Trees of Knowledge

White paper on an invention by William Sachiti, January 2020

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Summary

This paper features an invention called a Tree of Knowledge, in which we use cutting edge technology to cheaply make trees growing in the wild in Africa into a repository of educational content. The innovation is designed to help play a part in educating some of the 34 million children in Africa who are currently out of education. Using this technology, we can supplement - or even substitute for - the school, the teacher and books creating an easily accessible digital educator.

Introduction

Author Arthur C Clarke once said that ‘Any sufficiently advanced technology is indistinguishable from magic’. As technology advances, humanity's innovations have gone from seeming like the work of science-fiction to now simply being magic. This paper introduces a practical way to turn trees growing in the wild into hubs of knowledge where a child living in a remote village can access knowledge stored in a tree. This is done by starting with a large tree then utilising simple, but state-of-the-art computing, artificial intelligence, pre-loaded digital content (knowledge) and a durable wireless hub. This easily accessible knowledge, exists in the form of videos which range from video lessons on an entire educational syllabus, to how-to guides allowing one to learn a new useful skill and significantly more, we call this all combined, a Tree of Knowledge. In some areas, Trees of Knowledge will negate the need for a child to walk miles to get to a school where they may or may not find a teacher. Trees of knowledge can also offer considerably more than educating school children, they are able to share information about the ecology of an area and what to look out for if lost, or really useful tutorials for people living in a village such as first aid skills, health, and hygiene information. The paper will not only describe the technology but will also give technical specification and guides on exactly how to create and make Trees of Knowledge a reality today. Most importantly, With the publication of this paper, I am releasing this as an open-source project, with no patents or intellectual property. This allows anyone to create, replicate or share any part of the technology described in the paper for free.

Fahari & Simbarashe

Fahari is a 14 year old girl who lives with her grandma and two younger siblings. Each day, she wakes up at approximately 5:00am, performs her daily morning chores before getting ready to go to school. At 6:45am she begins a nearly two and a half hour walk. Living in a remote rural area there is no other way to get to school and education is the only way she too may have a better future. The two hour trek leads to her school where she begins her day with her fellow pupils sitting under a tree in an ‘outdoor class’. Today she is lucky, sometimes, the two hour trek can be in vain for weeks at a time due to a lack of teachers, but she walks there daily anyway.

Simbarashe lives in a rural area in Southern Africa, he wakes up at 5:30, he quickly does his morning chores, packs a bag and makes his way to the cattle pen. He opens the gate, herds the cattle out, down to the river for a drink of water and then to the grass field about 40 minutes walk away. Cattle are the family's most valuable asset and their value is considered the same as a person. It is Simbarashe's job to make sure the cattle are safe when they are grazing in the grass field. He will sit under a large tree to shade himself from the hot sun and spend all day with the cattle to ensure they don't stray too far, get stolen or attacked by a predator. He will stay with them until sunset when it is time to take them back home. He is 13 years old, he does not go to school, for him and millions of other children, this is just daily life.

Understanding the problem - addressing the digital divide

In the present, western world, the influence of technology upon the sphere of education has drastically changed the way in which we are able to learn and the availability of resources. With 43% of the worldwide population[1] owning a smartphone and the growth of wireless technology connecting all corners of the globe, learning for many can be as simple as typing a question into a search engine and being flooded with information. Schools can make their resources readily available to pupils online and the growth of online courses has removed geographic and logistical issues hindering achievement of an education from many. However, despite the synergy between technology and education and all of the tools available, the nonprofit organization, UNESCO Institute for Statistics reports that more than 1 in 5 (that amounts to around 32 million) children of primary school age are out of education in Sub-Saharan region of Africa alone. On a continent where the average distance for a child to walk to school ranges between 5-10km[2], with possibly longer depending on the quality of schools further away, infusing technology with education stands to significantly improve the quality of life. Not only do technological innovations have the capability to simply offer more to the children and adults of Africa in regards to learning, but to change the way smartphones can be utilized so that they become almost infinite textbooks of information when in dialogue with a Tree of Knowledge.

[1]Sources: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/ and https://www.gsmaintelligence.com/research/?file=b9a6e6202ee1d5f787cfebb95d3639c5&download
[2] Source: https://asanteafrica.wordpress.com/2013/04/06/how-far-would-you-walk-to-school/

Wireless Roots

While most of the continent of Africa now has access to cheap smartphones and mobile devices, most of these are not connected to the internet due to a lack of 3G service available in rural areas or the cost of data being prohibitively expensive, the dream of streaming online content is a long way away. As a continent sporting over 15% of the world's total population, the fact that less than 40% of the population are internet users in 2019 (vs. a global average of over 57%[3]) highlights how almost a billion people still lack the ability to join an increasingly connected world.

For the majority of us in the western world, the expansion of internet coverage and development of super-fast, durable wireless connections such as the most recent 5G has created an environment in which users can expect to find an internet connection as second nature. With technology such as mobile hotspots even allowing for people to turn their phones into a wireless router temporarily. Trees of Knowledge seek to embrace wireless hotspot technology, not necessarily being connected to a larger network but ultimately transmitting a wireless connection that allows users within a 100 meter radius to access the information contained within.

Landmarks that inspire

Landmarks both artificial and natural have always inspired learning, existing as cultural and historical hubs that evoke an interest in research. From the wonders of the world such as the Great Pyramids of Egypt, or The Great Zimbabwe Ruins that in researching teaches the rich history of a nation. To natural wonders such as the Great Barrier Reef, that can teach about delicate ecosystems and humanity's relationship with them, especially in a time period sensitive to ecological issues. Landmarks have always existed as hubs of learning. From that school of thought and deep appreciation, is where the Tree of Knowledge is born.

Currently, many schools in Africa do not have enough classes and as a result, teachers are forced to conduct classes outside under a tree.

[3] https://www.internetworldstats.com/stats1.htm

In many cases, not only are there not enough classes, there are not enough teachers and thus millions of children do not go to school. In an ideal world, the best solution is to raise loads of money and simply build more schools and pay more teachers, but sadly the world is not that simple. Trees of knowledge simply makes digital, a concept that already exists. The ‘teacher’ who teaches around the tree can now be replaced or amplified with a local store of videos of all the same educational content, which in some cases will come with a narrow A.I avatar to assist the learner.

What is a Tree of Knowledge?

A Tree Of Knowledge is a tree which has had technology installed into it. The technology is an ultra low-powered micro-computer system no larger than an apple(the fruit). The system perpetually broadcasts educational content which allows anyone to watch videos and learn anything that has been preloaded on that tree's computer system for free. This information as expressed, may range from educational content assisting the learning progression of children in Africa, to local information in places such as national parks that can provide educational knowledge about the surrounding environment.

How Trees of Knowledge work

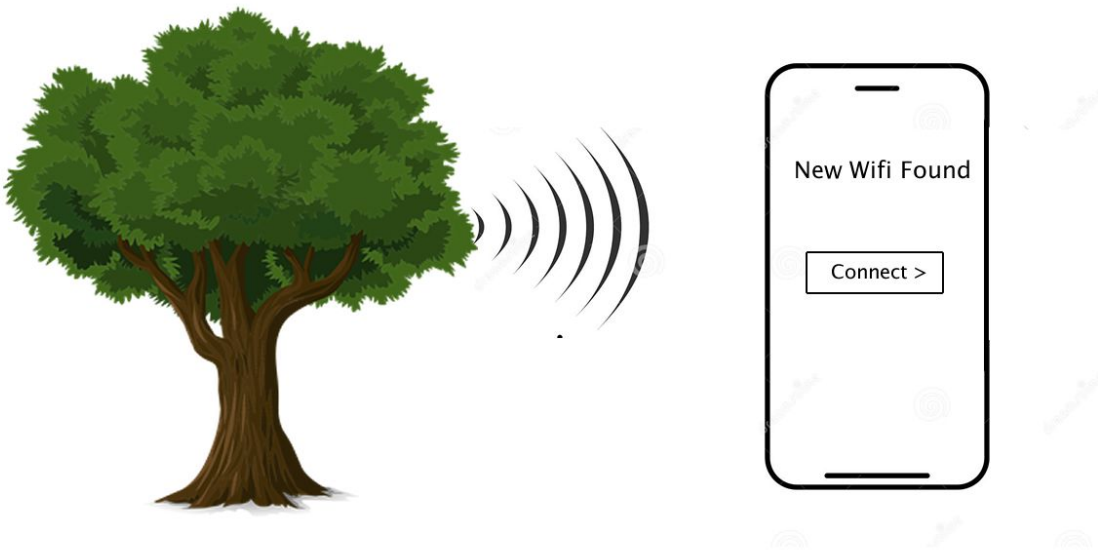
We are simply using tried and tested technology and using it in a very different way, the trees will be in strategic locations. The technology is an ultra low-power solar-powered mini computer which is used to create local wifi accessible mini 'educational server'. The computers themselves including their power source and casing take space no larger than than an apple and run on the power equivalent of a small rechargeable battery. Imagine such mini knowledge stores embedded high, atop trees in remote areas, not just schools, but at villages which are often known locally as 'Growth Points' and other areas of interest.

Namapa, Village Centre Mozambique

Remembering that in Africa many people do in fact have a cheap phone of some description, however what they can do with it is limited due to the lack of connectivity. For the user of a Tree of Knowledge, by simply being within 100 meters of a Tree Of Knowledge, their phone will notify them that a new connection has been discovered. By connecting to this wifi connection (the tree's connection), the user is instantly connected to a web interface that allows them to browse the content.

The experience is not dissimilar to how most modern coffee shops will allow you to connect to their wifi, but then serve you up a mini website with more information on the coffee-house and requesting you sign in. With a Tree of Knowledge, when a user connects to the tree's wifi, the user will be welcomed and simply asked what they would like to learn about.

Set up example



The figure above represents a tree with a Tree of Knowledge already installed. As a result of this, an open wireless signal is broadcast within a proximity surrounding the tree. When a user gets near the broadcasting station (in this case, the tree), the user will get a prompt asking them if they want to connect. A common dialogue which happens on all wifi-enabled phones today.

Once the user is connected, they will be served up with an interface for them to watch free videos on pre-loaded content as seen in the figure below.

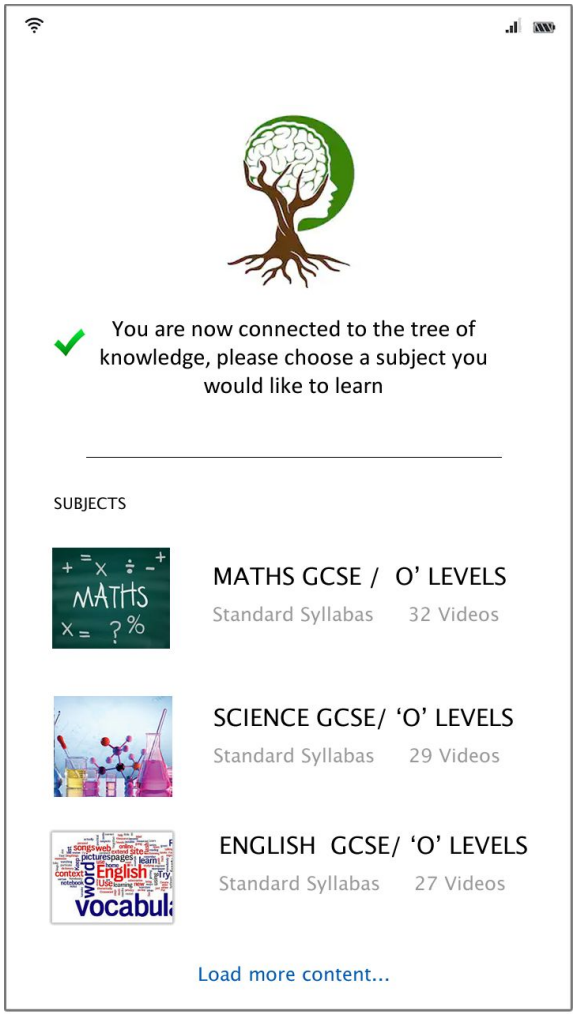


Fig 1.

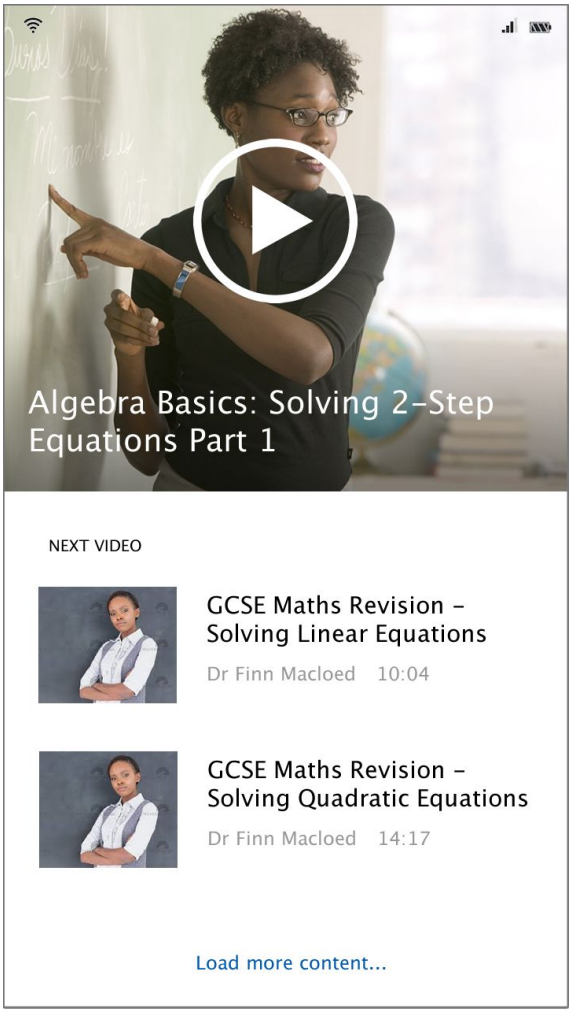


Fig 2.

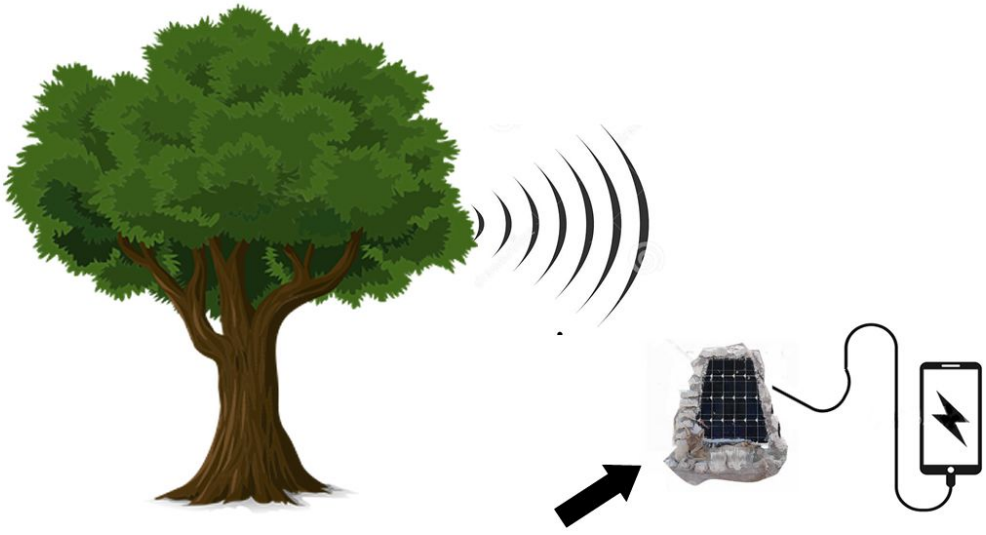
Fig 1 above shows a sample interface a user would see upon connecting to the wireless network being broadcast by the Tree of Knowledge.

Fig 2 Shows an example of what a user might see after having clicked on the option for maths lessons.

No ads, no fees, a simple clean interface which instantly shows content and allows the user to start watching right away.

Overcoming the challenge of access to electricity

While Trees of knowledge solve the content problem for under-utilised smartphones due the distance from a charging point to an area with internet connectivity problem, a further potential problem is that someone who wants to access the Tree of Knowledge will probably run out of battery quickly with no means to recharge the phone. Today, due to the challenges of availability of electricity, many people in rural areas keep their phones off, then only turn them on when they need to use them and then they turn them off again after. To address the power issue, an accompanying power base can be installed near the foot of the tree (see the example below). The power base is a small solar-powered battery charging station, this means that users can keep their phones charged while in the vicinity of the Tree of Knowledge.



Solar Panel encased in stone and concrete built casing with riot glass on the front offering 5 volt charging for mobile phones. Anyone can plug in a usb cable and charge most mobile devices.

How to build the Tree Of Knowledge

Requirements

- Any mico-computer such as raspberry pi (approx. US$20)
- Tree OS - Our custom linux distribution / or any Linux based operating system (FREE)
- A low power router (approx. US$25)
- Rechargeable battery pack / power supply with a solar panel (approx. US$20)
- Educational content such as video tutorials to load onto the computer. (FREE)
- A large tree with access to direct sunlight (FREE)

Optional Requirements (For the base charging station)

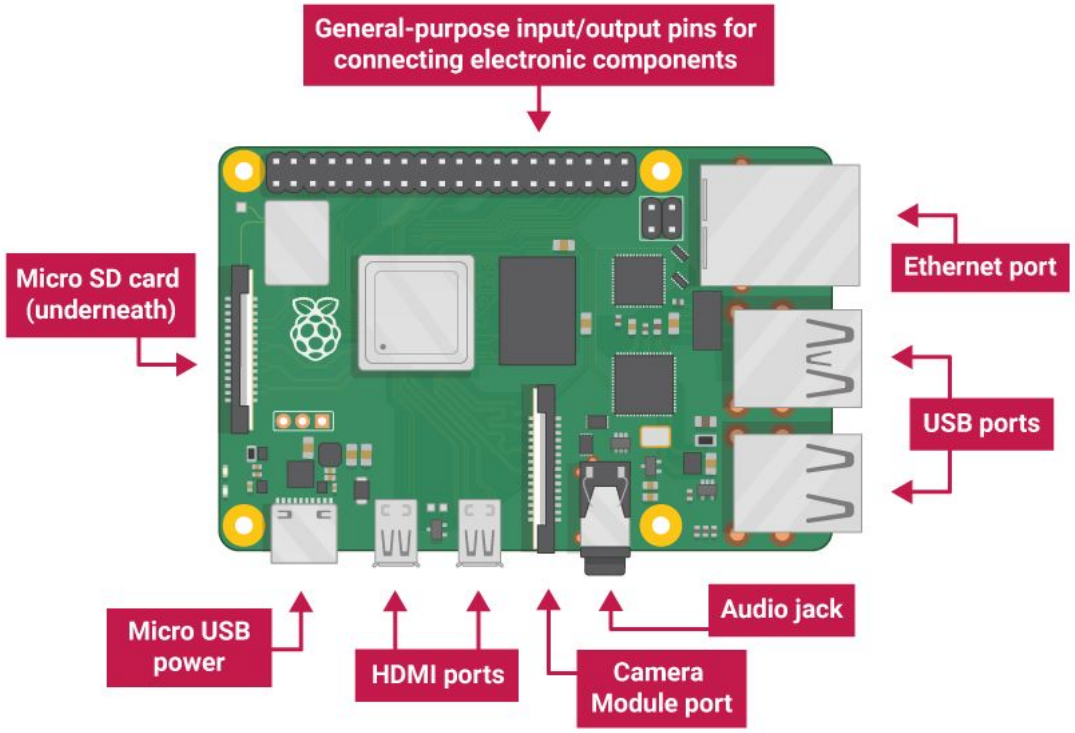
- Rechargeable battery such as car battery (approx. US$20)
- cabling and housing for battery and solar panel to be built with stone and concrete for security (approx. US$20)

The Micro Computer

The advent of mobile phones has brought about miniaturization of computers at an unprecedented scale. Today, the smartphone in our pockets is over 100,000 times more powerful than the computer which took man to the moon and also at least 1 million times cheaper. Trees of Knowledge take advantage of miniaturized low power computing allowing us make use of off-the-shelf development computers and create a hardware configuration ideal for our use case. The form factor of the complete system we use to run a Tree of Knowledge will be no larger than an apple.

While any low-power computer can be used to create the core system. For the purposes of this paper - and to keep the system simple - we can use an off-the-shelf Raspberry Pi. This computer measures 8cm x 5cm x 1cm. (Smaller than a pack of cards). It uses a Broadcom BCM2711 SoC with a 1.5 GHz 64-bit quad-core ARM Cortex-A72 processor with 1MB shared L2 cache. While the raspberry pi sports a Broadcom VideoCore VI 500 MHz as a graphics card, we will not need it because our computer configuration will not use any sort of screen. This is

because we will be running the mini computer as a localised streaming server only. In other words the computer's only job is to store videos for streaming over wifi.



The Operating system.

I have designed a custom linux operating system (distribution) called Tree OS. This is a version of the Debian based Linux operating system optimised for running the Tree of Knowledge. All anyone has to do to create a Tree of Knowledge is to connect the hardware as described in the guide in this paper, install Tree OS and everything should work. Tree OS is also open, allowing advanced installers to load their own content, add modules or include tutorial based narrow artificial intelligence to guide tree users. I am still optimising the system to use less power, but in the meantime the second option for custom installations is to install Raspian and then configure the system manually.

Alternative OS

For an alternative operating system, Raspbian is a free operating system based on Debian optimized for the Raspberry Pi hardware. An operating system is the set of basic programs and utilities that make your Raspberry Pi run. However, Raspbian provides pre-compiled software bundled in a nice format for easy installation on your Raspberry Pi but is not pre-configured to run a knowledge server like Tree OS. With Raspian, this process will be done manually.

A separate software configuration guide will be published in the coming months along with the Tree OS download file for those who need a step by step guide. It is however expected that anyone wishing to create a Tree of Knowledge should have sufficient technical skills for configuration without a guide as this is a relatively simple process for most IT professionals.

Router

A router is a device that allows the computer to communicate to other devices. In the case of the Tree of Knowledge, we will be connecting a small low powered router to the Raspberry PI. This will allow multiple mobile users to connect onto the router and stream video content from the Raspberry Pi

Power and Charging.

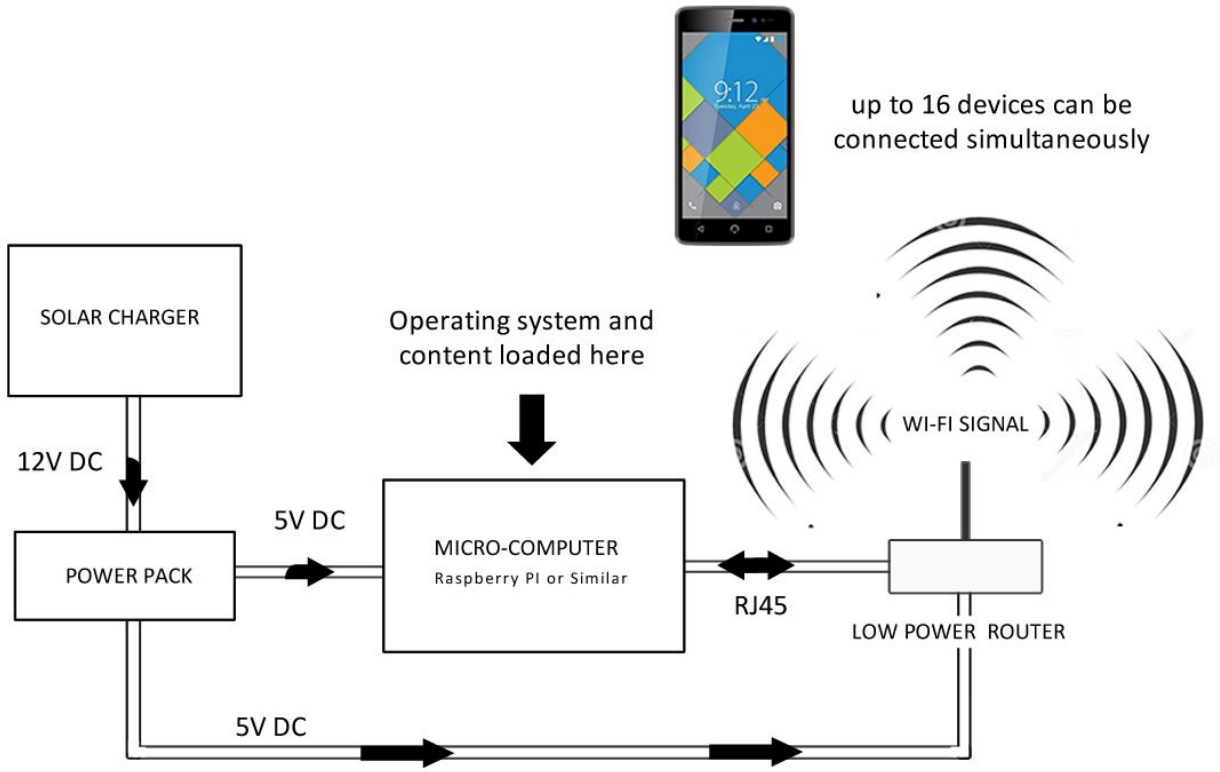
To power the computer, we need a battery pack and small solar panel. The solar panel will be used to trickle charge the battery enabling the battery to charge slowly - at the same rate that it is depleted.

A Raspberry Pi draws up to 2.5amps of power while running on 5.1V of power. If we run two 30000 mAH connected to both the router and PI, we should be able to get enough power to run the system all day. A 25 watt solar panel can be used to balance the amount of power being drawn with the recharge rate giving surplus energy.

Other power-saving techniques can be implemented such as setting up the Tree of Knowledge's computer to wake-on-LAN, this means that the Tree of Knowledge is usually asleep and only wakes up when someone tries to connect to the network.

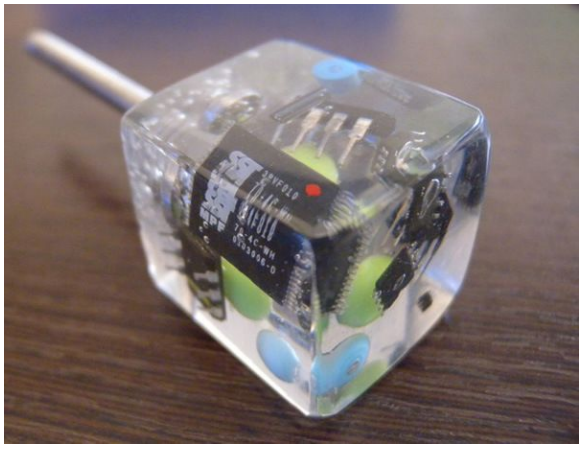
The Setup

The diagram below shows the simple setup of the system. I hope that this illustration will be simple enough for an IT professional to understand, but exact instructions can also be made available is required.



Securing and protecting the technology

Considering that this a bit of hardware which will be open to the elements and is at risk of being stolen an important final stage is a process called ‘Potting’. Potting is the process of filling a complete electronic assembly with gel which will then **solidify** into a glass-like compound. This makes the electronics resistant to all elements: shock, heat, fire, theft, decay, pests, animals. In the potting process an electronic assembly is placed inside a mould (i.e. the "pot"]) which is then filled with an insulating liquid compound that hardens, **permanently** protecting the assembly.



Above are two examples of potted electronics. A unique aspect about potting is that it makes the state of the electronic assembly permanent. Trying to remove the electronics from inside the ‘amber / pot’ will destroy the hardware and it can never be re-used. This means that there is no value in ever stealing the technology because it cannot ever be used for anything else.

It is recommended that the potting is done by moulding the hardware onto the tree making it very difficult to ever remove as it is now part of the thick branches atop the tree. The whole system is then finally software encrypted making it only read-only preventing anyone from uploading anything or using it for any other function.

Conclusion

Ultimately, Trees of Knowledge have the potential to be durable, affordable and high quality local wireless hubs pre-loaded with educational videos implemented via the Tree of Knowledge OS installed upon a low maintenance micro computer. This level of maintenance is an overstatement in reality, requiring only connection to solar panels in order to maintain its power levels and ensure a constant transmission of wireless signals. With a final step of ‘potting’, the enduring nature of a Tree of Knowledge is assured, protecting the device from both the elements and theft by keeping the low-cost high-performing contents safe within an indestructible shell. By using solar-harnessed energy to power both the Tree of Knowledge and keep local users mobile devices charged, we not only remove any cost elements to power consumption, but also offer a satisfactory response to the poignant situation of climate change.

In this way I hope we can also show humility and respect to the very natural world that Trees of Knowledge draw their inspiration from.

Further applications and extensions

Returning to landmarks and among them museums, exhibits often feature interactive displays to assist intrigued and sometimes bewildered users in learning about what they are seeing. Growing more popular, are the ways in which public spaces such as these museums, are featuring engagement with the mobile phones of a visitor. Trees of Knowledge have the very same potential to be implemented in this way. Whether a cluster is hosted across a sweeping national park, able to share the ecology of an area and important hyper-local information about species and things to watch out for. This can be extended to trails, hiking routes and anywhere remote, offering vital safety information and orientation to people in need if required. Essentially, in application, there are a plethora of use-cases for an equally diverse set of places where Trees of Knowledge can offer their wisdom.

Returning to the initial conceptualisation of the Tree of Knowledge and its intentions in the sphere of education in Africa. Beyond that continent and its encompassing countries are countless others, such as India and Asia, where education, life-skills, hygiene guides and much more serve to benefit impoverished populations. This technology can truly be applied worldwide and offers a promising future for many where the gift of knowledge can help struggling generations pursue their brightest futures.

It is important to remember that there are many organisations, governments, charities and groups making vital contributions to ensure more children have access to education. The Tree of Knowledge technology is designed to amplify the current efforts using modern technology in a novel way to try and reach even further, faster and to offer an even cheaper solution.

I look forward to seeing how the technology can benefit communities and whether, in some instances, it may even make sense to consider rolling out Trees of Knowledge over a large region and then giving every child in the region a cheap durable phone for free as a short term solution while waiting for schools to be built in a region of the same size.

This document is published as a white-paper, the aim is to put the technology into the public domain for free thereby allowing anyone to be able to create the technology and help make it all

a reality.

With that, I hand this all to you dear reader, Trees of Knowledge is yours, the only question is, What will you do with it?

About the Author: William Sachiti

William Sachiti (Pasihapaori Chidziva) is a serial entrepreneur / inventor from Zimbabwe. William studied Artificial Intelligence and Robotics in the United Kingdom where he runs the company Academy of Robotics which designs and builds self-driving cars for autonomous delivery.

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Instagram: https://www.instagram.com/williamsachiti/

Frequently Asked Questions

- **How will Tree of Knowledge content be selected?**

  It makes sense to work with each country's educational department to make sure that content matches their syllabus and is culturally appropriate. Please note, anyone can create a Tree of Knowledge using the information in this document and a government does not need to be involved.

- **How will you prevent people uploading inappropriate content?**

  Encryption. After we have encased the assembly in amber, it is software encrypted and made read-only. This means no one can ever put anything else on it or use it for anything else.

- **Artificial Intelligence?**

  We have all used Siri or Alexa, similarly, we can create a digital avatar which assists with teaching, testing and assessing levels before allowing a learner to proceed to more difficult stages. This is not a requirement for Trees of Knowledge to work, but it would be a good way to include pupil assessment. The only drawback is that this would require a little more development time and a slightly more compute power.

- **Why not just load the content directly onto phones and give them the phones?**

  We can only load so much content onto a cheap phone. Having a central content store separate from the phone allows us to store much more content. Many of these children are already used to classes under a tree and having a central meeting place allows different pupils to interact and keep a sense of community.

- **Who will manage the power station, charging and what is the cost?**

  No one its a self sustaining closed system, the abundance of sun means that power is provided for free, just plug in and charge.

- **What sources of content do you envisage using?**

  I envisage speaking with African educators, paying to create video content on subjects in local languages and then propagating it. I think its right to have all the content created by local educators.

- **Who will maintain them?**

  No maintenance required. The power pack may need to be replaced after two to three years at a cost of a few dollars to procure a new one.

- **Will this work on 2G?**

  This does not need a phone connected to a carrier or any network provider. All the user needs is wifi enabled device, be it a phone, tablet, laptop, computer. It is compatible with nearly every phone in existence today.