Building a modular γ-radiation monitoring system from off the shelf components

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1. Introduction

The Fukushima Dai-ichi accident revealed the need for a low-cost, modular gamma surveillance and spectrometry system for outdoor use. The system in question should not be limited to gamma spectrometry, but should also be able to measure dose rate as wells as ambient parameters such as temperature, humidity and precipitation.
Development of such a system has only been possible recently, with the advent of mass produced system-on-a-chip based Linux computers and all-in-one detector electronics packages. The system presented here, uses widely available computer and detector hardware.

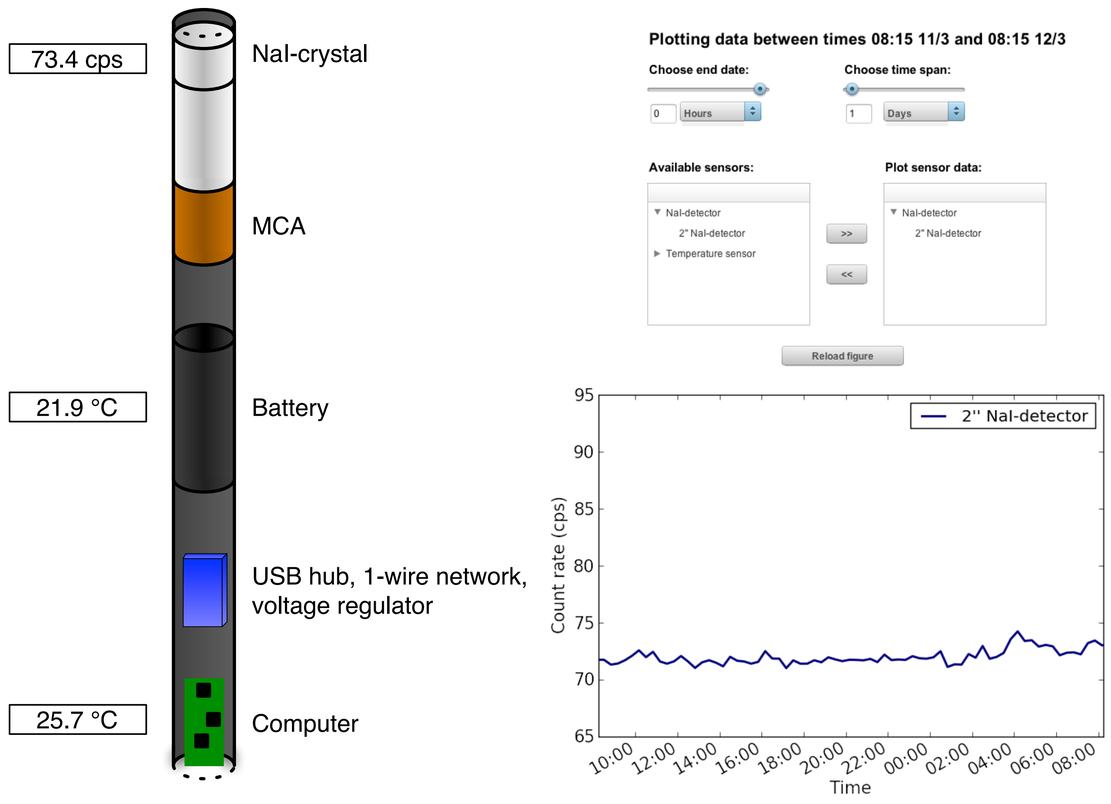
2. Hardware

The whole system is built with a Gumstix Overo computer at its core. A USB hub connects a Ortec DigiBASE multi channel analyser and 1-wire network to the computer. The DigiBASE is in turn connected to a 2” by 2” NaI(Tl)-crystal and photo multiplier tub package. The hub has additional ports available so as to enable the connection of other detectors, such as a dose rate instrument. The 1-wire network can be used to connect a wide range of ambient sensors.
Power can be supplied by battery or mains power. Run time when using lithium batteries is around two days.

To simplify transport of the system and to protect it from the elements, it is placed within a water tight carbon fiber tube.

3. Software

The computer is running a small footprint Linux distribution. Data collection is done by a Python script that manages communication between the sensors, the special purpose database and clients. Communication with the DigiBASE is done with a reverse engineered USB-driver for that device. The default data client is a web application, served by a web server running on the computer. This interface can be used to configure the system and review the collected data. Another client can be used to transmit the data to a central server on regular intervals.



Overview of connected sensors in the web-interface (left). Data review interface (right).

4. Results

A small form factor in-situ gamma spectrometry and surveillance system was built.
Because of the use of a DigiBASE MCA, it is easy to change the scintillator detector material for another one. It is also easy to connect other types of detectors and more sensors to measure additional ambient parameters.

The detector system placed in a natural environment.

5. Future developements

A top priority is to reduce power consumption and increase battery capacity, as a run time of one week on battery power is needed for practical use. Software and hardware support for connecting additional detector types, such as HPGe-detectors, is also planned.

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