UNIVERSITEIT TWENTE.

SMART ENVIRONMENTS PROJECT

DOCUMENTATION REPORT

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Chapter 0: Introduction

In this documentation report we will present the effects air pollution has on our world and we will explore some solutions we thought will make a difference for the outcome of this problem.

From a series of problems concerning climate change, like deforestation, meat production, greenhouse effect or frequent natural disasters, we have chosen to document matters concerning air pollution. Air pollution represents a real health hazard affecting lots of people daily, due to heavy industrial work, especially around big cities. A high amount of toxic gases are released into the air from factories and the multitude of cars around cities, creating the possibility of developing serious respiratory problems for the people breathing these fumes.

We came up with some solutions to compensate for this problem, some of them being devices that check the level of air pollution and notify the user, a smart gas mask, an automatic tree planter or software that tracks and stores information about the quality of air.

The solution we found most interesting and doable is a device in the shape of a bracelet that can be connected to a phone application which will allow the user to check an integrated map containing relevant information about the air pollution in the respective areas of where they live.

This project requires certain hardware parts and a compatible software application. The device will connect to the phone of the user through a bluetooth connection transmitter and will receive information from an air particle meter and a LED. The software part consists of a phone app that will use the bluetooth and GPS connection in order to receive and show relevant information about the air quality. The device itself will contain common electronic parts like a main board and batteries and it will have a cloth or a leather strap in order to be worn by the user.

The created device works by collecting information about the air quality through the air particle meter that measures the levels of CO, CO2 and NO in the air. These measurements are sent through bluetooth to the user's phone which later determines the device's position through GPS. By using a map connected to the application, the device will mark the level of pollution found in the area of the user and will assign a certain colour to it to show the air quality.

We believe that this solution can compensate for the continuous effort to reduce air pollution and we think that it can gather a high amount of data of the areas where air quality is very low. With this information the device can be further improved and action can be taken in the zones with a high level of pollution.

Chapter 1: Literature Review

Livestock and climate change: impact of livestock on climate and mitigation strategies

This article explains how and why agriculture is bad for the environment. It shows that 14.5% of total greenhouse gas emissions caused by humans is from agriculture and what this number is caused by. The reasons include methane emissions, enteric fermentation, manure storage and feed production.
It also shows some ways we could decrease the effects agriculture has on the environment and why they are or are not good ideas or even realistic.[1]

In vitro meat production: Challenges and benefits over conventional meat production

This article discusses how in vitro meat production could decrease the negative impact of meat on the environment while also being a way to feed more people. This could be achieved by needing less space to grow the meat and needing less resources compared to regular livestock production. Some problems however are the cost effectiveness and people's weariness towards eating meat grown in a lab.
Provided these challenges can be overcome, in vitro meat is a very promising means of nourishing more people while harming the environment less than what we are doing now.[2]

Is there a convincing case for climate veganism?

This article discusses the pros and cons of climate veganism and whether it's necessary or even a good idea to follow climate veganism to help save the environment. The conclusion is that veganism is better for the environment than an average meat eater diet, but full on strict veganism is probably not the answer to fix climate through diet.[3]

Security and climate change

This article discusses in turn the origins of the idea that climate change is a security issue, its national security dimensions, the widely held assumption that climate change may trigger violent conflict, its implications for the military, the risks it presents to human security, and the utility of understanding climate change as a security issue in these ways.[4]

Climate Change and Society

In this article he evaluated society in perspective to climate change and his results led to a focus on human practices as individualistic, market-based and calculative, and thus generated responses to climate change based on individual calculation to change behaviour, new technologies to fix the problem and developing markets for novel 'green products'.[5]

Liability for climate change

The 'attribution problem' for externally driven changes in climate (as opposed to specific weather events) boils down to questions such as: "what would the climate have been like had we not increased greenhouse-gas levels?" This is a well posed question to which, if we define climate rigorously to encompass all the properties of the 'attractor' of atmospheric and oceanic weather, there is only a single answer.The curve spoken about in this article shows how some external driver of climate change, such as past greenhouse-gas emissions, may have increased the risk of an undesirable event, such as the floods in Vicarage Road.[6]

Global climate change and greenhouse effect

This article analyzes the consequences of greenhouse gases and the dynamics of these greenhouse gas emissions. The amount of greenhouse gasses emitted can contribute not only to global warming, but also to negatively affect water availability and nutrition. Emissions are mostly caused by the major industries and can, if the local government is willing to, be reduced to seek for better and healthier lives. This paper tries to forecast different sectors of the greenhouse effect until 2030. [7]

A quantitative analysis of the causes of the global climate change research distribution

This paper looks at the amount of scientific knowledge distributed around the world in relation to the adaptation of climate change and the goal to reduce greenhouse gas emissions.This shows that there is a severe information shortage in poorer countries around the world with less money, development and school enrollment. Meanwhile richer countries have better access to information, yet give a bigger carbon footprint than the poorer countries. This paper looks at more than 15.000 scientific publications in order to look for the distribution of these papers and the impact it has on the environment in these areas. [8]

The impacts of climate change on marine mammals: early signs of significant problems

The fact that climate change is affecting the temperatures of the ocean and the wildlife within it, is a given. However, some species of marine mammals are more adaptable to the changing climate while others are not as adaptable to this change. This can lead to major problems for one species, while another species finds a way to adapt and does not have to face the same problems. This will eventually lead to some species becoming extinct while others will thrive in their new environment. The paper tries to indicate the future of some marine species and tries to make assessments as robust as possible.[9]

Climate change impacts and adaptation in forest management: a review

Forests represent an important mechanism of CO2 reduction, soil stability and the home of various animal species. In this article there are presented the negative impacts climate change has on the ecosystem of the forest and the animal species living in it, and how it is endangered by the rising temperatures, natural disasters and human activities. [10]

Lessons learned from ocean acidification research

In this article it is explained how the ocean absorbs the excessive CO2 produced by human activities resulting in a shift in climate stability. Acidification refers to the process in which the pH of the water is dropping in levels, leading to the formation of an acidic environment in the ocean.
Combined with the warming of the ocean's water, a lot of marine species are endangered in the coming decades, a problem which can even lead to extinction of certain species.[11]

Climate change and natural disasters: Scientific evidence of a possible relation between recent natural disasters and climate change

This research paper presents the link between climate change and frequent natural disasters. Human influence on the climate has increased greenhouse gases, a factor that has led to a lot of natural disasters happening.
The rising temperatures across the globe became more visible with the heatwaves that struck a lot of parts of the world, sometimes creating massive fires in the natures, affecting crops, forest but also animals living in their common habitat.

Frequent floods are also more common, most of them being flash floods that destroy both human settlements and natural environments.[12]

Transport and climate change: a review

This review is about the impact of transport on the climate and how to reduce emissions. Road transport accounts for 81% of total energy use by the transport sector. 76% is emission from fuel usage, 9% is emission from manufacturing of the vehicle and 15% is emission from the fuel supply system. A tactic to encourage the use of public transport is to offset the affordability of car ownership with indirect taxation. Technology will play an important role in the reduction of greenhouse gasses. The design, the size, ecological driving and alternative transport fuels will all contribute to less greenhouse gas emissions cars.
The movement of freight uses approximately 43% of all transportation energy. Because of increasing engine performance and improved vehicle design, fuel efficiency in the freight transport sector has increased by 20% since 1980. Increasing the proportion of deliveries made at night, software based touring and scheduling can help with making freight more efficient.
Aviation is a lot more damaging for the environment than is indicated only by CO2. This is because other greenhouse gases are directly released into the upper atmosphere, where the effect is way more damaging. Policy changes can help with the emission from aviation, but also improvement in technology will help a lot with reducing the CO2 emission from aviation.[13]

Renewable energy: a response to climate change

This paper discusses multiple renewable energy options that can help reduce CO2 emission and the role that it might play. Technological options for reducing greenhouse gas emissions are wide ranging. Hundreds of technologies and practices for end-use efficiency in buildings, transport and manufacturing industries, could account for more than half of the emission reduction potential. To produce an acceptable future world with the lowest cost, a rapid uptake of renewables to displace fossil fuels is required. Significant learning investments as well as other supporting government policies and mechanisms are needed.[14]

Climate change and human health: Impacts, vulnerability and public health

The effects of climate change on human health are discussed in this article. Climate change is likely to have a negative impact on health. It will have the most impact on low-income countries where capacity to adapt is weakest, but it will also have a lot of impact on the most

vulnerable group in developed countries. Adaptation strategies should help some of the negative effects, but it will be difficult to implement in low-income countries. With climate change already happening, the health sector and other sectors that have direct connection to human health, need to assess vulnerabilities and identify cost-effective intervention/adaptation options.[15]

Effects of tropical deforestation on climate and agriculture [1]

This article is about the impact of deforestation depending on the scale. Tower, ground-based and satellite observations indicate that tropical deforestation results in warmer, drier conditions at the local scale. Models show the regional or global impacts of deforestation on climate and therefore on agriculture. General circulation models show that the result of completely deforesting the tropics could be global warming equal to that caused by burning of fossil fuels since 1850, with more warming and considerable drying in the tropics. More realistic scenarios of deforestation show less drying and less warming. They suggest critical thresholds beyond which rainfall is substantially reduced. In regional, mesoscale models that capture topography and vegetation-based discontinuities, small clearings can enhance rainfall. Still, at this smaller scale, there is a critical deforestation threshold beyond which rainfall declines. Future agricultural productivity in the tropics is at risk from an increase in mean temperature and the associated heat extremes and from a decline in mean rainfall or rainfall frequency caused by deforestation. Through teleconnections, negative impacts on agriculture could extend well beyond the tropics.[16]

Sustainable intensification: What is its role in climate smart agriculture?

This review discusses the role of sustainable intensification in climate smart agriculture. Climate smart agriculture focuses on outcomes related to climate change adaptation and mitigation. Sustainable intensification is crucial to both adaptation and mitigation. Agricultural intensification is producing more output from the same area of land. Normal intensification of agriculture brings many problems, e.g. biodiversity loss and the decline of ecosystem services. Sustainable intensification increases food production from existing farmland in ways that have lower environmental impact and ways that do not undermine our capacity to continue producing food in the future. Adaptation and mitigation can be generated through various means, for example: enhancing soil quality generates vital regulating services of buffering, filtering and moderating the hydrological cycle; improving soil biodiversity; and regulating the carbon, oxygen and plant nutrient cycles, enhancing resilience to drought and flooding, and carbon sequestration.[17]

The influence of consumers' environmental beliefs and attitudes on energy saving behaviours

In this article, it was investigated whether known antecedents of environmental behaviours were associated with those behaviours. General environmental beliefs influence environmental norms on environmental actions and prices, but only environmental norms on price are correlated with environmental attitudes. Both intrinsic and extrinsic environmental drivers together with social norms and community influence are associated with environmental attitudes, but cost barriers may have a negative influence. There is a strong association between environmental attitudes and environmental behaviours but the latter was not in any way influenced by government policies or subsidies.[18]

"Global climate change mitigation potential from a transition to electric vehicles"

This paper investigates the potential for electric vehicles to contribute toward leading nations' climate goals. Around 2015 many governments have announced new climate change mitigation commitments that include national or regional commitments to reduce their carbon emissions in the 2025-2035 timeframe. Thus many of these governments have set the goal to have certain percentages of total vehicles be electric. Not only does it consider fully electric vehicles, but also plug-in hybrid vehicles.[19]

"Climate change and marine plankton"

Oceans cover 71% of the surface of the Earth and thus we must strive to understand how a changing climate will affect the biota not only in terrestrial systems, but also in marine environments.
In this paper it is described not just what plankton is, but the effects of increased temperatures on the organisms, and the effect that the organisms in turn have on the climate itself.[20]

"Organic agriculture and climate change"

This article discusses the mitigation and adaptation potential of organic agricultural systems along three main features: farming system design, cropland management and grassland and livestock management. An important potential contribution of organically managed systems to climate change mitigation is identified in the careful management of nutrients and, hence, the reduction of N_2O emissions from soils.N_2O emissions are the most important source of agricultural emissions: 38% of greenhouse gas emissions.In organic systems, the nitrogen

input to soils, and hence the potential nitrous oxide emissions, are reduced. Another important source of GHG emissions from agriculture are the methane emissions from enteric fermentation, which account for 4–5% of the global anthropogenic GHG emissions. The paper elaborates further on how organic farming systems reduce these numbers.[21]

Chapter 2: Identification of General Problems and Challenges

1. **Melting glaciers**
   The rise of the temperature of the environment not only affects organisms, but their habitats as a whole. This is not just a problem other animals have to face, it will likely become a problem for the 'habitats' of humans as well. The ice caps melting means a rise in ocean levels, which in turn means a potential to have whole parts of the planet flooded, leading to the possible destruction of whole cities, ecosystems and of course a massive loss of life.

2. **Unsustainable agriculture**

   The current way agricultural intensification is handled brings with it many problems, for example biodiversity loss and the decline of ecosystem services. In order to be able to adapt and mitigate climate change, climate smart agriculture is crucial. Sustainable intensification instead of normal intensification plays a big role in this. Because sustainable intensification methods are often not as profitable as those of non-sustainable intensification, the non-sustainable methods are used a lot. This needs to change for climate change adaptation and mitigation.

3. **The transport sector**
   The transport sector is one of the biggest emitters of greenhouse gasses and thus has a big impact on climate change. The transport sector is still growing, therefore the emission of greenhouse gasses from transport is still rising. Within the transport sector, road transport is the biggest emitter. Reducing transportation and finding more environmentally friendly alternatives is a big step in fighting climate change.

4. **The changing of environments**
   Through the steady and fast process of climate change the environment changes as well, but not in a good way. Two of the most important environments on Earth, the forest and the ocean are going through a lot of changes due to rising temperatures, acidification, greenhouse gasses, which result in natural disasters that destroy the ecosystems of this two, consisting in trees, plants/marine plants creating oxygen, but also the eradication of the species living in this environments.

5. **The greenhouse effect**
   The earth's atmosphere has a sort of blanket around the globe. This traps the heat of the sun and keeps it in the atmosphere. The gasses that make up this blanket are

CO2, MH4, N2O and some fluorinated gasses. The amount of greenhouse gasses in the air since 1750 has risen a total of 48% by human activities. This means that the earth is holding more heat from the sun in its atmosphere than before. This leads to a rise in temperature which leads to other problems such as: more frequent heavy weather events, less water availability and less habitable land.

6. **Loss of species**
   A loss of wildlife species as increase in temperature and change in vegetation designs have constrained some bird species to become terminated while others have moved to another spot. Assuming specialists are to be accepted, one-fourth of Earth's animal groups could be wiped out by 2050. In 2008, polar bears were added to the rundown of creatures that could become terminated because of an increase in ocean level.

7. **Meat production**
   The increased need for food caused by the increased population is having adverse effects on the climate through increased meat production. There are possible ways to mitigate this but it's going to be difficult.

8. **Health hazards of rising temperatures**
   With rising temperatures due to climate change, more people will suffer heat cramps, heat exhaustion, hyperthermia (high body temperature) and heat stroke as days that are unusually hot for the season hamper the body’s ability to regulate its temperature.

Chapter 3: Identification of Relevant Problems

1. **food production and consumption.**

   Producing food takes a lot of energy and requires soil, fertilizer and water. In addition, food must be packaged, refrigerated and transported. Food production and consumption has a big impact on the environment. Factories that produce food have a lot of CO2 emission. Food has to be transported to the supermarkets.

   Not all food has the same impact on the climate. Beef has an especially big impact on the environment. Cows emit a lot of methane, which has a more global warming impact than carbon dioxide. Forests are being destroyed, to make place for animals to graze or to grow fodder for the animals. With the destruction of forests, a lot of CO2 is being released.

2. **More natural disasters (extreme weather)**

   Due to the effects of climate change, more droughts and increased intensity of storms will likely occur. These natural disasters have so far disproportionately impacted poorer countries. As a larger amount of water vapor is evaporated into the atmosphere, it exacerbates extreme rainfall and flooding. More heat in the atmosphere and warming oceans have led to an increase in the frequency and extent of tropical storms. Due to rising sea levels, higher locations, previously not in danger because of the sea and erosive forces of waves and currents, become exposed to more danger that they are usually not equipped to deal with yet.

3. **Health hazards (respiratory problems)**

   Climate change is now affecting health in a horde of ways, by prompting death and sickness from continuous extreme climate occasions, for example, heatwaves, storms and floods, the disturbance of food frameworks, vector-borne illnesses, and psychological well-being issues as well. Besides that, climate change is sabotaging a significant number of the social determinants for good health, like occupations, equality and admittance to medical care and social help structures. Many health problems include Heat-related illness, Injuries and fatalities from severe weather, Asthma & cardiovascular disease from air pollution, Respiratory problems from increased allergens, Diseases from poor water qualityWater & food supply insecurities

4. **Melting ice caps and glaciers**

Due to the average temperature on earth rising, the ice caps are starting to melt and shrink. A large portion of ice that was on land or above water is melting down into the oceans. Because this adds a lot of water into the ocean, its volume is increased. This increase in volume leads to the water levels rising, which is a huge risk factor for people that live below the current sea level. This includes, for example, a third of the Netherlands. These areas will be flooded if we can't keep the sea level low enough, or if we fail to reinforce the dams and dykes, potentially leading to massive loss of life, livestock, farmlands, etcetera.

5. Economic challenges (as a response and as a prevention method)

Climate change is a major factor when it comes to the global economy. The climate and the economy are directly proportional, meaning that a change in the values of one of them affects the other. In other words, if the climate of the world remains at a normal value, there will be less economical damage. Climate change affects the economy through the damage inflicted on the infrastructure of cities and power shortages due to more frequent natural disasters, a shortage of food and water because of drought and increased mortality rates due to extreme heat.

Chapter 4: Problem Selection and Motivation

Health hazards (respiratory problems)

The problem that we picked from chapter three, is health hazards as a result of climate change. The world is faced with more extreme weather, air and water pollution and, in general, a tougher climate. This has consequences on our health and well-being. The result of that is that the amount of deaths related to heat, extreme weather, toxication or mental illness is steadily rising year by year. This can also lead to an increase in heart problems, a decline in fertility and extreme fatigue. We want to have a look into the reason for these increases in deaths and the decline in health. We want to make a device that could react, or even better, prevent these health risks from taking place. The health hazards as a result of climate change is a very broad topic with loads of research already taking place. However, we think that there is not enough research done in this field, as it could be life threatening to all of us around the world and a lot of problems still need to be properly addressed.

We would like to focus on certain aspects of this problem; mainly air pollution and the health risks involved. This problem is of great extent, especially in industrial intense places and big cities around the world. There are certain places around the world, where even the pollution meters cannot measure how high the pollution is in that area. Some health risks involved are: respiratory problems, heart failure, Chronic Obstructive Pulmonary Disease, a lower immune system, reduced annual lung function growth in children, or in the worst cases, death. The prevalence and mortality of many of these health risks is expected to increase in the coming decades. The long term effects of living in an area with high air pollution levels are becoming increasingly clear. The World Health Organization (WHO) estimates that ambient air pollution is responsible for 3.7 million premature deaths worldwide in 2012.

Our idea for a potential solution to adapt to the worsening air quality in certain areas is to create a device that would measure the pollution levels of the air around the user. If the air quality is past a certain level of risk, the user would get notified and be able to take appropriate action. This way, people can avoid certain polluted areas or take measures to protect themselves. This can lead to better health and well-being for people living in areas where pollution causes a higher risk of respiratory problems. The device needs to be cost efficient, low maintenance and not need too much user interaction.

Chapter 5: Potential Solutions

Parts of the problems that could be addressed:

- Mitigation: improving quality of air by purifying it in a way
- Mitigation: preventing air pollution
- Warning (adaptation): preventing people from breathing in polluted air by either showing them where the polluted air-zones are or warning them when the air quality is getting worse
- Filtering (adaptation): a system that filters the air

Potential types of solutions:

1. A technical device that checks the quality of the air and then notifies you by sending a signal to you on whether you should put on a mask or not. The device will measure the air quality with embedded sensors. When the air is too polluted, it recommends putting a mask on. The device can be fitted onto any place where we want to check which makes it highly portable, adding on e.g. buses would help us get the pollutant levels of multiple places and will give access to data of more areas. This can help prevent people from bad health issues related to lungs, skin etc. The device can help adapt to the worsening state of the air quality by giving warnings and awareness.
   Pro: An advantage of this would be that it could give an overview of a lot of the gasses and toxins in the air and therefore would be able to give specific advice to people with all kinds of different health problems.
   Con: By the time you get notified about the bad air quality, you still have to put on a mask, so you kind of get notified too late.

2. Smart gas mask. This would be like a regular gas mask but it would have a sensor and a wireless connection to your phone which will display the recordings of you telling you exactly in numerics how much percentage of bad or toxic gas there is around you so that you can either avoid or move more cautiously. It can be built through an app so it could be easily accessible to use and to advertise. This makes individuals self aware and mindful of the air quality around them and it can assist with securing them and forestall terrible medical problems. The smart gas mask is a way to adapt to air pollution by warning people of polluted air and preventing them from breathing in this toxic air.
   Pro: You're already protected from the bad air when you enter the polluted area. There is no time between getting notified of the air quality and having a mask on, meaning there is also no time frame in which you're breathing in the too dangerous gasses.
   Con: You'd have to be wearing the mask constantly, which might lead to some discomfort. If you were to put it off, you'd probably miss the notification that the air quality is very bad, so you wouldn't know when to put it on, defeating its purpose.

3. Automatic tree planting device that detects the air quality. This would be installed specifically in areas of acres of farmland and land and a few sensors across the city on buses etc which would detect and send signals back to the main router which in return gives the program to plant (1000 seeds). When the air quality is really bad it

can plant new trees increasing the amount of oxygen being produced in that area specifically and if it went large scale and multiple areas started working on it. Planting trees can help get CO2 out of the atmosphere which is a necessity as humans are constantly producing carbon dioxide in more ways than one. The biggest emitters could also plant the most trees. The United States for example emitted **5.1 billion metric tons** of energy-related carbon dioxide, while the global emissions of energy-related carbon dioxide totaled 33.1 billion metric tons. Planting trees consistently in the long run can help reduce air pollution. This is a way to mitigate the problem, because the bad quality of the air gets (partly) fixed.
Pro: It is a natural and economically friendly way to filter our air from toxins
Cons: Unrealistic goal relating to space, resources and time as this process will take way too long to reach the end result

4. Automatically deploy soda lime crystals to decrease co2 levels quickly. Can be planted on specifically counted and marked traffic lights as the road is one of the places where the most co2 is produced due to cars and rush etc, it can also be planted or be a (precautionary important rule) to be attached near factories and also if needed for special reasons(medical) have a small one attached near your house When the co2 levels are too high Soda lime crystals can get quickly co2 out of the air. Which can improve the air quality for a small period of time. The crystals can for example be put on vehicles like buses or cars to take the emissions from traffic out of the air. This solution is a way of mitigation, because the problem, bad air quality, gets (partly) fixed.
Pro: It purifies the air specifically in the areas that need it the most.
Cons: Expensive and high maintenance. A lot of crystals are necessary in order to make a significant change.

5. A keychain or something they can hang on their bag that checks air quality and changes the color of the LED based on pollution levels of its surrounding area. This would be easy to notice especially for enabled people such as ones who have trouble hearing or older in general with sensitive senses. A light would be an easy and eye-catching way to show the problem. This makes people aware of the highly polluted air areas. They can avoid these area's next time and this can help prevent health issues. This can be integrated as a smart environment as with the help of those sensors we can find out and record in real time the levels of toxicity in the air of specific regions and make a tally to be useful for multiple reasons in reports etc. This solution helps adapt by bringing awareness of the most polluted areas and warning people.
Pro: it is extremely light and portable and wouldn't need to be expensive as it would just be a light.
Con: it could be easily misplaced or since ist would not be very big it could be easily broken

6. A map where everybody gets a free device from the government that checks for air quality and there is a real time map attached to the devices that everybody can access to check the recommendation in that area or maybe an app that says that it recommends you to put on a mask for this area. Or the device can perhaps connect

to your phone via bluetooth and display the badly polluted areas via a sensor in the keychain on a map which you can access via the internet. This would be a smart environment as it would be connecting through a large scale network and would be a consensus over time and can be viewed by anyone. Easy to access and use by anyone and not a very complicated to understand map. This solution would help adapt by informing people of the pollution levels in the air around, so that they can take the action necessary.

Pros and cons of both 5 and 6:

Pro: Because the keychain is attached to the bag, it's always in direct contact with the air. If a lot of people use the keychain and share their data, you can check beforehand if someone has already been in the area recently and if the air quality is safe. When you're coming close to an area which has recently been measured to have bad air quality, you could get a notification telling you to look out and be warned.
Con: The device would have to be measuring and transmitting data constantly, making it not very energy efficient. If you're the first person to have recently entered the polluted zone, you'd only get notified about this when you're already there. This system in a way depends on people breathing in bad air to prevent other people from doing the same.

7. A project where there are several poles placed in a neighborhood. These poles have a solar panel, a fan and a filter to pick up bad air. The poles would be systematically placed in, for example, a city and would be very efficient as we would be using renewable energy. This is a smart environment for that reason but it would be a little time taking to set up and expensive to maintain in areas that cannot afford such equipment. This however is a very environmentally active project where you are using the sun's energy to power the fan and clean(or try to clear) the air. If the air quality is below a certain threshold, the fans start spinning. If the air is really bad, it starts filtering the air. This can help improve the air quality around the poles. This solution is a way to mitigate the problem by fixing the worsening air quality.
   Pro: constant checking and filtering with renewable energy resources, maintenance of fans etc.
   Cons: Solar panels are quite expensive and if they're placed in an open area there are chances of it being stolen or broken.

8. Jewelry with embedded sensors (maybe a necklace or a ring or bracelet). This is a wearable extension on solution 1 and 7. The bracelet will have a sensor and a bluetooth connection with your phone. This connects to the internet and uses GPS location to display a map on a certain website which you can access on top of a LED that turns on after a certain threshold has been reached in the air.
   Pro: Because the jewelry is being worn, it gives a very local measurement for the air quality around the person that is wearing the jewelry. The user gets a better constant idea of the air quality around them specifically than for example if the sensor would be on a bus or streetlight.

Con: In areas with bad weather, the jewelry is likely to get covered when people are outside (the times the measuring is the most important. The bracelet would get covered by coat sleeves, a ring by gloves, a necklace by a coat, etc.

9. Pets to detect bad air quality in homes. These animals would be trained by smell as some animals have heightened senses of smell to detect the difference in air quality just like how they are trained in the forces for specific marijuana or other searches. This idea derived from certain mines where they used birds to detect bad air. An animal can be trained to detect certain smells in the air and therefore, warn the owner of bad air quality. This essentially is a living sensor. It can help adapt to the worsening air quality.
   Pro: It is extremely environment friendly and cost effective as you will just be training your pet.
   Con: It takes a lot of dedicated time and effort to make a pet be able to detect air quality. One big con is also making the dog have to smell the bad or toxic gasses to train is very harmful and not environment friendly as a smart environment project or in general to make an animal undergo.

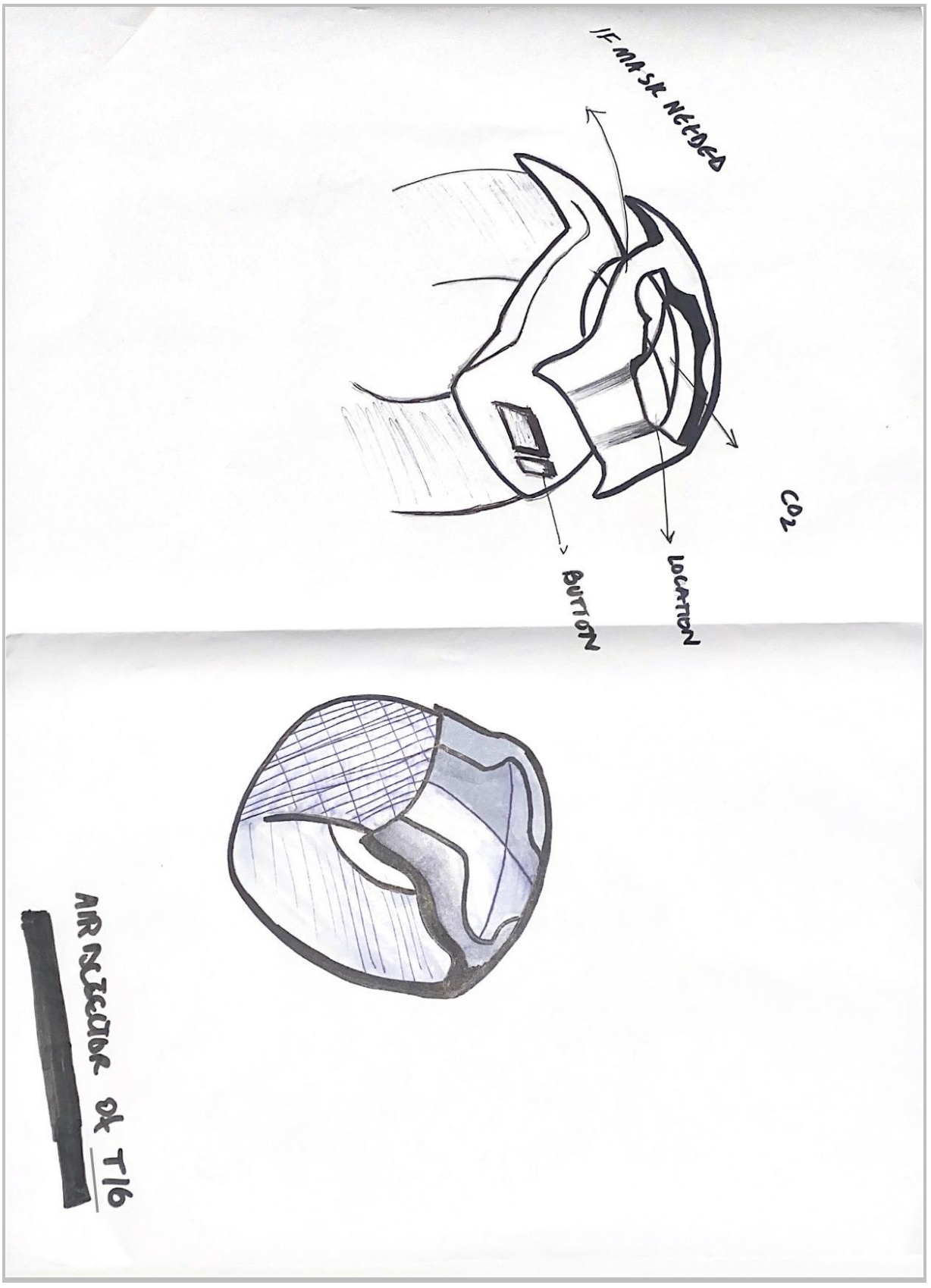
10. Wearable air purifier. This device could be worn on your body as a bracelet or kept in your bag or be a handheld device where it simply filters the air around you. This could for example be made into a necklace, since it is very close to the face.It would be an air purifying device that sucks in air and blows out purified air which can be used on a small scale as mentioned above or a little larger in homes, offices etc. It can drastically improve the air conditions around e.g. someone who is asthmatic and is having trouble breathing. It is a way to mitigate the problem of worsening air quality.
    Pro: It will always keep on checking the air quality around you which is the best for individualized and personalized results
    Con: Only detect area right around you, not the best for high scale and accurate filtering

Chapter 6: Solution Selection

We have decided to make a bracelet with a gas sensor which displays the amount of a specific gas for e.g. CO2. This will make us aware of how much toxic gas is around us as they are damaging to your health; specifically for people with respiratory problems. Awareness of the pollution levels of the area around you will inform whether it would be wise to take cautious care such as wearing a mask or avoiding the route etc.. The bracelet should notify the user if they are close to a polluted area, if the pollution levels are thus bad that action should be taken and when the pollution levels are not dangerous anymore. The sensor is connected to a Web page of a map which shows the density of bad gasses in specific areas around the city or town (whichever scale we decide to use it for). Through enough people wearing the bracelet and sharing their information, a detailed overview of the pollution levels of different areas in the region at specific times will be formed. Therefore, wearing the bracelet does not only help the wearer of the bracelet, but also others who want to be informed about the air quality of an area before they enter the area. It can also help with projects for improving the quality of the air; knowing where the bigger polluters are enables us to take action against them and also tells us where the biggest efforts have to be made to get the pollution out of the air. This solution could raise some potential privacy concerns. Therefore, all sharing of data should be voluntarily and well-informed. No other data than location and the information of the sensor is needed for our specific plan, so no other data than that should be collected.

The modules needed for this project are a gas sensor connected to an arduino, which is then set up to show pollution levels of specific gasses, a bluetooth module for the arduino and an application for android that then takes the data from the arduino and shares it via gps. When we get all of this to work we will make it compact enough to wear on your wrist.

As for the role division we have decided, since our leader and another member last minute left, that we all just had to put in equal amounts of work and make everything come together. Thus, we have no specific team leader; we are all kind of team leaders. The distribution we decided on was that Yasin will make the gas sensor work with the Arduino and have it relay information to the bluetooth module, Emma and Emilia will make the website with the GPS function work and Inèz and Leeza will finish everything in regards to the documentation.



Concept art for the bracelet

Chapter 7: Methodology

Sensors bought for the project:

Equipment for Bracelet

- bluetooth transmitter for the connection through the phone
- air particle meter (CO,CO2,NOn) to detect and transmit a certain signal to the bluetooth transmitter and LED
- LED's to give a direct indication of the air quality if the app or phone is not available
- Cloth or leather for the bracelet. This depends on the fire protection and flexibility of the fabric.
- A small board to put all the components together. This has to be really small, because the bracelet will otherwise be too big to wear comfortably.
- battery holder and small batteries. Possibly a charging component, as the bluetooth transmitter can be heavy in terms of power.

Calibration

The air particle meter needs to be calibrated to a certain extent. It does not have to be extremely accurate, as 3 - 5 rough threshold values are enough to give an indication of the air quality. This does not have to be indicated in numbers, just in colors on a map.

Data collection

- The amount of CO, CO2 and NO in the air through the air particle meter
- The bluetooth transmits this information to the connected device (usually a phone)
- The position of the device (GPS location)
- This gets combination of air quality and GPS location (if turned on) gets sent to a central server where the map is updated

Testing the project:

Data use/analysis

The air particle meter measures the amount of CO, CO2 and NO in the air. These measurements will be sent to the app with bluetooth. The smartphone has a GPS which determines the position of the device. With this data we can share information about pollution levels in a certain area and display it on a map. This data gets collected on a central server from where the data can be accessed through an app or website

Time planning:

	TASKS	
week4	**Potential Problems**	✔
week5	**Solution choice**	✔
week6	**Methodology**	✔
week7	**Ideating and rough designing**	✔
week8	**Building web server**	✔
week9	**Building the prototype**	✔
week10	**Results & conclusion**	✔
week11	**Final tweaking**	✔

Chapter 8: Validation

The (name of sensor) was validated through testing, by putting it near different types of carbon dioxide (or whatever gas) and recording the values as they all are different. This interaction was tested multiple times in 2 unique settings to measure all parameters and accuracy in other areas with surrounding hindrances.
When checking the gas, we (can just turn on a lighter close to the sensor and gathered information/particles.
(breathing and checking)
(smoke from air)
(air in general)

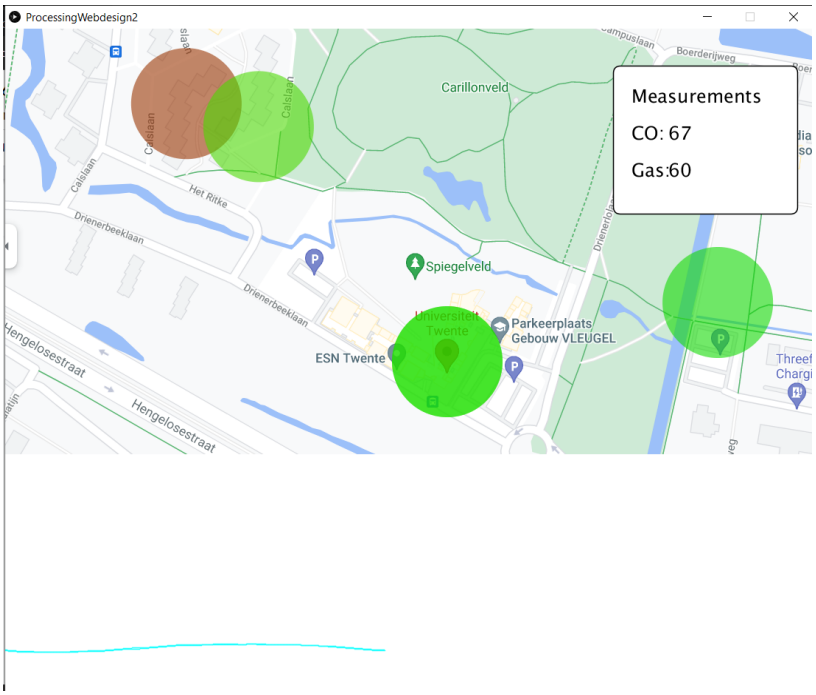
DATA COLLECTED

air in bedroom:	**150-180 ppm**
breathing heavily on the sensor:	**250-450 ppm**
air from the environment:	**~170 ppm**

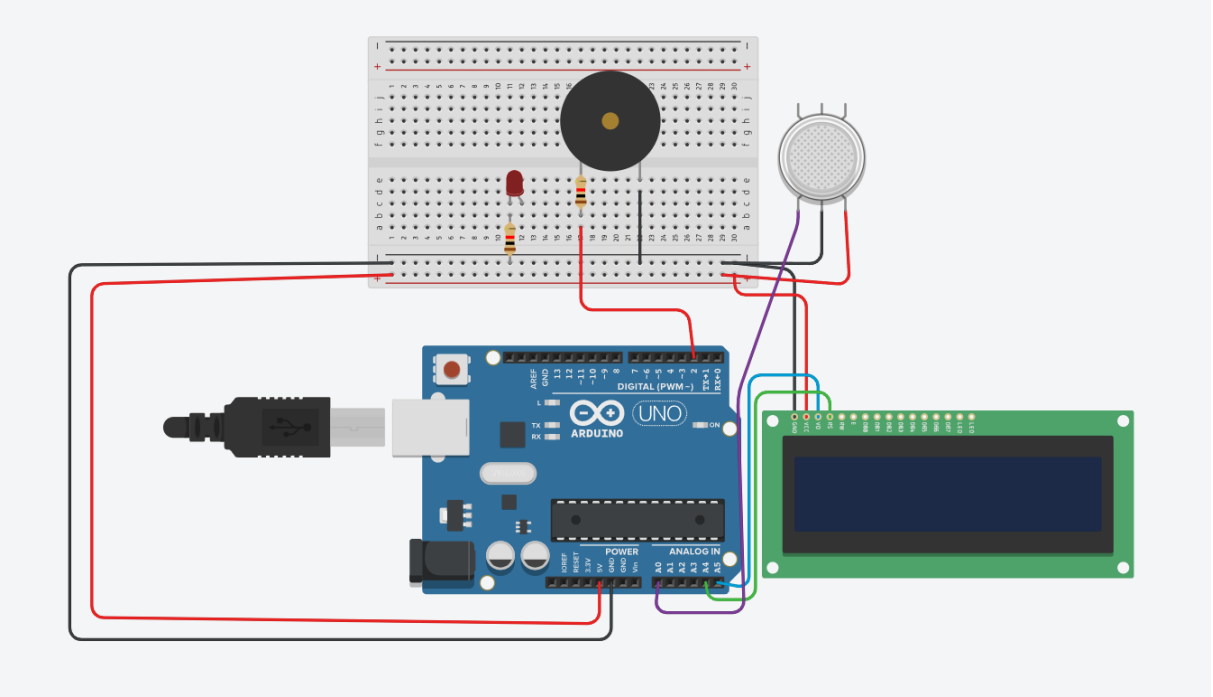
Chapter 9: Results and Conclusion

The website design

For the website, we decided to make a concept in Processing. The Processing program can read the serial values that the Arduino measures. The values it reads, can you see on the right of the screen. On the location of the device, a circle is drawn. Now it is just an image of google maps with a fixed location. Based on the value that it measures, the colour of the circle changes. With a lower value, the circle becomes green. With a higher value, the circle becomes more red. The other circles are circles from other people with the same device, so you can see the air quality in other locations. For the concept website, it draws a random circle with a random value.



Circuit



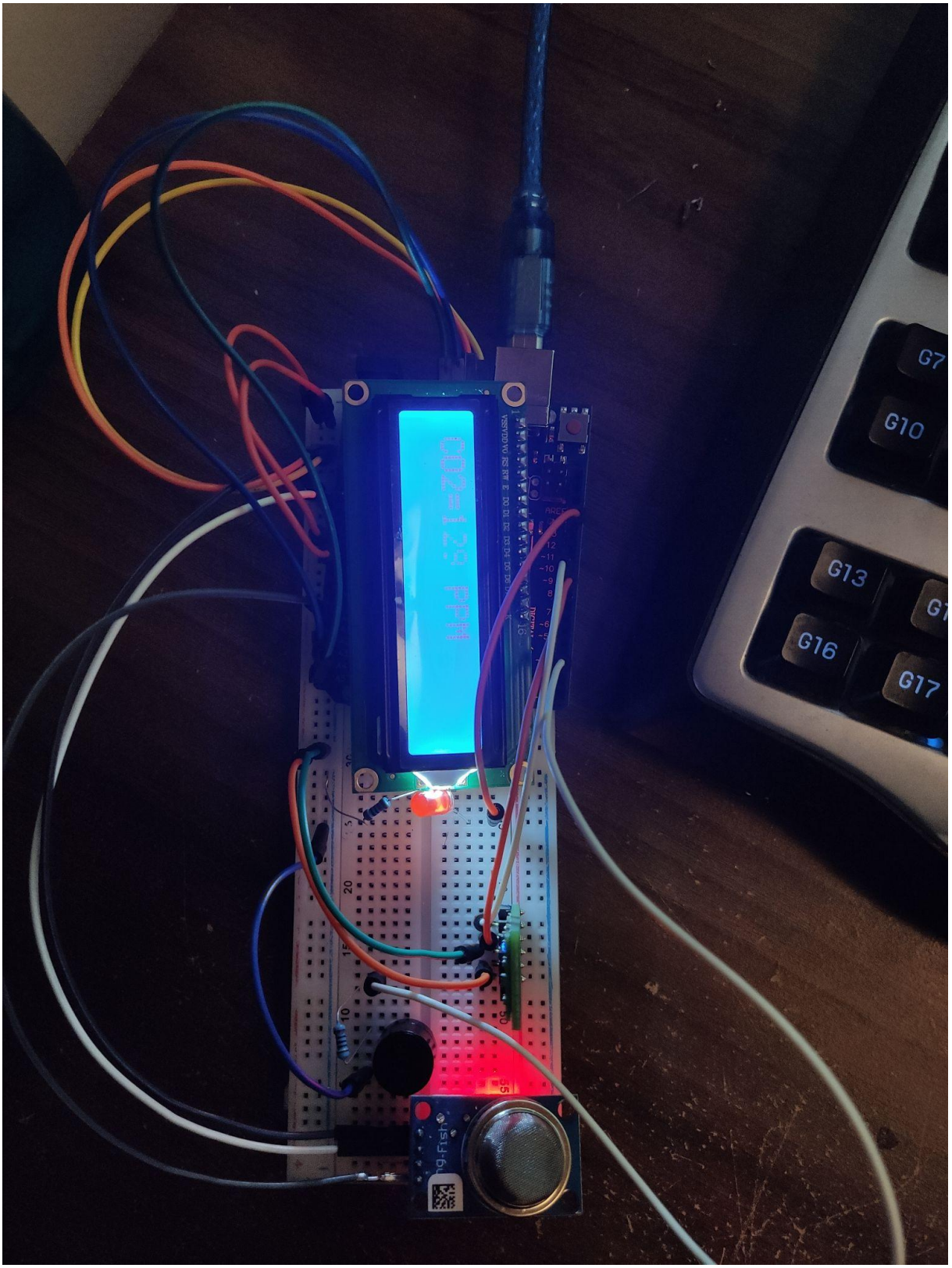
Our LCD is connected through an i2c backboard which makes it only need the 4 wires shown in the sketch.
There is no model for the HC05 or any other similar wireless module so I could not include that in the sketch.

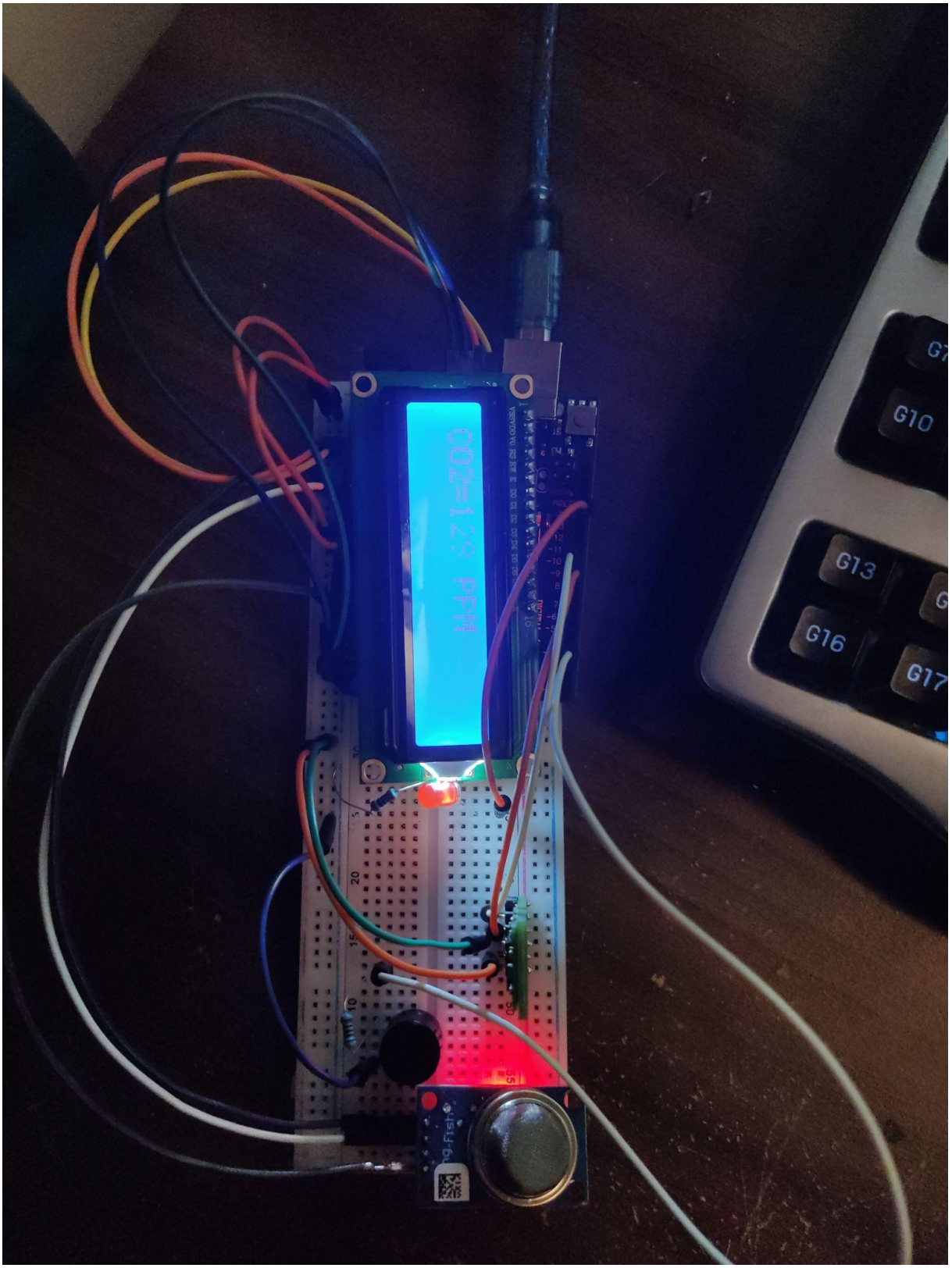
Prototype before casing

The prototype at this stage takes CO2 ppm readings from an mq135 sensor and prints those values on a 1602 lcd. At the same time this data goes through an HC05 Bluetooth module and gets transmitted to Processing in which it is shown as a readable value.
If the CO2 ppm gets above 300 a buzzer and red LED will turn on and off every second to warn you. 300 is an arbitrary value but it is one that is easily reproduced to demonstrate the capability of this little device.
For the next step, hopefully before the demo we will use processing for android SDK to reproduce this with an actual gps location and run the device on battery power as seen in the last picture and video here: https://youtu.be/94SwyTqGpQY

Code

The code is a bit long so to take a look at it you can check this github page
https://github.com/Yasinzo40/GasSensorProcessingArduino


CO2=129 PPM
G7
G10
G13
G16
G17


CO2=129 PPM
G10
G13
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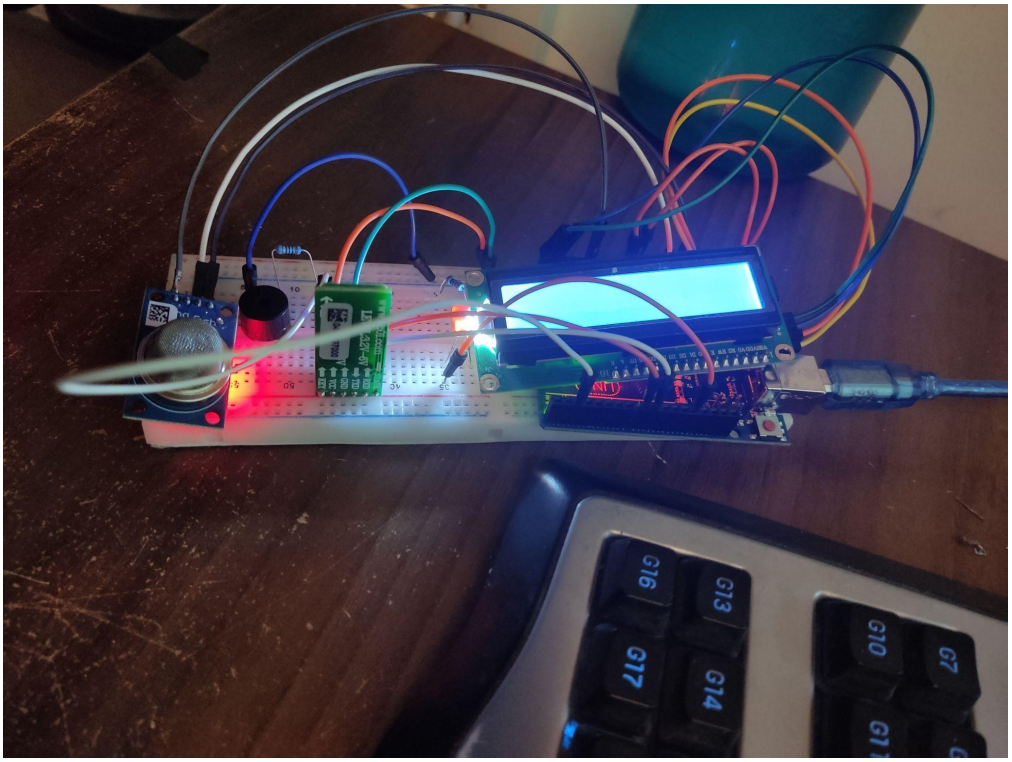
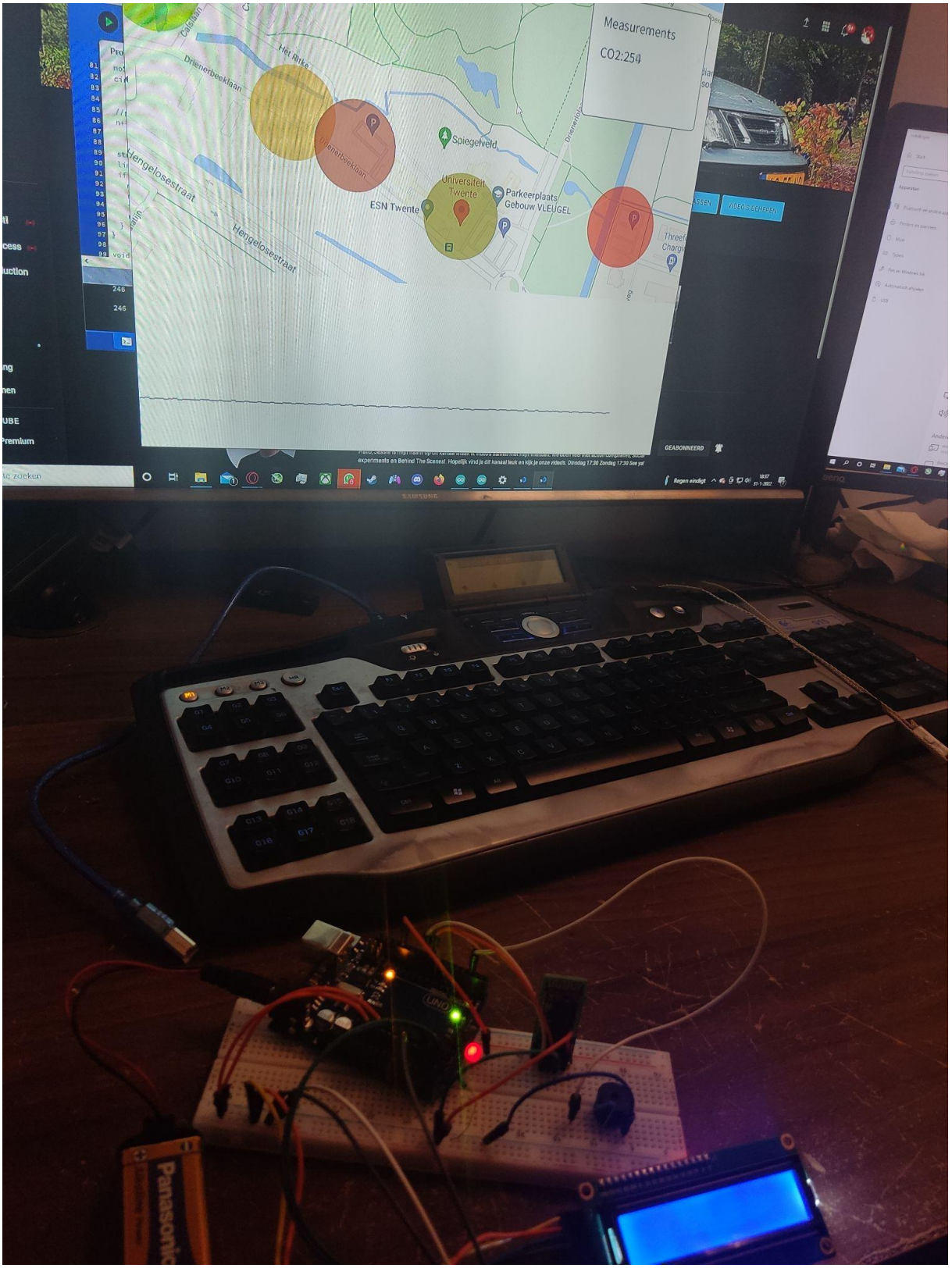
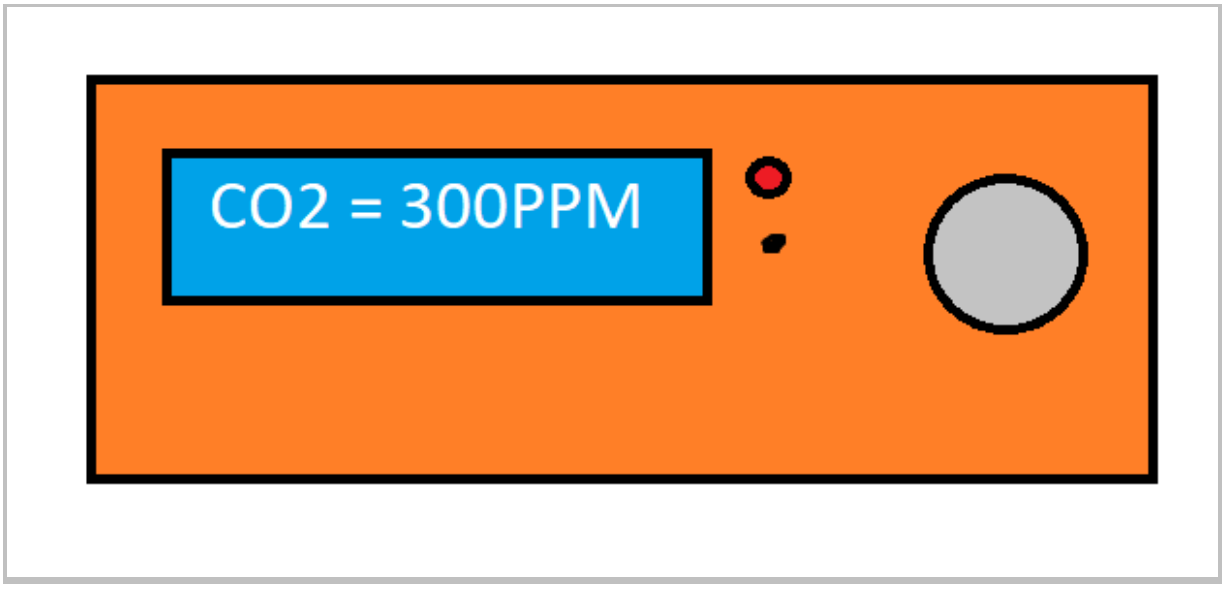

G16
G13
G10
G7
G17
G14



Obviously this is an extremely rough design but we will design a 3d printed casing around it to make it compact, durable and actually portable.

The initial idea was to make a wrist wearable thing but we decided that something to put in your pocket would be cooler and honestly just easier to make.
We plan to make something like this:
The red LED and speaker hole to warn you when the co2 value is too high with the co2 sensor flush with the casing so it doesn't get snagged on anything and damaged.
Then on the android side you can open an app to see local average CO2 levels.
That is the idea if we were to do this on a larger scale with many users anyway.



Conclusion
So to conclude
We are quite happy with the way the arduino and sensor work on their own. We really would like to make it work with google maps integration and android but that might not be possible in the given timeframe.
As it is right now, or I should say as it will be during our presentation we quite like how the machine works.
You can see the air quality around you and are warned when it gets too high.
As far as learning goes we collectively learned that even simple ideas like this take a lot of time, thought, attention to detail and trial and error.

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