Smart Environments Project – CreaTe M2

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# Challenge

(500 words)

We will be working on the problem that cities are facing in their regional food supply. As cities grow there will be less space for agriculture. We think tackling this problem will help a lot of other problems we are facing as humanity that are caused by our food supply. For example, the climate change that is caused through the emissions of transport. Or the uncertainty of what exactly is in our food; we don’t know what is added to make it look better, taste better or expire slower. Regionally produced food would need less additives (because it doesn’t have to travel so far) and will be easier to trace along its production line, because there are less people that have anything to do with it.

On top of that, we think the idea of growing your own vegetables will encourage people to eat healthier.

We as a group liked the idea of trying to solve the problem that cities are facing in their regional food supply because it is tangible. If we manage to increase the regional food supply, we can take on the bigger challenges that would be harder to handle, like the emissions of transport, by simply reducing the need for transport. Thinking about this problem immediately sparked ideas in our group and that’s why we have chosen to increase the regional food supply in a way that will be relatively cheap and easy.

# Solution

(500 words)

We want to make smart tiny modular greenhouses. We have made this decision because we think this will have a positive influence on the many problems that are being faced in the city regional food supply. By implementing these tiny greenhouses in cities, we would be able to cut back on shipping, reduce unnecessary packaging, and ensure that the food that will be grown has no unnecessary additives. This will influence the climate in the best possible way.

We want to make our greenhouses modular, so it will be accessible for everyone. If somebody wants one box, they can get one box, but if somebody wants 10 boxes, they also can. By easily combining different greenhouses you can assemble your own preferred mix of food to fit your own taste. There will be a simple connection for the power and water so it will take minimal effort to set up, adjust and expand.

The box is also very nice for people who don’t know a lot about growing plants or vegetables. The integrated Arduino takes care of everything from lighting to watering.

All the boxes in one household are connected to each other via a hub. The hub is connected to an app on your smartphone from which you get a notification when the plants are ready to harvest. You can also see how many times a plant was watered and how many hours of light it has had.

# Method & tools used

… (software, hardware) (1,000 words)

The tiny greenhouses will be a square box of around 400x400 mm, with a drawer of 300x400mm where the plants will grow. The boxes will all have automated irrigation, light levels and monitoring. They are daisy chained and connected to a central hub, which contains the water, wireless connections and a control unit. The irrigation system per box is connected to a central container with water, which spreads the water over all the boxes.

The water container on top of the boxes is filled with water by hand. This will need to happen once in approximately 3 weeks. It distributes its water to the smaller containers in the modules using gravity.

In every box there is a small container, about the size of a small bottle (10-15 cm), which gets filled with water by gravity. This small container has a small pump that gets turned on when the earth is too dry.

The moisture sensor is implemented in the earth of the plant. If the sensor senses that the earth is to dry, it will send this message to the Arduino, which again sends a message to the pump to start watering the plant. The water container can sense the water level. It will notify the user when the water supply is running low, after this notification the user can refill the supply.

Then we have the light. We are going to use grow lamps in the boxes. These lamps consist mostly of red LEDs, a lot of blue LEDs, and some UV LEDs and IR (Infrared) LEDs. These colors are the best light for the plants to grow.

In the middle of the left and the right inside of the box, we have a light sensor. This sensor measures the light that comes from outside of the box. The Arduino uses this value to calculate how much extra light the plant needs.

In the front of the box we have a hole, so the user can see the plant, and the plant can get some air.

Next to the boxes and the container there will be an app for the user to download on their phone or tablet. Here the user can see all the data of a plant in a user-friendly way. The app will send a notification when it is time to harvest the plant. After a plant is harvested, it will be visible how many times the plant is, for example, watered, or how many hours of light it has had. The conditions will vary slightly from box to box. The user can give a rating as to how the plant looked at the time of harvesting and how it tasted. The hub will then send this to a global server to compare growing conditions and learn to optimize these conditions for every different type of plant.

# Results/observations/data gathered/graphs

… (1,000 words and/or 3-4 figures/graphs)

During the making of our lightning system we have found out[21] that the best color to grow plants is a combination of red and blue with the ratio 5:1. Blue is the most important for the growth of the plant because it is easily absorbed by chlorophyll and converted in to energy through photosynthesis. Red is the second most important wavelength, red on its own does not influence the growth of plants that much but when combined with blue it will lead to a better flowering stage, not only increasing the quantity of the harvest but also the quality.

We have encountered that different plants need a different day and night cycle to optimize the growth of the plants. For the growing of the plants you need around 1500 till 5000 lux[22], where 1 lux = 1 lumen/m2. The optimal light requirements differ a lot between the plants we have chosen to research:

Garden cress[23], which grows optimally with around 2-3 hours of light each day.

Champignons[24],which does not depend on the light to grow but it would rather grow in the darkness because the darkness preserves the moisture that mushroom spores need to reproduce.

Strawberries[25], which needs around 6-10 hours of light each day.

Lettuce[26] and Radishes[27], which needs about 12 – 14 hours of light each day.

Some plants need more water than other plants, we have researched the watering needs for the plants we use:

Champignons[24] need a steady moist soil with a moisture level from 35-40%

Strawberries[28], Garden cress[23], Lettuce[26] and Radishes[27] need to be moisturized once every day while making sure the plants do not overflow.

## Conclusion:

Sadly we could not research the optimal growing conditions ourselves because it would take too long for the plants to grow and then to compare the different harvests so we decided to trust the internet on the ideal growing conditions, these growing conditions will be calculated over time because users can grade their harvest. Resulting in the hub learning the best growing conditions for each plant.

We found out that making the boxes modular is much harder than we expected we’ve not been able to make the boxes modular enough that it would automatically detect another box next to it. We have added the modularity through the app, where you can enter which plant you’ve put in the box and the box will then automatically set the correct day and night cycle and it will automatically set the correct watering cycle.

We also researched the combination of different plants where they would improve each other’s growing conditions. But because most of these combinations only affected outside conditions, for example[29] tomatoes and cabbages where the tomato would repel the diamondback moth larvae which will eat the cabbage leaves. And most of these combinations are an inedible plant and an edible plant, and because our boxes are focused on edible plants, we have decided not to use these combinations.

We think our box will solve the regional food supply problem, if everyone would have a few of our boxes in their homes, it would supply enough vegetables and herbs to decrease the times we would have to buy vegetables in the supermarket, what will lead to less transportation for these vegetables, less packaging and no need for pesticides or conservatives. We also think that because our boxes are controllable by an app it will also encourage younger people to start growing their own vegetables.

# Video

See the folder of this document to find the video.

# Full working code

See the folder of this document to find the code.

# Photos

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