student Name:Timothy Hoo

Interviwee Name:Joey LaMorte

Interview Location:Toletine

Interview date and time:3:30

Duration of interview:

Write at least 3 planned, open-ended questions to bring to your interview:

(a) What was the biggest issue when welding?

(b) What do you think would be the most helpful when welding?

(c) Where would you want the device to be the least inconvenient for you?

Notes
The items in the setup took the longest, the right voltage was very important and how long to hold the welder to know how long. I simulation would have been helpful. vibration, sound, sight is said how he ranked what be useful to him. He thinks that the device we are making would help him improve quickly and would definitely give it a try if he could. It was also insightful what the biggest fears of new welders are which were

getting electrocuted from the mig gun and was interesting of the precautions of watching YouTube video being his guide. This gives me insight to look at the Youtube to try and get data to tell people who are new welding what they are getting into and what the information we are giving and what they mean on how to get better at welding.

Extra Key Notes
Learning from someone who has only welded the first time gave a good perspective of people who we are mainly catering this device to and how to help these people the most. This also helps give a good idea to what features we should have toggleable for more of experts and how we might want to give them different options of how they get the feedback response.

Transcript
Using https://otter.ai/, include a transcript of your interview below. BE SURE to get permission from your interviewee for recording them PRIOR to starting the interview and recording. Include a link to the otter recording. Your interviews should be **at least** 15 minutes. https://otter.ai/u/7g7swnEkazRH9jdClgjpLUMRDP
Speaker 1 0:01 Okay, my name is Timothy who I'm with Joseph Lamorte,

Unknown Speaker 0:06 aka Joey.

Speaker 1 0:07 And he is a first a beginner welder, and he hasn't been welding much but he is one of people that you will probably want to design a product for because you want fast improvement on people who aren't very good at welding. So some quick since you've already welded a few times, I will prepare some questions. So when you were welding, what was like the biggest issue that you had when you think like, what, what do you think inhibited your ability to weld the most?

Speaker 2 0:45 Well, since I've only welded the ones I it took me a while to make sure I was doing everything right so like the setup was probably the hardest part for me. Yeah,

Speaker 1 0:57 so what about the setup like what items in the setup took the longest? Like?

Speaker 2 1:09 Well, it wasn't like me particularly attached to this to this. That took very long it was mostly like, what did I have? I had like an emoji of Italian big guns. She

Unknown Speaker 1:21 had a MIG so you're doing MIG welding?

Speaker 2 1:22 Yes. Yeah. So I just wanted to make sure like I wasn't gonna electrocute myself. It was like watching YouTube videos making sure that like my setup matched their setup.

Speaker 1 1:34 So like so you had Hamid on like what would have been like the most helpful like when welding like but you know that while you were welding like what what would you like to have known like, whether it was fun like, like knowing how many volts were getting pumped in and

stuff like that? Yeah, we've been like the most important do you think? Like how close you were like, things like that? Would you think?

Speaker 2 2:01 Honestly, yes, the like right voltage is something that I was worried about. I guess also like, like how long to hold the gun in one place before moving it like make sure that you're actually like, because I guess is something that like I was worried about, I was welding a very like, small rod to something and it wasn't sure. The extent like how firmly it had to be honestly I didn't know when to stop I guess I guess

Speaker 1 2:29 that sounds like to have like had something like a simulation beforehand to tell you like to show you something and then you will have to follow that.

Unknown Speaker 2:36 Yes. I do think that would be useful.

Speaker 1 2:44 Like, okay, so you've done welding before, right? Thanks one time. So, you know, I tell you focus on it like really hard, right? Like, what do you think would be like, it's something that would be useful, like, do you think a heads up display the most useful or like,

Unknown Speaker 2:59 What do you mean a heads up display?

Speaker 1 3:00 So like, if like we did like an AOA type thing like it would like put something in the mask would show you Oh, the voltage and something or do you think like, would you rather have something like we didn't know that but instead, like it would like do the calculations for you and be like, Oh, God, like a sound to tell you like to move fast or slow and give you like when you think would be more helpful

Speaker 2 3:18 in that second thing sounds more useful to me possibly just because I don't know if there if there was like a screen and my visor actually going to like the brightest.

Speaker 1 3:36 So why don't you describe a little more about your welding project and like, Okay, how you experience was,

Speaker 2 3:42 okay, so pretty much I, me and my brothers have made a forge in my backyard, because we had watched the show forged in fire like this is cool. Let's make one and then we didn't have any metal to forge, but we live live next to train tracks, and they always have like, extra like railroad spikes like hanging around. So we got a few and then in order to stick it in our Forge, what we did is we took a piece of rebar and welded the railroad spike to the end of the rebar. In this way we can use the rebar to like pull it, put it into the forge and then take it out without burning ourselves. So that was the extent of the project

Speaker 1 4:22 to how like, does it look like how did you learn? Do you just watch YouTube videos and you bought the thing and then

Speaker 2 4:28 so we aren't my dad already had the welder and yeah, we well first asked him a few questions. And then since you guys such as How does it How does reweld like very, they add that he like he kind of started

to set it up for us but then we still like I was like I'm gonna electrocute myself. So I just watched like a couple of example videos on like people welding some things and like you there are videos specifically for beginners like okay, this is like the type of metal moldings like this. What I want to do with in terms of like, like the voltage setting and things like that. Okay. Is that not the answer? Yeah, that was fine.

Speaker 1 5:09 But like, so like, so like, how long did this project like take and then like?

Speaker 2 5:17 It did not take that I would say from intent to start to finish an hour 15 minutes now in 15 minutes. Yeah, well, two Well the one railroad spike onto one piece of rebar so probably too long for the

Speaker 1 5:35 so do you think you you think you have a good you think you have a good grasp of welding or do you think you'd like to have a long way to improve?

Speaker 2 5:43 Oh, I think if I were to weld again, it would probably the setup would probably take me just as long as did the first time I did it because it was an isolated experience and only like I was yeah, it was cool. Yeah.

Speaker 1 5:57 Okay, so you would you would definitely this is an experiment that you would want to do again,

Speaker 2 6:02 yeah, I would like to, like, eventually be good at welding to the point where like, if I had to do like a home improvement, something rather I could be capable of doing.

Speaker 1 6:11 Do you think like, like, if you had something like, when you think where would you think a device like, is like would not inhibit you the most berbeda would not inhibit me? Yeah. Like what would you like, if you like, let's say it was on your handout and was a bulky thing on your hand. Right. And you had to use it it?

Speaker 2 6:30 Yeah, it's a huge describe what you're suggesting again? Okay, so

Speaker 1 6:33 the idea of five per se is the senior design project is to like give it like a small microcontroller, right? That will send you feedback response based off either like a simulation or something saying like, Oh, you might be going too fast to you're not close enough to the thing. And so it will help to try to improve you faster. Like to improve your welding skills, basically.

Speaker 2 6:58 Yes. That's cool. Okay, I mean, I know like in the safety videos that I watched it like always keep two hands on the MIG gun. So I think the G and MiG actually stands for gun some saying big gun is repetitive.

Unknown Speaker 7:13 guy got into its legal game game.

Speaker 2 7:20 So I like probably something in the palm of the hand would interfere. I don't know how large this thing

Speaker 1 7:26 would be. Yeah, that's what we're trying to figure out is like what's your wrist thing would be cool. I go Yeah, but like, it's like thinking AI is like something that you maybe either have something in your ear, right? Oh, yeah. And like, because the biggest thing is like you when you are welding like I was hopefully when you did it, you're super focused. Like what you would get a heads up display would be a good distraction that you'd be looking at. Yeah, and that sounds like a flashing light. And then you'd realize, oh, that means stop. Green means go fast or slow down something like that. Just no possibility. Just make it a year.

Speaker 2 8:06 I don't know it'd be too much just like a single light. Whereas I think if it was like trying to show me like gauges and stuff on the visor, I'd be like, What is going on?

Speaker 1 8:13 Yeah, because that's our main thing is trying to prove someone who's not really good, right? Yeah. such as yourself. And like one off faster than usual they can so they can go get experience of like, oh, this is what shouldn't feel like if I did it like because yeah, when you did it I could you tell like when you were like messing up or not? Oh, yeah, yeah. Did you have to do multiple times? Yeah, I

Speaker 2 8:40 definitely have put the overwhelming down like step away like what just happened? And just like we get my bearings, so yeah,

Speaker 1 8:48 but once you did it when did you feel like oh yeah, this is the right way. Well,

Speaker 2 8:52 yes, we started the fencing but at the end of it like you could, you could feel like this is this is not making horrible sounds. Okay, yeah. Okay. Yeah. So definitely getting over the hurdle of like, beginning is the hardest thing.

Unknown Speaker 9:10 So do you think a device like this will make you improve fast?

Speaker 2 9:12 Oh, yeah. It really does help. Honestly, like the more you talked about, the more I'm like, wow, I wish

Speaker 1 9:19 Okay. Okay. But do you do you think like, what do you think for you in your opinion, I, even as a beginner do you think would be like, do you think sound vibration lights would be like the easiest way to communicate to a person

Speaker 2 9:38 say bracing was what had been my first thought measure that's my best thought but for some reason leaned towards vibration going to

Unknown Speaker 9:44 vibration.

Unknown Speaker 9:46 I would probably wait him vibration sounds

Unknown Speaker 9:51 okay, so

Speaker 1 10:00 So, let's say you did so like, if you did like future projects, so would you be would you be willing to test me maybe if like, Yeah, especially if we're doing something cool like fortune five? Yeah. Let's think. Yeah, so I guess I asked. Yeah, we would, so you didn't look like so. Do you think like a device on the hand would inhibit you or do you think like, it would have to be somewhere else?

Speaker 2 10:38 I don't I don't I don't think your hand would necessarily be prohibited. My question for you is how does this device like know if you're welding minor, right? Like does it have to have a camera

Speaker 1 10:51 attached to the gyroscope plate like the angle and stuff that you have your gun at? Laser Distance it and then beforehand, so

Speaker 2 10:59 would it be attached to the gun? That's that's under designing a welder

Speaker 1 11:04 that we're not designing the world that way. It shouldn't be something attached to the world. Oh, that's cool. That's cool. That's coming to you. Because I was because you didn't make it's pretty easy to do. Something's fit is it's the biggest problem we're having right now is stick welding. Yeah. Oh, that looks sketchy. It's very sketchy. It's very

Unknown Speaker 11:25 hard because you just have like a clamp and

Speaker 1 11:27 you don't happen to stick and so does that but the biggest thing it's not it's not very consistent. Because because there's a lot of factors that we have to come into. Such as a key in like, speed doing it and it's beyond me. really figuring out right now. But so do you think that you will try different other types of welding as well?

Speaker 2 11:57 Yeah, why not? Like if I had the possibility to not only do I know are like using the MIG or a stick welding is there is there another force TIG take?

Speaker 1 12:10 It sounds like maybe stick to three buildings. Yeah, because right now as it is a you'd have to go check a school and stuff because hopefully this will work because the only thing we want to do is like after you're done well, you know, you can see like with the differences between your wealth and like, the ideal. Yes. So like, what improvements you could have made?

Unknown Speaker 12:31 Oh, that's good. So it's not only for beginners. It's also like to help you improve.

Speaker 1 12:35 Well, it's fun beginners to help them move into like all levels. So we're also thinking like, okay, maybe I have a For beginners I can like, also turn off like what information you want as feedback, right? Because, oh, maybe you don't want the vault. That's another thing. You don't want to overload somebody with too much information. I always keep that in mind. So did you also well,

Speaker 2 13:06 um, so that I was working with my younger brother. So he was kind of just taking charge. He was watching me like set up at least

when he left when I was actually welding. And then but my one of my older brothers, he, like just recently started to get really into welding and he came back from deployment because I guess when they're deployed, they don't have very much to do, but they had a welder. So he was teaching himself. And so when he came back, he was throwing a whole bunch of words at me and I was like, I don't know if

Unknown Speaker 13:39 you have any accidents in welding.

Speaker 2 13:42 And now, thank God, I'm sure he did. You didn't tell me about it. I'm sure people probably do

Speaker 1 13:48 an education yourself. Nothing bad. terrible happened. No.

Speaker 1 13:59 So what is the fire the welding a?

Unknown Speaker 14:09 Is there a way to make the welding like it? Yeah.

Speaker 1 14:14 Quality of life do you think would improve the welding? Like what do you think? Had the most you hadn't responded with?

Speaker 2 14:28 I mean, I think also like my finished product wasn't very clean. Yeah. And so I think your device will also help with like, making it look nice and professional. Fashion.

Speaker 1 14:41 DCSF this is just a fun hobby to do.

Speaker 2 14:44 I mean, for now, I only patient myself using it as like, when I need it. Whereas in the future, you know, when I'm like a dad and I have a house, I would like to know so that like if something does break or I want to improve something I could do it.

Unknown Speaker 15:00 Okay, okay. Welding in

Transcribed by https://otter.ai

A.4 Literature Review

A.4.1 Search Terms

Complete this table as a team

Search Word 1	**Search Word 2**	**Search Word 3**	**Number of Returns**
Welding	Feedback	Response	17 Results

Real-time	Welding	System	472 Results
Augmented	Reality	Welding	31 Results
Bluetooth	Data	Transmission	980 Results
Voltage	Measure	Temperature	6506 Results
LiDAR	3D	Model	1306 Results
Welding	Data	Collection	33 Results
Laser	Distance	Measure	2119 Results
Heat	Sensor	Bluetooth	49 Results
Current	Measure	Welding	225 Results
Welding	Defects	Automation	133 Results
Weld	Quality	Testing	468 Results

A.5 Reference Information

For each article, include the following information. Make sure you include your name in bold, so we can ensure each team member obtained 4 articles.

A.5.1 Title of Article: Weld quality assessment based on arc sensing for robotic welding

Student Name Timothy Hoo
Author(s): Tomasz Marek Lubecki; Fengjun Bai
Journal/Publisher: IEEE
Year: 2015
Summary: In this article the authors experimented with machines on how develop robots to take in real time data while welding mainly TIG and MIG to determine whether the weld is good and hold or have issues. They trials with around 4000 bots and measured mainly the current change and voltage change to determine what should they expect from good and bad welds and why they happen. Next they put threshold values to check when the bot would go above or below these values and determine where the bot made a poor weld and can pinpoint where to check and not make robots more consistent when welding with the new data.
Key Takeaways:

(a) Shows the possibility that data such as voltage change and current change can determine a good and bad weld

(b) Demonstrates that since the information can be transmitted to a robot we can possibly to it to a human

(c) Tells us what steps to take to see how good our product could be in comparison

CRAAP: The article is relatively current only coming out in 2015 and using modern technology to determining their results. It's relevant to what we are working on because we are also trying to get feedback data from welding such as them so its a good starting point for us. The authority comes from that it was published in IEEE International Conference on Advanced Intelligent Mechatronics (AIM) which should be both an authoritative and accurate publisher that should be trusted. The purpose of this article is to help us determine how to get relevent data from the feedback that should be told to the welder so he knows what to do to improve his weld while welding. **In Text Citation:** [7]

A.5.2 Title of Article: Real-time Inspection Method For Laser Welding Process

Student Name: Sean Meals
Author(s): Hee-Shin Kang, Ji Whan Noh, Kyung Han Kim
Journal/Publisher: IEEE
Year: 2012
Summary: This article focuses on a study conducted to measure the quality of laser welding. Specific parameters are given, such as the power consumption of the laser and the specific industrial welding robot used. The authors describe the laser welding system and argue that it increases the processing speed and improves overall efficiency. To defend this claim they observed the shape of weld pools and beads using UV and IR sensors. Finally, a full analysis of the test results are given. I learned from this article the industrial applications of robotic welding and how real time sensing data is used to make them more efficient.
Key Takeaways:

(a) Illustrates the types of sensors used in order to capture real-time data such as UV and IR

(b) Measuring plasma intensity in order to determine tensile strength

(c) Using signals to measure temperature instead of using conventional temperature acquisition devices

CRAAP: This article was published in 2012 which may seem dated but in the realm of welding, there hasn't been much innovation. Therefore it is current by today's standards. It is relevant because it relates to a study on monitoring weld quality, which is one part of the project our team needs to master. This article is from the IEEE therefore it comes from good authority and is proven to be accurate as it goes through multiple peer reviews. The purpose of this resource is to provide us with specific quality tests that can be performed in order to test the accuracy of our prototype.
In Text Citation: [4]

A.5.3 Title of Article: A Study on Measuring System of Submerged Arc welding for Panel Butt Joint in Shipyard

Student Name: Sean Meals
Author(s): MoonYoung Chung, SungHoon Ko, Hyeong Soon Moon, Jin-Woo Choi
Journal/Publisher: IEEE
Year: 2013
Summary: This article focuses on submerged arc welding and discusses

how the error between measured and actual data values can be problematic. This error causes the weld quality to diminish and the weld cannot be guaranteed. To overcome this problem the authors write how they designed a new system to accurately account for current, voltage, and speed. In this new design if an error occurred the onsite workers could correct the problem immediately after it occurred to increase quality.
Key Takeaways:

(a) The need for accuracy from sensors in order to determine present conditions

(b) Having the ability to determine weld defects as they occur is crucial

(c) There is large error in existing systems on the market

CRAAP: This article is from 2013 so it is somewhat current. It is relevant because it presents information that most likely would have been overlooked in our project given the time constraints. A small error in measured data versus the actual data can lead to inaccuracies that risk the quality of the weld. The article originates from IEEE therefore its authority can be trusted and it is accurate since the article must pass through peer review. The purpose of this resource was to draw attention to the need for accuracy when researching and designing our sensors in order to have a good outcome for our project.
In Text Citation: [**Chung2013AShipyard**]

A.5.4 Title of Article: Experimental Research on Welding Defect Detection Based on Thermal Imaging

Student Name: Sean Meals
Author(s): Mengmeng Li, Tao Ma, Ding Yan, Handing Liu, Hongliang Wang
Journal/Publisher: IEEE
Year: 2022
Summary: This article discusses how thermal imagining can be utilized in order to determine the quality of a weld. Particularly it discusses how a weldment can be photographed immediately after it was welded to determine areas that may pose a risk for discontinuities. It goes into detail on how areas with a lower temperature are specific cases when debris may have entered the weld.
Key Takeaways:

(a) The information provided by temperature readings on welds can help determine the quality

(b) This is a non-destructive way of testing welds

(c) Image processing is still required to flag discontinuities

CRAAP: This article is from 2022 so it is very current. It is relevant because it provides a way for nondestructive quality testing and can be redesigned to provide that information in real time. It is published by the IEEE so it comes from good authority and can be considered accurate as it undergoes peer review. Its purpose is to provide insight into different types of procedures that exist in order to test weld quality by utilizing temperature readings from thermal imaging cameras.
In Text Citation: [6]

A.5.5 Title of Article: Evaluating technology of spot weld quality for coated high strength steel sheet based on ultrasonic guide wave

Student Name: Sean Meals
Author(s): Zhenhua Chen, Yaowu Shi, Haiyan Zhao
Journal/Publisher: IEEE
Year: 2008
Summary: This article discusses how existing welding parameters can lead to poor quality such as in splatter or sticking the weld. The authors investigate using ultrasonic techniques in order to perform nondestructive welding tests. They mainly focus on spot welding under certain parameters such as the metals being coated in zinc and using a lamb wave and measuring its reflection or transmission.
Key Takeaways:

(a) Ultrasound is relatively safer than performing x-ray analysis in field applications

(b) Relates to current coursework in electromagnetics therefore most of the information is understandable

(c) Specific parameters are required for this analysis such as the metals being coated in zinc

CRAAP: This article is not very current as it was published in 2008. It is relevant because it focus on ultrasonic and nondestructive weld testing that we may need to utilize for the project. It is published by the IEEE therefore it comes from good authority and is accurate as it went under peer review. It's purpose is to provide insight into ultrasonic testing and its relation to the welding industry.
In Text Citation: [12]

A.5.6 Title of Article: Adaptive Control on Wire Feeding in Robot Arc Welding System

Student Name Timothy Hoo
Author(s): H.B. Chen; T. Lin; S.B. Chen; J.F. Wang; J.Q. Jia; H. Zhang

Journal/Publisher: IEEE
Year: 2008
Summary: In this article the authors experimented with machines in completing tig welding. From their experiments they collected data while the robot was completing the weld and realized that one of the important aspects was the feed speed of the metal for the weld. With this info they took outside data around the weld and was able to identify what speed to feed the metal to fix the weld automatically for the weld so that is stays consistent.
Key Takeaways:

(a) Can give automated help to humans instead of feeding information to them

(b) Gives another solution on what to do with the data and how we could change another aspect of welding

(c) Gives another data point that we should pay attention to and what data is important when welding.

CRAAP: This was published within the last twenty years so it is current, it's relevant because it has to with welding and what data to collect and how to use it. The authority comes from the IEEE which we should trust with accuracy since they go over the reports thoroughly. Finally the purpose of using is that its gives new ideas of how to solve the problem and more data on what we should collect.
In Text Citation: [3]

A.5.7 Title of Article: Development of Travel speed detection method in welding simulator using augmented reality

Student Name Alex Rhodes
Author(s): Ario Sunar Baskoro; Irwan Haryanto
Journal/Publisher: IEEE
Year: 2015
Summary: This paper is about the development of a travel speed detection method for a welding simulator using augmented reality. Learning to weld can be very expensive but with the proposed welding simulator makes it easier and cheaper. They conducted different experiments with different light sources and tracking speed to find the best combination and their accuracy's. In their finding they decided that 450 lux lighting gave the best results. In their fixed data mode, the program saves data of the main tracker in temporary storage. Turning on this mode made it more accurate as well. Overall, this paper presents an interesting way to track the travel speed of the weld tip by using existing technology in ARKIT

and using augmented reality.
Key Takeaways:

(a) Shows the possibility of using tracking markers and cameras to get the location data of the welder for our detection

(b) Talks about some of the existing technology and what they are currently doing with the products on the market

(c) Gives us a good start to our tracking by taking their findings and adding to them to create of design

CRAAP: The article is pretty current as it came out of a conference in 2015 and is using some current technologies like ARKIT. It is relevant to what we are working on because in our project we would like to have real time tracking of fine movements of the weld tip to allow us to guide the welder. The authority for this paper comes it being published by IEEE and came from a conference in 2015 the ICACSIS. This means that the article should be authoritative and accurate. The purpose of this article is giving us the basic understanding of how to track display data on the location of the welding tip. **In Text Citation:** [2]

A.5.8 Title of Article: Model based feedback control of gas tungsten arc welding - An experimental study

Student Name Timothy Hoo
Author(s): Fredrik Sikström; Anna-Karin Christiansson; Bengt Lennartson
Journal/Publisher: IEEE
Year: 2015
Summary: In this article the authors experimented with simulations and to try and give an example before performing the real weld. They discovered by simulating the weld before completing the actual weld has turned out with better results since they can predict the process and answer the critical issues that might appear during the weld.
Key Takeaways:

(a) Gives an idea of instead of real time we can predict

(b) Demonstrates that welds are predictable

(c) Allows us to compare a simulation to when welding to they can correct it with reference to the simulation

CRAAP: This was published within the last ten years so it is current, it's relevant because it has to with welding and what data to collect and how to use it. The authority comes from the IEEE which we should trust with accuracy since they go over the reports thoroughly. Finally the purpose of using is that its gives new ideas of how to solve the problem and more

data on what we should collect.
In Text Citation: [9]

A.5.9 Title of Article: An embedded Electric Meter Based on Bluetooth Data Acquisition System

Student Name Alex Rhodes
Author(s): Peng Xuange; Xiao Ying
Journal/Publisher: 2010 Second International Workshop on Education Technology and Computer Science
Year: 2010
Summary: This article describes the design of an embedded electric meter based on Bluetooth data acquisition system. The goal for this design is to reduce complexity that tradition cable-based data systems. They used standard arm chips that have its own Bluetooth chip built in. They built in the correct measures to protect the chip from the effects of ESD before it connects. The major difference between this Bluetooth data acquisition and other collection methods is that it realizes the data transmission after the A/D conversation. This makes the system simpler and more resistance to interfere. The authors provide a lot of data comparing their method to other common methods.
Key Takeaways:

(a) Gives us ideas on how to handle our Bluetooth transmission in an area with a lot of interference.

(b) Gives us ideas on when is it best to collect our current and voltage data

(c) Let us understand better the plus and minus to wireless data transmission

CRAAP: This article is coming up on 13 years old as it was published in 2010 which is not the most current. However with it still discussing current technologies it is still relevant today and for our project. The authority for this paper is from it being published by IEEE and discussed during a conference in 2010 in China. This means that this paper should be accurate as well. The purpose of this article was to research new ways to transmit data by a wireless and reliable way. **In Text Citation:** [8]

A.5.10 Title of Article: Weld Quality Inspection Based on Online Measured Indentation From Servo Encoder in Resistance Spot Welding

Student Name Timothy Hoo
Author(s): Lai Xinmin; Zhang Xiaoyun; Zhang Yansong; Chen Guanlong

Journal/Publisher: IEEE
Year: 2007
Summary: In this article the authors experimented with a huge data set and where they have a recording device of when a person completes a good weld and a bad weld. From this data they then see what was happening during the weld and extrapolate the data and create a range for the data of what is a good weld and what is a bad weld. From this they can complete another experiment where they have the people complete welds and only using the data to determine the good welds and the bad welds if they were or weren't in the given ranges.
Key Takeaways:

(a) Gives idea of how to collect data

(b) Show how to test the data and what tests to confirm our information

(c) Demonstrates we can get data online to help us complete data sets

CRAAP: This was published within the last twenty years so it is current, it's relevant because it has to with welding and what data to collect and how to use it. The authority comes from the IEEE which we should trust with accuracy since they go over the reports thoroughly. Finally the purpose of using is that its gives new ideas of how to solve the problem and more data on what we should collect.
In Text Citation: [11]

A.5.11 Title of Article: Influence of temperature variation on the accuracy of DC voltage measuring device

Student Name Alex Rhodes
Author(s): Xie Tingting; Yang Zhongzhou; Feng Jianhua; Wang Lu
Journal/Publisher: 2017 4th International Conference on Electric Power Equipment - Switching Technology (ICEPE-ST)
Year: 2017
Summary: This paper discusses the importance of voltage measurement devices in DC transmission systems. These devices are installed in the transmission lines to get a reading of the voltage that is sent to protection devices. The main part of this paper looks at the impact of temperature variation on the accuracy of the voltage reading. It suggests that internally generated heat of the voltage in the cable. This could change how the voltage is being read. It can cause changes in the ratio of the voltage divider and affect the accuracy of the measurement device. This paper presents suggestions on the ratio test and how the national standards should be.
Key Takeaways:

(a) Even though this paper is on electric transmission the measuring of

voltage will be the same and with us handling high voltages it can get hot

(b) gave us a good background in voltage measurements

(c) let us know what to do when we come across these issues

CRAAP: This article is from 2017 and talks about current technology. It is relevant because of the voltage measurement and the issues that could occur and we are doing that in our project. This article has authority because it was published in ICEPE-ST a big conference on electric power equipment. This also means it is accurate because others have cited it as well. The purpose of this article was to address the variation in temperature can change your voltage readings. **In Text Citation:** [10]

A.5.12 Title of Article: Fusion of thermal imagery and LiDAR data for generating TBIM models

Student Name Alex Rhodes
Author(s): A. Adan; T. Prado; S.A. Prieto; B. Quintana
Journal/Publisher: 2017 IEEE SENSORS
Year: 2017
Summary: This paper proposes the combination of 3 different types of sensors to make a comprehensive 3d map of buildings. The three sensors are a RGB camera, A FLIR thermal camera, and a 3d laser scanner or LiDAR sensor. This created this sensor suite to map out building more efficiently and more effectively with more data than ever. They call this model the TBIM or (Thermal Building Information Model). They then went through the calibration process that you have to do to get all the sensors aligned correctly. After that they showed images of the corresponding data of a room. They are currently testing more in larger scenarios.
Key Takeaways:

(a) The ability to make a fusion of different image technology to get better data

(b) Even though it is for room purposes that can be scaled down for our purposes

(c) You can get a lot of good data from this fusion

CRAAP: This article is from 2017 and is talking about cutting edge technology still today so that makes it current. This is relevant for the project because we would be taking both lidar and thermal images so with fusing then it could just be better. This article has authority because it was published in IEEE sensors meaning it has been checked. This is also accurate for the same reason and has been cited 6 times meaning people have agreed with their findings. The purpose of this article was to talk about the fusion of 3 sensor technologies to create a whole room depth map with thermal data. **In Text Citation:** [1]

A.5.13 Title of Article: Effects of Welding Time and Welding Current to Weld Nugget and Shear Load on Electrical Resistance Spot Welding of Cold Rolled Sheet for Body Construction

Student Name Rafael Guerrero
Author(s): Ario Sunar Baskoro, M. Rizky Trianda, Jos Istiyanto, Sugeng Supriyadi, Danardono A. Sumarsono, Gandjar Kiswanto
Journal/Publisher: IEEE
Year: 2014
Summary: This article talks about how welding time and current have an impact on an electrical resistance spot welding used in body construction. These investigators did a series of expiriments trying to determine the effects of different parameters on the formed weld nugget. The concluding finding was that increasing weld time and current has the probability to enhance the formation but the optimal combination of time and current has a higher shear load. This optimization can then be used in body construction later in time.
Key Takeaways:

(a) 1) Welding current and time are critical parameters that has an effect on the quality of welding.

(b) 2) The higher the welding current and time has the result of a higher nugget size and strength of the weld.

(c) 3) The parameters being controllable allow for stronger weld joints for body construction.

CRAAP: This article is from 2014 talking about how different parameters affect the weld nuggets which always happens in welding so it is still current. The relevancy for the project is that we are considering these same parameters so having past work will be extremely helpful. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to talk about how the time and current impacts the weld and what are the optimal parameters.
In Text Citation: [**IEEE2014**]

A.5.14 Title of Article: Research of Intelligent Welding Control System of Swing Arc Narrow Gap

Student Name Rafael Guerrero
Author(s): Xin Yanggui, Zheng Shida, Gao Shiyi*, Xu Wanghui, Li Su
Journal/Publisher: IEEE
Year: 2021
Summary: This article talks about how there is some type of intelligence welding control system that narrows the arc gap. This process combines

swing arc and narrow gap welding techniques with the goal of having a greater efficiency and quality. There are hardware and software parts that shows how implementation can adjust the parameters in real time. They found that the control system is effectively control the swing arc narrow gap and improved it.
Key Takeaways:

(a) 1) The intelligent system for swing arc narrow gap can be improved through quality and efficiency.

(b) 2) This system has real time sensor data to improve welding.

(c) 3) This has potential to be used in large-scale applications.

CRAAP: This article is from 2021 talking about how intelligence welding systems allow for a better efficiency and quality of welding. The relevancy for the project is that we are need a real time sensor finding and that is what this has completed. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to talk about how the algorithm and real time data can result in welding outcomes.
In Text Citation: [5]

A.5.15 Title of Article: Detection and Classification of Weld Defects in Industrial Radiography with Use of Advanced AI Methods

Student Name Rafael Guerrero
Author(s): Ryszard SIKORA, Piotr BANIUKIEWICZ, Tomasz CHADY, Przemysław ŁOPATO, Bogdan PIEKARCZYK, Grzegorz PSUJ, Bogdan GRZYWACZ, Leszek MISZTAL
Journal/Publisher: IEEE
Year: 2013
Summary: This article talks about how AI systems have a detection and classification of the defects in the weld using radiography. The author then talks about how the combination of this AI with industrial radiography will help detect defects by an increasing accuracy of 90 percent. This has potential to be an autoamted inspection procedure. This improve quality control and reduce cost and time.
Key Takeaways:

(a) 1) Developing AI has algorithms that can show the defects in welds through industrial radiography.

(b) 2) This AI system achieved 90 percent accuracy rate

(c) 3) The weld defect detection can improve quality and reduce cost.

CRAAP: This article is from 2013 talking about how artificial intelligence can help detect defection in welds. The relevancy for the project is that we

need to find a way to use advanced technology to find the real time data of this exact problem. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to propose AI methods in combination with industrial radiography can detect weld defects to improve quality.
In Text Citation: [**IEEE2013**]

A.5.16 Title of Article: Parameterized Study of High-Frequency Welding System

Student Name Rafael Guerrero
Author(s): Ilona Iatcheva, Rumena Stancheva, Nikolina Petkova
Journal/Publisher: IEEE
Year: 2018
Summary: This article talks about how high frequency welding systems is used in making steel pipes. The welding parametes are frequency, voltage, and current to have the best quality. The optimization of the high frequency welding process leads to improving quality and efficiency.
Key Takeaways:

(a) 1) The frequency and current are the key parameters that affect the quality of steel piped welding.

(b) 2) The weld speed in high frequency welding can be by increasing welding frequency improves the welding speed.

(c) 3) Improvements in welding quality and efficiency on steel pipes can be by optimizing the high frequency welding.

CRAAP: This article is from 2018 talking about how high frequency welding can be affected by certain parameters. The relevancy for the project is that we need to find real time data of these exact parameters so looking deeper in this can be helpful. This article has the authority and accuracy due to IEEE publishing this article. The purpose of this article is to show how parameter studying can improve welding quality and efficiency through optimizing of welding.
In Text Citation: [**IEEE2018**]

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