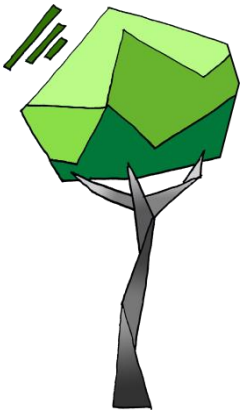
Treeborg



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The objective of this article is to present the work done by the Treeborg Team during the European Project Semester on the development of the device that would collect data about the air pollution and surrounding environment, while providing a Wi-Fi hotspot, which would be powered by the energy coming from the tree.

1. Introduction

Nowadays, it is becoming more and more popular to be innovative, 'green' and efficient. The group of students on their EPS (European Project Semester) was to investigate the possibility of implementing an electronical device in a tree. The energy powering the invention should come from the natural processes of the tree. Their idea was to make a device that could measure the temperature, humidity and CO level and display the data to the general public. Moreover, it would provide a Wi-Fi hotspot. But does it exactly work?

2. Energy Generation

The energy is obtained with the use of BIOO's technology. There are two possibilities: either the energy comes from the process of the photosynthesis of the tree or from the bushes and grass around it. But how exactly does it work?

When the plant is growing while performing the normal photosynthetic processes, the organic substances or products of the chemical and biological processes are transported downside to the

Fig 1 Example of a BIOO technology; a BIOO Panel [1]

bacteria sitting in the bottom of the pot. Those products function as a nutrition for the microorganism, which are previously isolated by a patented secluding process. The bacteria digests the organic substances and cause electrons during the digesting to set free. The electrons are getting directly obtained by the rhizosphere (directly

influenced area in the soil, near the roots). As a result, the electrons travel through the nanowires created by the bacteria from one electrode to the other and create a current between the soil and the electrodes in the system. At the same time, water (H_2O) is generated due to an access of hydrogen. The current is driven to the accumulator or battery and supplying the wire to the actual device. So, the products of this process are just water (H_2O) and electricity, which is a really green solution to generate energy. The BIOO Panel working in this way is presented on Figure 1. [1]

3. The Functions of the Device

Once the energy is obtained and transported to the Treeborg device, it needs some sort of electrical components to do the job. There are four main components: the Arduino Uno, the Wi-Fi Shield, the Power Shield and the battery. They are all connected to the two sensors that collect data about the environment.

When the energy from BIOO's technology enters the Treeborg device, it is met with the Power Shield that has two functions. Firstly, it powers the whole device and secondly, it acts as a recharge platform for the battery, so that it can be used to store energy. If the BIOO technology failed to provide the device with the needed current, the energy stored in the battery will be used. The Power Shield will act as a filter which controls the energy that flows into the device. For example, if the level of energy is too small, the Shield will boost up the energy, so it can be used by the device. [2]

After powering the device, the sensors start to collect data from the surrounding area. It is due to the Arduino Uno. All of the data obtained from the sensors will be processed here through coding. One can tell Arduino what exactly to do by writing code in the Arduino programmming language. [3]

Through the code, the device can connect to the Wi-Fi surrounding and create its own server. The value of each data collected by the sensors will be displayed on this server. For future, this communication module can serve as a Wi-Fi hotspot to the people nearby.

4. The Appearance

The inside of the device is clarified, but what about the housing for those components? Two different ideas are developed. One is the housing for the internal parts and the other for the sensors that have

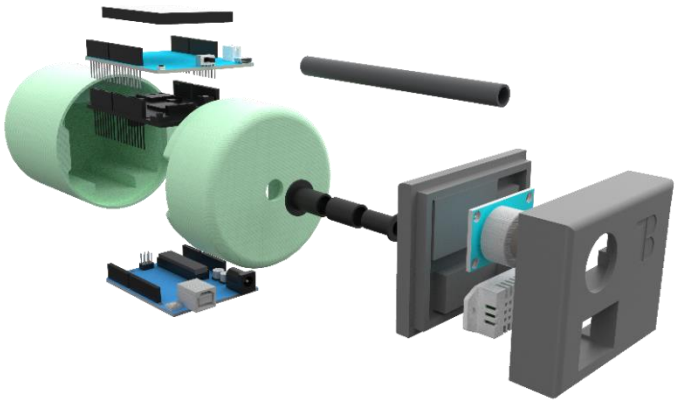

Fig 2 Render of the exploded view of the device

to be placed outside the tree.

For the interior device (containing the electronic modules), a capsule-shaped design that is similar to a general biscuit tin is created. The edges have a smaller fillet radius to reduce the size of the overall capsule to ensure no extra space is used. The capsule itself is made of two parts (bottom and top) which have a specially made slot for the combined modules (Arduino UNO, Wi-Fi Shield, Power Shield and battery).

For the remaining space inside the capsule, cables are soldered to the modules instead of connectors to allow for minimum space to be used. Both parts close together with a simple slot mechanism that allows the top part to slide onto the bottom. The capsule will be sealed with a strong adhesive such as Gorilla Glue, as it will protect the capsule from moisture inside the tree. For cables to connect to the module from the sensors and BIOO's technology, a 10mm diameter hole is placed on the top part. A cable made of tough material such as Kevlar is used to cover the hole and also protect any wires/cables that are used in transit. The overall dimensions for the assembled capsule is 95mm in height and 74mm in total diameter.

For the exterior device (containing the sensors), a simple box-shape design is chosen. Like the capsule, the sensor housing will also be two parts that can close onto each other. The cavity of the sensor is specially made to house both the DHT22 and MQ-9 sensor and secure them in place. Since the sensors are placed outside of the tree, they will provide accurate data for the modules. The overall dimensions of the housing are 50mm in height, 60mm in width and 22mm in depth. To tackle vandalism and the weather, the housing will be coated in a wood veneer that replicates the current tree and sprayed with a waterproof coating. The CAD model of the final device is presented in Figure 2.

5. The Impact on the Tree

When it comes to the implementation into the tree, it should be considered that trees are living organisms and will be harmed through an implementation of an electronical device. Therefore, a methodology where the least damage to the tree is provided should be used.

The best option is to find an appropriate tree where such aspects like the age, health, height, diameter, position, species and the condition of the bark have to be taken into consideration.

Once the suitable tree is found, three cuts:

Fig 3 Layers of a tree; the outer bark, the inner bark, the cambium, the sapwood, the heartwood [4]

one horizontal and two vertical, needs to be created in order to make a rectangular opening in the bark to gently drag down the three important outer layers of the bark (the outer bark, the inner bark, the cam-

bium). The tree layers are depicted in Figure 3. [4]

The next step would be the drilling of the canal for the device. It will be stored in the heartwood which is situated in the middle of the tree and consists only of dead cells, so it will not hurt the tree.

Once the device is placed in the tree, the next step is to put the bark in its original spot and fix it to the wood to ensure that the important cambium layer, which controls the growth and nutrition transport is undamaged. As one of the last steps, the Kevlar canal for the cables can be drilled to connect the device and the sensors.

Finally, a treatment with tree growth hormones can be considered to give the tree a small boost for its recovery from the implementation and attachment of the device.

While considering the options for implementation, there was a different method investigated. It will provide possibly less damage to the tree by using the uncut section of a cut branch as a hideout for the device without hurting the main trunk. This might be also a good option for the platane trees as they get trimmed every year, they offer a lot of uncut sections to hide the device in it.

6. Future Development

In the future, the device will be consisting of new, smaller and more compact components, because it is necessary for the device to decrease in size and in price. Using the smaller substitutions for the electronical parts will allow the final size of the device to plummet.

This device will be very useful and can be developed further in the future, so it can follow the needs of people. With the energy obtained from the tree, people do not need to be worried for the power supply of this device, so it can be installed anywhere and everywhere, whenever there is a tree.

7. Conclusions

Though it may seem as an impossible invention, it is obtainable and the Treeborg team managed to build a prototype and prove to the world that the device is fully powered by the energy coming from nature and the implementation into the tree is possible, and be ‘the future’ which was never before, considered.

8. References

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