LizardNet: Environmental Study of the Bernard Field Station Lizard Habitat

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1 Introduction

Lizards have various unique methods of regulating their internal body temperature. Many involve various positions on rocks or tree limbs in varying degrees of sunlight. Biologists who are interested in how lizards regulate their temperature have used the ingenious method of creating model lizards that have been tested to reach the same equilibrium temperature as actual lizards in the sunlight. However, until now there have been few to no methods of extracting the temperature of the model lizards short of walking around with a data logger and manually extracting the data every so often. Using the data loggers quickly becomes tedious and does not achieve a high resolution of data. For our summer project, the Computer Science and Biology departments have come together to devise a method of automatic, wireless temperature detection of the lizards out in the Bernard Field Station.

2 Solution

LizardNet was created to test the feasibility of a deployed network of wireless **motes** to take various temperature and possibly other measurements, and broadcast the data back to a central server. The motes we have chosen to use are the MicaZs from Crossbow Technology. We use the MDA300, also from Crossbow, as an input board for the thermistors we use for temperature sensing. The embedded wireless sensor network will be able to take temperature readings at a much higher frequency than traditional data loggers; every few seconds or minutes instead of hours. The data will then be sent back to a central location where it will automatically be parsed and put into an easily readable format (such as in an Excel file). Biologists will be able to spend their time analyzing the data instead of wasting hours simply taking the data.

3 Software

The MicaZ motes of course cannot run themselves. There are two major operating systems which currently run the motes: TinyOS and the SOS Operating System. TinyOS is more or less the current industry standard, while SOS is still in a much more infant stage of continuing development. SOS turned out to be a more modular system which is easily updated remotely. Also, Roy Shea, a Harvey Mudd graduate, is involved with the development of SOS. SOS was a perfect choice for us to have fun with and help with the development of an evolving OS.

To make SOS work for us, we had to first develop drivers to run basically the entire MDA300 board. Thanks to help from Roy Shea, we were able to produce working drivers and get the network up and going in our lab in around six weeks. The remaining time was spent attempting to make the motes work correctly out in the actual field. We encountered various problems with both the software and hardware which will take continuing work to overcome.

4 Deployment

We had a few qualifications for our deployment location. First, we needed a central location with a permanent power supply to run the base station computer. Since the motes do not have a very long effective range, we found a deployment location close to the base station. Luckily, there is an outdoor classroom which meets the previous criteria. However, we still had many issues that arose.

First, we were not aware of the effect of radio frequency on transmission range. After visiting the James Reserve, a site also deploying similar motes, we discovered that lower frequencies, while having a lower bandwidth, are able to penetrate brush and other obstacles much easier. Since the temperature data is only two bytes every minute or two, bandwidth is not an issue. However, we already invested in eight MicaZ motes, so we continued using them as best we could.

Second, we used a tree routing program to dynamically setup the network and forward packets back to the base station. However, the networking software was very preliminary, and did not work as well as we hoped. Combined with the poor range of the MicaZs, motes would be dropped from the network, and their packets lost for extended amounts of time. Much more work will need to be done to make the routing software more rubust to failures. There will also need to be mechanisms for queueing up data if a mote loses its connection to the network, which can then be sent out when the connection is regained.

Finally, we had problems with protecting the motes from the elements. We chose clear plastic enclosures to protect the motes from water. The clear plastic let in too much sun which caused the motes to overheat, so we had to take measures to shade the motes. We used simple straw hats to cover the motes, which seemed to work fine for now. A longer term network will need a more permanent solution.

5 Results

Even with the problems we encountered with deployment, we were still able to acquire a few days worth of data. We have multiple days of data from inside the library where we worked. As seen in 1, we can note that the air-conditioning is turned off at night

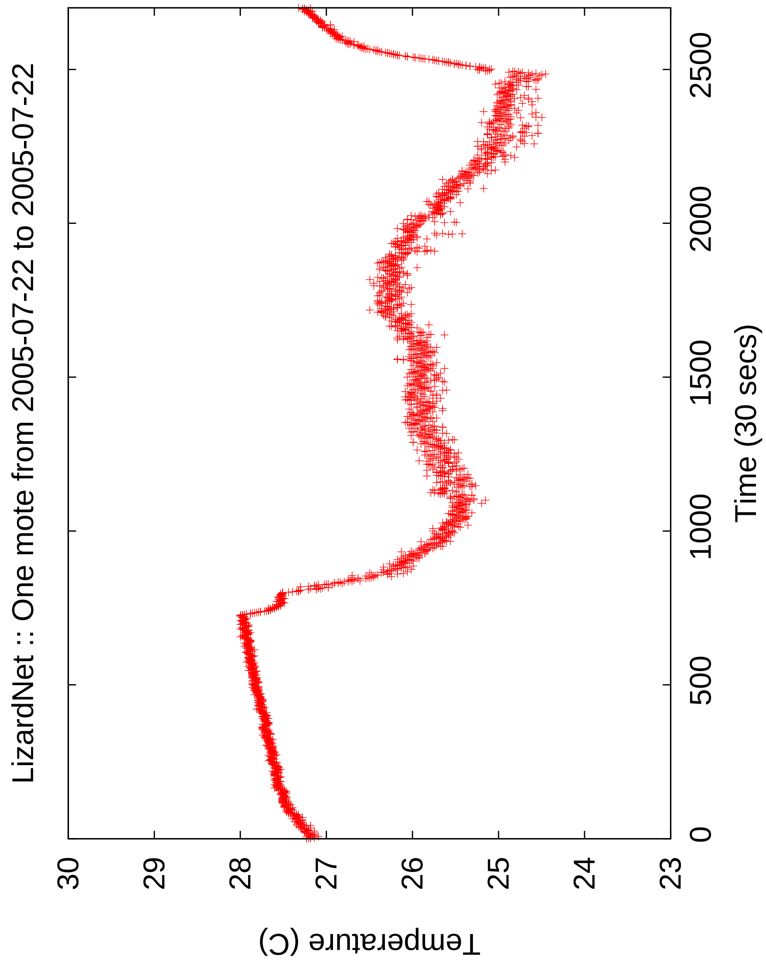

Figure 1: Interior temperature of the Sprague library over a 24 hour period. Notice the temperature rises at night when the air-conditioning is turned off, and also slowly raises then lowers over the course of the day.

to conserve power. We also have temperature data from the field station. The SHT15 data, Figure 2, is from the onboard temperature sensor, used to be sure the motes are not overheating. The thermistor data, Figure 3, is from the external sensors attached to the MDA300 as described in Section 2.

6 Acknowledgements

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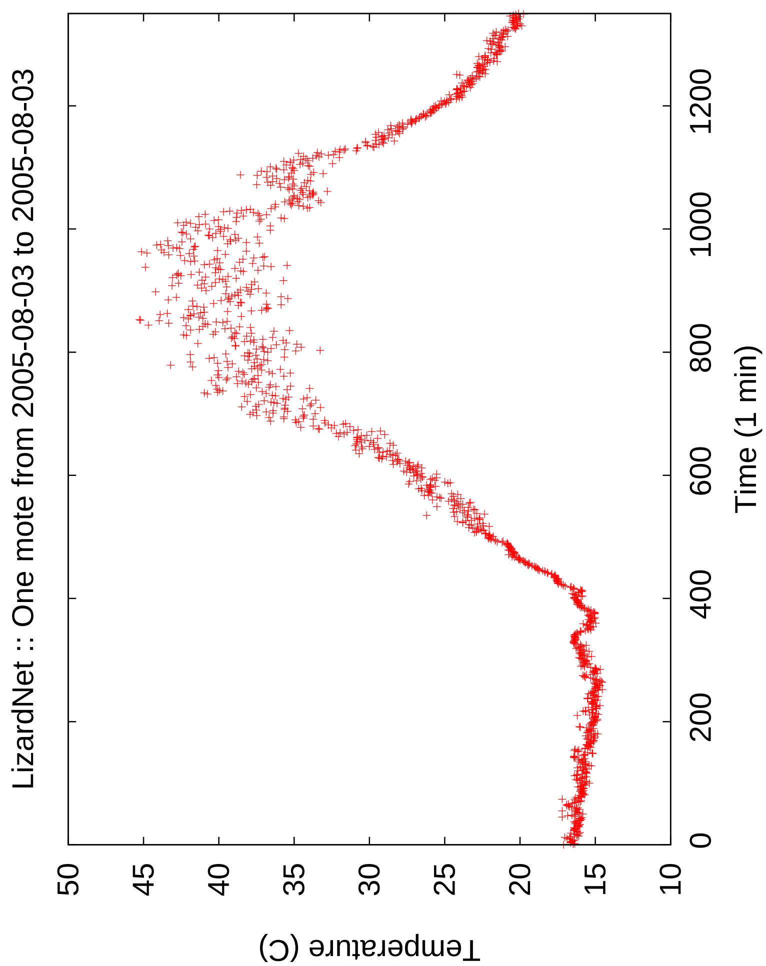

Figure 2: Temperature readings from the onboard SHT15 sensor on the MDA300 from the Bernard Field Station over a 24 hour period.. 55 celcius is the maximum rated temperature of both the motes and the batteries.

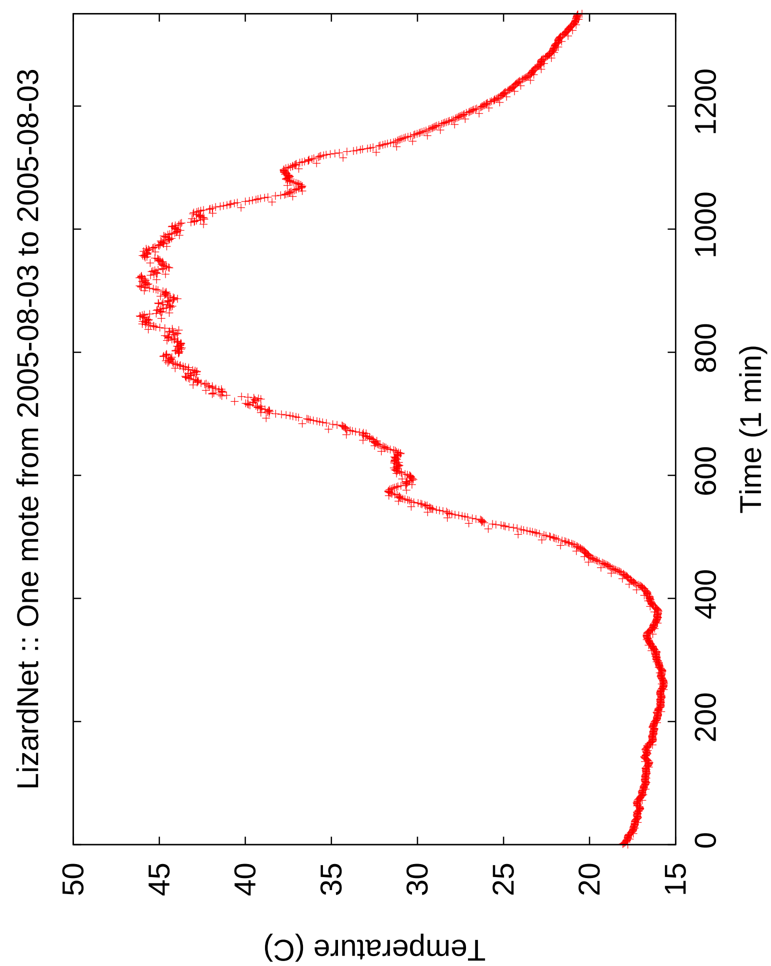

Figure 3: Temperature readings from external thermistors at the Bernard Field Station over a 24 hour period.