Tree of life – intelligent environment system station design

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Abstract. The three elements essential for life are sunshine, air, and water. This is an undeniable fact, but with advancements in technology, amenities such as electricity, smart phones, and the internet have become the urban versions of these essential elements for life. Most people living in cities desire constant connectivity. This connectivity requires significant electricity and access to a high-speed internet connection. The purpose of this research is to design a wind turbine system modelled after the shape of a tree with the blades built inside the tree. The power generated by the tree will be stored in a power bank located inside a station adjacent to the tree and will be available to the public. Additionally, there will be WLAN antennas built inside the tree branches to provide wireless internet signals. Finally, the electricity produced will be green energy, which will help us achieve the goal of eco-friendly but intelligent life.

1. Introduction

Our life has changed drastically since the smart phone appeared. In the past, the cell phone only has simple functions like sending and receiving calls or text messages. Today, smartphones can replace many things like wallets, tickets or even car keys. Therefore, power has become a big issue for phone producing companies. Still, no matter how big the battery is inside the phone, the power is never enough. Thus, a power bank seems to be everyone’s must bring item. However, a power bank can be heavy and take up lots of space.

Moreover almost every function in the smart phone requires internet connectivity. For those who do not have unlimited access to a cellular internet, government provided free Wi-Fi can be very useful. The Tree of Life - Intelligent Environment System Station provides these two major functions: a green energy generated power bank and free public Wi-Fi.

1.1. Traditional wind turbines

A wind turbine is a device that converts wind energy into electrical energy. This device is composed of wide blades and is usually oriented along either vertical or horizontal axis. Different sizes of wind turbines provide different levels of power for various devices. The wind speed can be categorized in different levels of wind powers as shown in table 1.

Poul La Cour, a meteorologist from Denmark, invented the first wind turbine in the late 19th century. However, the low efficiency of these early wind turbines made them unpopular until recent years due to the rise in awareness of eco-friendly power.
During the 1980s, wind turbines were able to reach 55 kW of generated power. Today, due to advances in technology, wind turbines are able to reach a maximum power of 5000 kW, and there are more than 600,000 devices installed all over the world.

1.1.1. Horizontal axis wind turbine The rotating speed of horizontal axis wind turbines is high. Almost every horizontal axis wind turbine is equipped with a wind-facing device that allows the turbine to change direction to receive the wind. For large horizontal axis wind turbines, this kind of device uses sensors to detect the wind direction. The horizontal axis wind turbine requires a higher wind speed and energy to start, however, the voltage generates is also higher [1].

1.1.2. Vertical axis wind turbine Conversely, vertical axis wind turbines require lower wind speed to start the blade rotation, but because of the starting power requirements, the efficiency of vertical axis wind turbines is lower than horizontal axis turbines. The wind restriction of this type of wind turbine is lower, meaning there will not be a need to face a certain direction to start the turbine. Further, owing to the vertical placement of vertical axis wind turbines, the space needed is much smaller than that of horizontal axis wind turbines. Therefore, it is more suitable for urban environments [2, 3].

| Level of the Winds | Corresponding Speed (m/s) | Performance |
|--------------------|---------------------------|-------------|
| 0                  | 0 ~ 0.2                   | 7           |
| 1                  | 0.3 ~ 1.5                 | 8           |
| 2                  | 1.6 ~ 3.5                 | 9           |
| 3                  | 3.4 ~ 5.5                 | 10          |
| 4                  | 5.5 ~ 7.9                 | 11          |
| 5                  | 8 ~ 10.7                  | 12          |
| 6                  | 10.8 ~ 13.8               | >32.6       |

1.2. Social benefits of wind turbine
The reason why renewable energy is more popular than conventional energy is because of its lower social costs. Traditional energy generation methods, such as coal-fired power generation, require nearly 40% more social cost per kwh of energy consumed than renewable energy.

The regenerative energy such as wind power generation not only reduces the persecution of the earth in the acquisition of raw materials, but also exerts lower pressure on the environment than traditional energy sources. Although the environmental pressure is low, it is not zero. The biggest shortcomings of wind turbines are two. The first is the noise generated by it and the second is the ecological impact. At present, the development of new-type wind power generation equipment has been very advanced, but the noise generated is a case of a one-megawatt wind turbine. The noise detected in a square of 300 meters is about 45 decibels.

At the same time, offshore wind power equipment is generally built on the windward coastline in order to obtain more wind energy. Usually, this area is also a route for general migratory birds, and many birds are also injured. However, compared with traditional energy generation, the environmental and social benefits provided by wind power generation are much higher, such as reducing environmental pollution, safe energy supply, lower cost in the long-term perspective, and even providing more employment opportunities. The creation of social prosperity, etc., these advantages have also made this power generation method popular in the world [4].

1.3. Public Wi-Fi service
By the end of 2018, the percentage of offload internet connections will reach another high mark due to the 16% year after year increase in smartphone and tablet usage. The reasons why people are choosing
to use Wi-Fi over cellular networks is the lower or even free cost of Wi-Fi. Consequently, the risks of using public Wi-Fi also rise. Therefore, people tend to use their mobile service more than offload traffic. This situation can be seen in Figure 1.

![Figure 1. Percentage of Mobile and Offload Traffic from Mobile-Connected Devices](image)

At the beginning of the twenty-first century, every major city in the world declared they would build public Wi-Fi for citizen and visitor use. Initially, this effort would seem to be very easy due to the mature technology of Wi-Fi service. However, it turns out not to be as easy as it seems because of security and blocking problems.

The major security problems of Wi-Fi are hacks. Because the majority of free Wi-Fi or public Wi-Fi network services are always unencrypted, anyone with cheap and readily available software can hack into any device connected to these unencrypted services. Therefore, wireless eavesdropping can happen on any free Wi-Fi service.

Even though people are aware of the safety issues of using public Wi-Fi, sometimes these issues are forgotten or ignored because they are in a rush or it is convenient. Therefore, connecting to a safe and certificated public Wi-Fi system is a better solution [5, 6].

2. Design and Methods
To achieve the goal of making an intelligent environment system station, this design took the three elements of life (sunshine, air, and water) as concepts and drew parallels with modern technologies. After analyzing the way people live, the results show that it is nearly impossible for people to live without any assistance from technology, especially as the Internet of Things has become so popular. Therefore, the three new elements of urban life are internet, electricity, and smart phone. This design combines these three entities into an intelligent environment system station with the hope of making people’s lives easier.

2.1. Electricity system
To achieve better efficiency and save space, we will use H-type as the design concept. There will be three blades using NACA 0018 airfoil. The wind turbine will be two meters high and one meter in diameter. When the wind turbine is rotating in a fixed condition, the rated power is 783.2 W, as shown in Table 2.

| Table 2. Wind Turbine Efficiency Analysis Parameter |
|--------------------------------------------------|
| Parameter/Value                                  |
| Swept Area (M)                                  | 2        |
| Rate Wind Speed (m/s)                           | 12       |
| Air Density (kg/m³)                             | 1.225    |
| Power Factor Cp*                                | 0.37     |
| Rate Power (W)                                  | 783.2    |
2.1.1. **Wind turbine blades design** According to the result, NACA0018 airfoil has the best performance under low wind speed condition. Therefore, this design used this type of airfoil as blades [7]. The coordinate plot of NACA0018 can be seen in Figure 2.

![Figure 2. NACA0018 Airfoil](image)

2.1.2. **H-Type wind turbine structure** To reduce the unnecessary spaces, this design use H-Type of wind turbine structure. This structure allows the design to achieve the goal of saving spaces but also generating high efficiency of electricity power as shown in Figure 3.

![Figure 3. H-Type Wind Turbine Structure](image)

2.1.3. **Tree trunk structure design** This research designed a tree trunk outside of the wind turbine as shown in Figure 4 to not only protect people from getting hurts by the rotating blades but also make this design more like a tree.

This tree trunk is three meters tall and the diameter is two meter, this size can entirely storage the whole wind turbine and keep one meter distance between the blades and the edge of the trunk. The main function of this tree trunk is to prevent people from injured, the ventilation calculation is not being tested in this period of research.

![Figure 4. Tree Trunk Structure](image)

2.2. **Power bank land and return**

The power generated by the wind turbine will charge the power banks located inside the station. The station design can be found in Figure 5. A touch screen installed inside the station allows people to register their personal information and start to land the power bank.
On the other side of the station, there is the area for battery to storage and charge and the image can be seen in Figure 6.

Every power bank has 5000 mAh power capacity as shown in Figure 7, which is almost enough to recharge a dead phone battery to 100% within an hour. On the back side of the battery, there is a special charging system installed. This unique charging system only allows the battery to only charge in this station, so when the battery is running out of the electricity, it can only be taken back to the station to charge. This unique charging system can be seen in Figure 8. Even though there are many other ways to bring a dead phone back to life. For example, there are many convenient stores where provides free charging services, but these services require users to stay at a certain location until their phones are fully charged. Also, bring a dead phone back to life only need few seconds, but if the purpose is to fully charge a dead phone require at least thirty minutes and above. Therefore, the portable power bank provides these benefits of convenience and mobility. When landing the power bank, the user swipes their metro card to pay the charge fee according to the amount of time the user landed. However, devices cannot be charged outside of the station so that power banks would not be lost. The Figure 9 indicates the image of how the battery will be like charging inside the station.
2.3. Secure public Wi-Fi service
The Wi-Fi device will be stored inside the battery exchange station. In Taiwan, the most public Wi-Fi is “iTaiwan”. This service now has more than 10,000 hotspots all over mainland Taiwan, even on the high-speed rail (HSR). Therefore, installing this service into the station allows more people to stay connected.

3. Conclusions
As technology improves, it is very hard for people to live a life without assistance from technology. In particular, with the development of the smart phone, power needs have reached the next level. Because electricity demand is so high, power generation is a big problem for every government. Clean energy resources are a better way for people to get electricity. Among all the clean energies, wind is the easiest resource to capture. However, most wind turbines are built by the government, therefore it is sometimes difficult for people to feel the benefits of clean energy. The design of this smart tree allows people to enjoy the benefits of clean energy directly and reduces the use of non-clean generated electricity.

Additionally, a city’s convenience is a big factor for visitors. A city that provides complete Wi-Fi for free is another attraction point. Therefore, this design not only uses clean power electricity as the main source, but also employs stations all over the city to provide the secure government-sponsored free Wi-Fi system. This design achieves the goal of go green but smart and gives our next generation a better future.

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