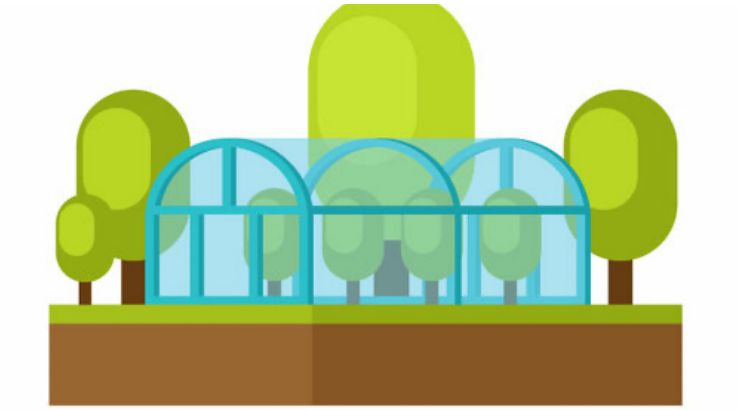
ENGR 130-05

DR. CONNIE

GREENHOUSE FINAL REPORT

Arduino Greenhouse Engineering Term Project



By Erica Coleman, Sara Cerecedes, Zaynab Abdallah, Kimberlynn DeBolt, Renee Daniel

INTRODUCTION

Problem statement:

Food insecurity is a wide-reaching issue that is becoming more widespread in recent times. Fifty million people in the United States struggle with food insecurity. In the absence of access to nutritious food, short term and long-term health concerns are more prevalent. Poor health has overarching consequences on quality of life, not to mention life expectancy.

Research:

Article 1: Greening Canada's Arctic food system: Local food procurement strategies for combating food insecurity

Citation:

Chen, Angel, and David Natcher. "Greening Canada's Arctic food system: Local food procurement strategies for combating food insecurity." Canadian Food Studies/La Revue canadienne des études sur l'alimentation 6.1 (2019): 140-154.

Abstract:

Across northern Canada community gardens and greenhouses are being used as alternatives to imported foods that are often unaffordable, are of compromised quality, or simply unavailable in local retail outlets. Community gardens and greenhouses are seen as part of the solution to lessen local reliance on costly nutrient-poor market foods imported from the south. In spite of their acknowledged benefits, research on community gardens and greenhouses in northern Canada, including their numbers and locations, remains sparse and anecdotal. The objectives of this research were to inventory and map community gardens and greenhouses in northern Canada, encompassing Labrador, Nunavik, Nunavut, Yukon, and the Northwest Territories. This inventory represents an initial stage of research that will determine the extent to which community gardens and greenhouses, as local procurement strategies, are meeting the food needs of northern residents. This research is part of a circumpolar research project supported by the Arctic Council's Sustainable Development Working Group, which is examining the opportunities for the Arctic to become a self-sustaining food-producing region.

Article 2: Implementation of a community greenhouse in a remote, sub-Arctic First Nations community in Ontario, Canada: a descriptive case study

Citation:

Skinner, Kelly, et al. "Implementation of a community greenhouse in a remote, sub-Arctic First

Nations community in Ontario, Canada: a descriptive case study." Rural and remote health 14.2 (2014): 79-96.

Abstract:

Food insecurity is prevalent in northern communities in Canada and there is a movement to improve food security through both the revitalization of traditional harvesting practices as well as through sustainable agriculture initiatives. Gardening in northern communities can be difficult and may be aided by a community greenhouse. The objective of this project was to conduct a descriptive case study of the context and process surrounding the implementation of a community greenhouse in a remote, sub-Arctic First Nations community in Ontario, Canada.

Article 3: The significance of vertical farming concept in ensuring food security for high-density urban areas

Citation:

Kalantari, Fatemeh, et al. "The significance of vertical farming concept in ensuring food security for high-density urban areas." Jurnal Kejuruteraan 32.1 (2020): 105-111.

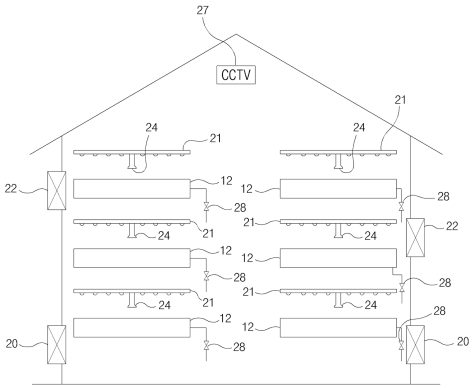
Abstract:

Cities are increasingly turning into megacities due to their enlarged and intense population. There has been a global attempt by designers to spread the view that cities can be potential areas for producing loads of food required by communities and fitted for specific ecologies. A similar trend has been spread to developing countries where it is essential to provide food for local consumption, and serious attempts are made to distribute food materials to protect particular urban communities. Therefore, recent attempts of food security have aimed not only to guarantee availability but also the provision of sustainable, locally-fitted and food production that is not industrialized to sustain the potential for production. The solution seems to be Vertical Farming (VF). Producing food can be brought into cities through VF and this significant step, if taken, can make life in cities more viable. The present research aims to review the VF plays in the future of food production in high-density cities. The present research reviews the body of related literature, both online and printed publications on the issue. VF is a turning point of the millennium in urban designing but not limited to that. It further presents a new type of architecture as both a local and global remedy for the 21st crisis.

PRIOR SOLUTIONS

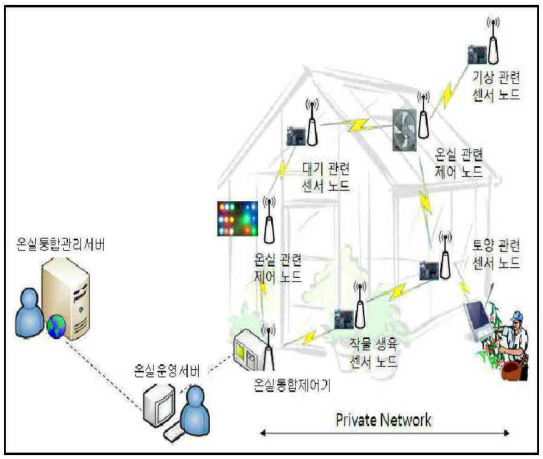
Patent 1:

- **Title:** LED Plant Factory Automation Systems (KR101692486B1)
- **Inventor:** Injoo Park
- **Pros/Cons:** An automated greenhouse helps to optimize a perfect growth environment and gain high crop yields by controlling the heat, light, humidity and other parameters including better irrigation control. The downside is it requires higher initial capital investment and constant monitoring, maintenance and care.



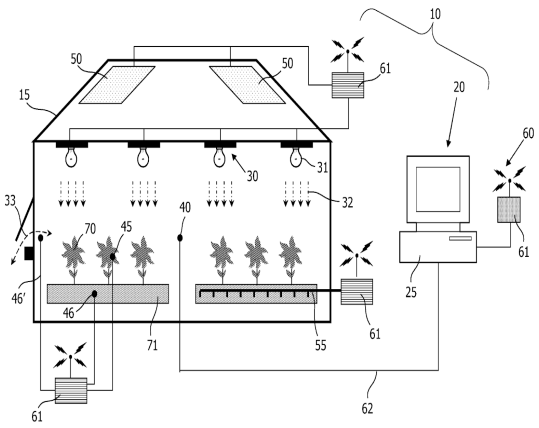
Patent 2:

- **Title:** Smart Greenhouse Control System (KR101815531B1)
- **Inventors:** Daewook Bang
- **Pros/Cons:** This smart greenhouse includes a greenhouse management server and various nodes that report internal information to create a suitable environment for crop cultivation and sustainability. The cons include how this product allows a person with little gardening skills to accomplish a crop yield. Cons can include how it requires various designated servers which will lead to additional costs and needs for security. User interface of greenhouse application/software is also not user friendly for a gardener with little to no technology experience.



Patent 3:

- **Title:** Controlling Device for A Greenhouse (US8061080B2)
- **Inventor/s:** Hans-Peter Loebl, Wolfgang OBudde, Joseph Hendrik, Anna Maria Jacobs
- **Pros/Cons:** The pros of this patent include its well detailed components for a control system for various smart greenhouse elements such as lighting and computerized control. The cons include the element of measuring oxygen partial pressure and plant photosynthesis. This would be beyond the scope of our project and would undoubtedly take a long period of time to initialize depending on location and plant type. This patent may need to be simplified for a smart greenhouse to be widely available and accessible to food insecure communities.

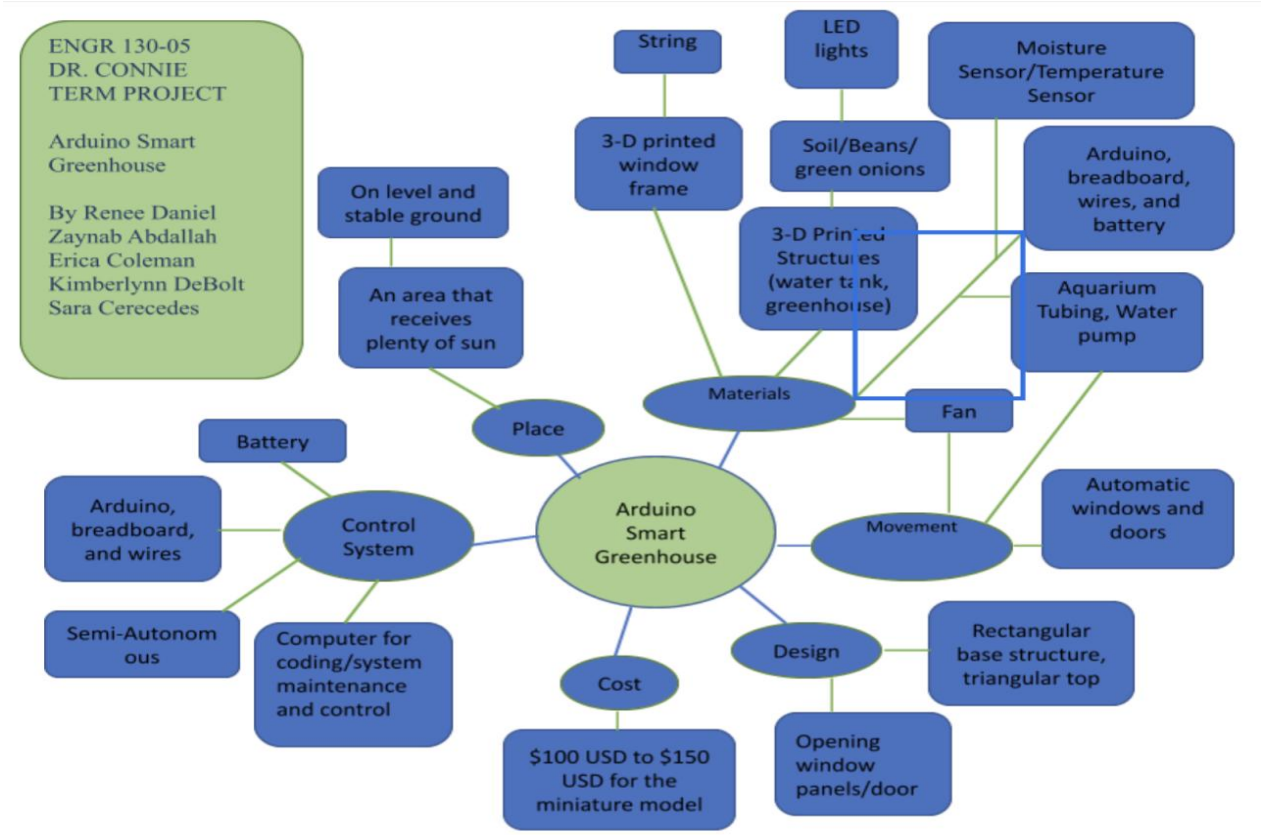


DESIGN PROCESS

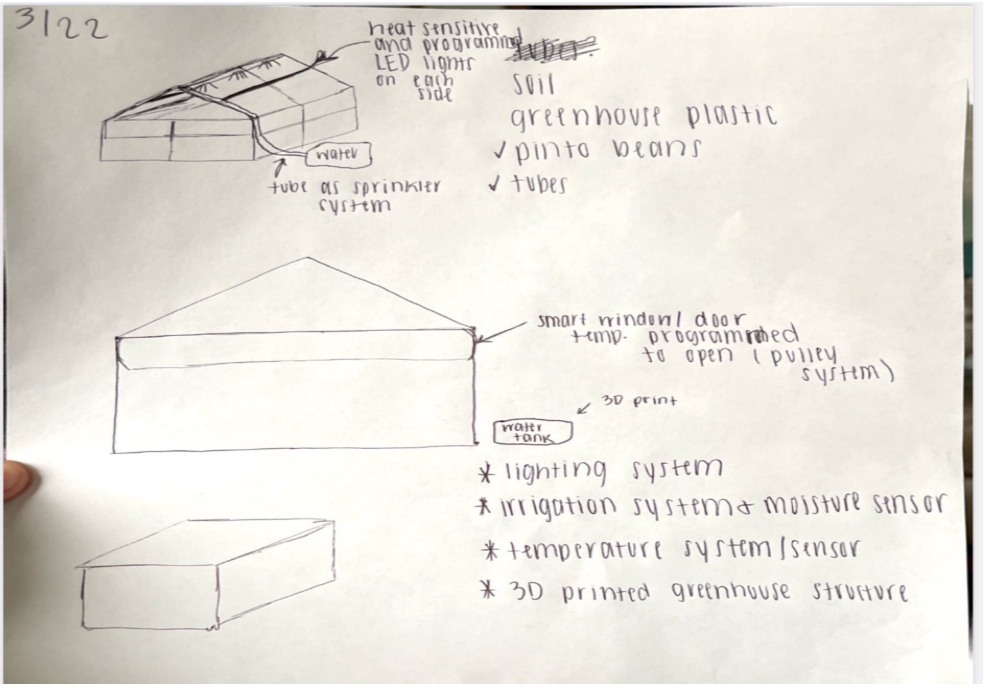
Design specifications:

1. **Customer Needs and Wants:**
    a. Needs: Provide an optimal environment to grow healthy foods and easy access to food.
    b. Wants: Help with food insecurity, be aesthetically pleasing.
2. **Form:**
    a. Rectangular base: length about 13 inches, width about 9 inches.
    b. Triangular roof consisting of automated/opening panels.
3. **Function:**
    a. Performance: Grow food that is easily accessible
    b. Durability: Lasts about 4-5 years
    c. Maintenance:
        i. Changing water
        ii. Planting seeds
        iii. Picking the vegetables
    d. Standardization: traditional greenhouse structure with pointed roof (gothic arch-style) to create more even circulation and optimized circulation of heat greenhouse plastic exterior.
4. **Material:**
    a. Soil
    b. Beans
    c. Aquarium Tubes
    d. LED Lights
    e. Fan
    f. Water pump
    g. Batteries
    h. Arduino
    i. Breadboard
    j. Wires
    k. Computer for coding each automated component
    l. Temperature/Moisture Sensor
    m. 3-D printed structure
5. **Cost:** Around $100
6. **Aesthetics:**
    a. Similar to regular greenhouses
7. **Ergonomics**
    a. Ergonomically benefits food security and accessibility.
8. **Safety and legal issues:**
    a. Uses chemicals and PPE is required.

Brainstorming:



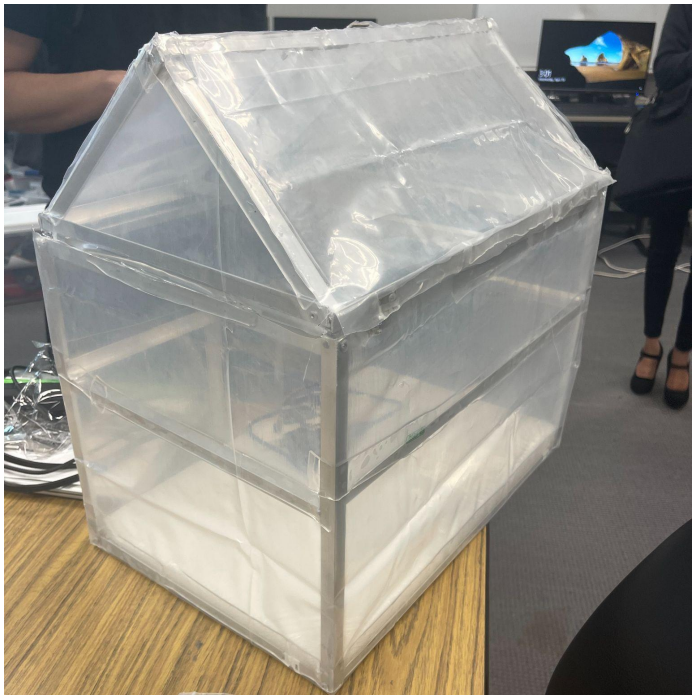
Sketches:



PROCEDURE

Construction:

1. Connect the aluminum L-brackets by screwing them together to build the frame of the greenhouse
2. Place the Styrofoam base in the bottom of the aluminum bracket structure to create a stable surface for the plants and organisms to be grown
3. Using double sided tape, secure the clear greenhouse plastic around the aluminum. Cutting the greenhouse plastic will be necessary to ensure a proper fit.
4. To code the components, use the breadboards, wires, and Arduino application. Make sure to test your codes and properly compile them all into your program.
5. After coding everything, place each component around and into the greenhouse (the moisture-controlled water pump and irrigation system and the temperature-controlled fan)
6. Take the soil tablets and arrange them in the greenhouse
7. Add water to expand the tablets and then plant your seeds
8. Your prototype community greenhouse should be ready for demonstration! :)



CONCLUSION AND RECOMMENDATION

This greenhouse prototype will hopefully be used to build larger scale community greenhouses around the world. We would like to see these greenhouses be built in struggling communities; the fresh fruits and vegetables that grow will be available to the public and will help to diminish the growing problem of food insecurity. It is statistically proven that in economically struggling communities, nutritious foods are harder to obtain, so with anticipation, our smart greenhouses will be scattered across the globe, providing many communities with healthier food options and one less thing to worry about in an uncertain world.