# The Raspberry Pi in Siavonga

This year we were very fortunate to spend nearly a month in Siavonga, a town in southern Zambia next to Lake Kariba on the border with Zimbabwe. This is a short summary of why we were there, what we achieved and what we would like to do next.

The Swansea – Siavonga Partnership is a not for profit partnership between two charitable organisations, Discovery Student Volunteering in Swansea and the Siavonga Nutrition Group based in Siavonga, Zambia.

The Partnership aims to build relationships across different cultures through shared experiences and learning alongside supporting children through education and making the best use of the environment to improve health.
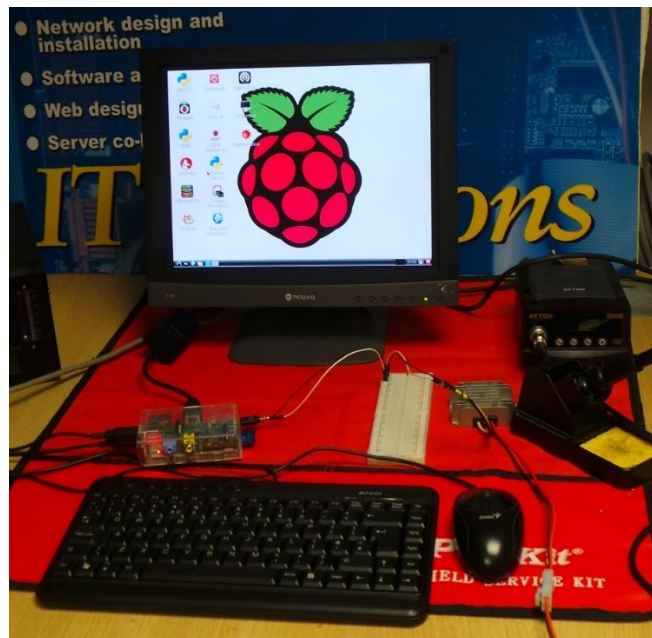
Figure 1 Pi setup in GiaKonda workshop, Swansea

While talking to the Discovery Project team at Swansea University we came up with the idea that it should be possible to provide a school with a way of delivering Computer Science lessons to children, even if there was no mains electricity available at the school

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The first beneficiaries of the project would be two primary schools just outside Siavonga, Kabila and Bbakasa. Both of these schools had solid buildings but no mains power. We considered several alternative computer systems but settled on the Raspberry Pi because of its low power consumption and the wealth of educational material being developed for it. We were also very keen to use open source principles in order to keep our costs down and to help make the project more sustainable.

We began working on the practicalities of providing sufficient solar energy to run a computer.

We thought if we could set up and test a working system in Swansea, then it might be possible to transfer the system to rural schools in Siavonga.

While we were busy cracking on with the practical work the Discovery group set about looking for funding to make our plans a reality. The good people of S&C Electric, a company steeped in alternative energy solutions generously agreed to provide a contribution of £3650. With this money we knew we could provide the power for the project if only we could get the prototype to work.

Technical and Practical Considerations

We bought an eighty watt solar panel and a heavy-duty deep-cycle battery (the sort used in campers and caravans) to power the Pis. We needed to add a regulator between the solar panels and the battery to ensure the system would not over-charge and allow us to monitor the state of the battery closely. We set up two Pi computers because we wanted to put two into each of the schools. One for the teacher to demonstrate and one for the pupils.

Figure 2 Finishing touches to the solar panel at Kabila Primary school

The battery had to provide sufficient power for the computer and its screen, it would have to not only run our Pi computer for a few hours, but be sustainable for years to come.

We were concerned about the power consumption of the screens and their cost. To keep both of these down we decided on Tontec nine-inch 12V hdmi led displays. The only problem with them is they are just that, screens, this meant we had to build enclosures that could hold the screens and their controller boards securely.

Figure 3Testing Pi and screen in Bbakasa Primary school

One big advantage of using this equipment was it could all be run off 12V. No need for inverters which would mean extra cost and significant power loss.

One slight impediment was the fact the Pi needs 5V not 12V. To overcome this we used a 12V to 5V step-down regulator.

Figure 4 Formal Handover to Department of Education Board Secretary at Siavonga Primary

Figure 5 First children to use the Pi computers

Logistics

Equipment we took with us: (Our weight limit was 23kg per bag x 4 bags)

Raspberry Pi computers, Screens, Cabling, Video adapters, SD cards etc.

Equipment we bought there: (Because of weight and fragility issues)

Solar panels, Batteries.

Technical Details

We also needed to test the solution, anything that worked in a Swansea winter would certainly work in Siavonga. With a lot of research and looking around we came up with the component list:

The Raspberry Pi computer: This is a credit card sized computer designed at Cambridge University with Education in mind. It's low cost, low power consumption and wealth of educational resources meant it was an obvious choice. An additional bonus is that it is made at the Sony factory in Pencoed. Not far from us in Swansea

The screens were Tontec nine-inch 12V hdmi led displays put into a home-made enclosure.

Although a 50 Watt solar panel could have done the job the 80 Watt Baird was, in £/Watt much more economic. This consistently powered two Pi computers and screens for two weeks in December, a lot less sun than in Zambia!

The battery for the solar powered Raspberry Pi must be a deep cycle battery. For a deep cycle battery to last many years, it should not be used below 40% of its charge, and should be kept fully or nearly fully charged as far as possible. The batteries were 120Ah bought from Muhanya Solar in Lusaka who provided us with a lot of advice and parts for free, (the 16mm cable for connecting the batteries and other fittings).

The regulator we chose was a switching 12V to 5V step down regulator/converter. These can offer efficiencies well over 90-95% which is exactly what we needed for a

solar powered application like this. They are usually rated at 15 Watts (3A @ 5V) Ideal for two Pis.

The cables were standard 4mm Solar cables, the connectors however were not standard they were different to the Zambian connectors and gave us some problems. Luckily we took more than we needed so were able to sort this out.

Finally the solar charge controller. This device stops the battery from being over-charged when the Raspberry Pi is using less battery charge than the solar panel is capable of putting into the battery. Assuming a solar panel of under 80 watts, a 10 Amp rated unit is all that was needed. We chose one with a digital display so it was easy to monitor what was going on.

If you would like further technical details I would be pleased to supply them, email me at Howard@giakonda.com

The Physics

The current, I, in amps (A) is equal to the power, P, in watts (W), divided by the voltage, V, in volts (V):

$I_{(A)} = P_{(W)} / V_{(V)}$

So

$P_{(W)} = I_{(A)} * V_{(V)}$

The Raspberry Pi uses 2 Watts at 5 Volts that's 400 mA

Note: The Pi uses 5 V not 12 V provided by the battery. To overcome this a step down regulator was required.

2 Watts is not a lot of power and we were using 2 Pi and their screens.

Each Pi needs 2 Watts so that's 4 Watts

Each screen was rated 12Volts at 2 Amps i.e. 24 Watts so 2 of them would be 48 Watts.

Hence the total power requirement for the systems is 52 Watts. Running them for say 5 hrs a day would require 52 x 5 = 260 Watt hours.

Using 2 solar panels each rated at 80 Watts generates 2 x 80 Watts = 160 Watts. If the Sun was shining for say 6 hrs, not unusual in Zambia, this would give us

160 x 6 = 960 Watt hours. More than enough to keep the Pis going.

As a comparison, if you made 4 cups of tea 4 times per day using a 2400W kettle (4 mins to boil) you would use:

2400 W x 4/60 h = 160 Wh

Pi for now

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