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Engineering Design VI – Homework 2
February 4, 2011

Low-Powered, Scalable Greenhouse Control System

Overview

The world's population increases every day. The infrastructures that support our food supplies are very delicate. Natural disasters/diseased crops/low yields/political instability/energy concerns can lead to food shortages on a large scale. Besides the logistical means of producing and consuming the food, the risk of inflation, especially today, where more people are financially strained, would put food out of reach of many people.

A modular greenhouse system would be ideal to ensure that food is available to the general public. A "green" system, when applying the terminology, generally refers to a system that produces efficiently with the least amount of input energy. Because energy can become a concern, the adaption of solar and other alternative energy systems would provide year round, scalable growing opportunities for anyone using the system. A small microcomputer would be the heart, controlling the other peripherals that would be required to produce a certain crop. The reason I stress scalable is that the system should be relatively inexpensive and almost universally adaptable to size, crop, nutrients, available daylight and temperature. The system would ideally run solely on the electricity produced from a solar cell, but will take other compatible inputs to maintain the system operations.

This greenhouse system should be modular and programmable in all aspects: temperature, lighting schedules, nutrient supply, crop growing cycles, and etc etc. The main focus is to provide a viable option that can *consistently* produce vegetables to feed people year round, using nutrients that are readily accessible. A single microcontroller, using modular options, should have the capacity to produce and execute a repeated cycle that could be isolated and tuned for each individual crop. The data can be logged and used for analysis, further allowing the system to be tuned for optimal yields. Maintenance of wearable elements should only require off-the-shelf, common agricultural supplies.

Senior Project Constraints

This project and the research into its creation should be possible within the two semester constraints. A team of engineers, with specific skillsets, should be able to contribute to the overall project, and I would expect rapid development and prototyping. The components are inexpensive and elementary, but the intelligence and finesse of the design to make it an attractive, sustainable option for an end user, should test the skills and creativity of the team. The construction of the physical platform should be considered just as important as developing the logic.

Marketability

This greenhouse system is designed to be implemented on a regional scale, to provide food for hundreds or thousands, depending on the size of the facility. The ideal usage would be for a group of individuals to convert unused factory space to agricultural space, utilizing hydroponic growing methods. These units can be hot-swapped, and should be stackable, in order to maximize the use of available space. Growing vegetables and grain indoors would allow for year round harvests. The total cost should be attractive to all people, as it inevitably saves money.

A person simply cannot move forward without steady supplies of food. The product has a large market, seeking many of the consumers that have turned to “green” living standards. Not only would this lower energy consumption on the global grid, it would reduce the reliance on large scale farming and the environmental damage caused by it. In addition, many of those who desire organic, non-genetically modified foods would find this product appealing. Urban dwellers are becoming more aware of food costs, and are beginning to seek their own methods of production in their living spaces.

Components

The market is saturated with low-cost electronic components and microcontroller boards which could easily handle the tasks required, and do so with minimal energy requirements. The push for more efficient, safe energy production will only drive the cost of batteries/solar cells down, which will play a large part in how this system works. Besides the main electronic components, an array of sensors will tie together to monitor all aspects of the growth and ensure optimal yields. The use of artificial light in the operation should be supplied by LEDs of proper wavelength to promote growing. Hydroponic methodology would be built into stackable cubes, that piggyback or connect to a main hydration/nutrient delivery system. Electricity is of utmost importance, and it cannot be wasted, so this system would tap into a controllable power grid that would link each box to the bus line, through itself. The concept would be similar to Lego sensors and motors that connect to each other to form this type of connection method. Use of impact plastics for construction of the cubes would allow for longevity of the system and inexpensive implementation. All the support lines and pumps to move the water and nutrients through the system should implement simple, off-the-shelf parts.

Skills

I would require the skills of an electrical, mechanical, and possibly chemical engineer. I and the electrical engineer would possess the skills to complete the logic of the system.

SWOT Analysis

- Strength: Food shortages in the world could be mitigated, intelligent/efficient agriculture, allows for the conversion of unused factory space, low power consumption/pollution overall, empowerment of local communities and inexpensive components make this widely implementable.

- Weaknesses: Power consumption will be of utmost importance, and our crumbling infrastructure cannot be relied on for stable cost and uptime. Some issues could arise in delivery systems and their longevity, and the water used in them may be an issue when it comes from a public utility.
- Opportunities: Implementing this on a small scale, or putting it under a tent, could make this marketable from families to developing nations.
- Threats: Crops that are effected by bugs and viruses, competition with other types of agriculture, and inability of components to last long enough to be useful.

"I pledge my honor that I have abided by the Stevens Honor System."