

MOTIVATION

Landfills are engineering facilities designed and constructed with a barrier system (lining system) intended to assure the protection of the environment. The passive barriers comprise a Compacted Clay Liner (CCL) and/or a Geosynthetic Clay Liner (GCL), while the active barriers includes a Geomembrane (GM), protected by a Geotextile (GTX), and a drainage layer known as Primary Leachate Collection System (PLCS). The effectiveness of lining systems in service conditions depends, above all, on the performance of the GM. A critical issue for its performance are the defects that, unfortunately, are unavoidable. Most of such defects appear during the placement of the PLCS.



Figure 1: Landfill facility.

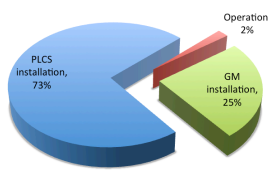


Figure 2: Defects on construction stages.

OBJECTIVES

Development of an autonomous embedded system for data acquisition and information storage, based on an improved method of the mobile probe liner integrity survey. In the proposed methodology, a fixed power supply unit and one matrix of electrodes are used to detect defects in the GM. This matrix is mounted on a mobile unit that is used to survey, point by point, all the basement of the landfill. While the mobile unit gets away from the power injection point the voltage measured drops, since the potential decreases with distance. However, in the presence of a near hole/defect the voltage measure raises.

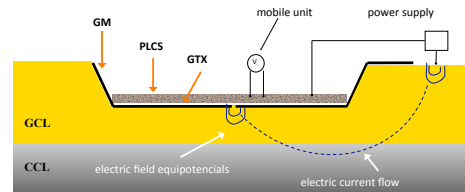


Figure 3: Improved mobile probe line integrity survey method.

PROPOSED EMBEDDED DATA ACQUISITION SYSTEM : EarthMeter

The EarthMeter allows to start/stop the acquisition process and to store the obtained measures in a SD card. The users can select a configuration file containing the sequence of electrodes used in the fault detection search. All the commands are sent to the system using a graphical LCD with touch screen functionality, which also displays the system responses.

HARDWARE IMPLEMENTATION

- ARM7 based hardware platform to implement the *Data Processing and Human Interface* modules (DPHI)
 - LPC2378 micro-controller – used to control the whole system (through SPI and GPIO) and to process all the acquired data
 - Touch-screen monitor (SPI) – resistive type 2.8 inches touch screen TFT LCD with 240x320 pixels of resolution
 - SD card (SPI) – micro-SD card socket supporting up to 2GB of storage capacity
 - Electrodes switching circuit (GPIO) – selects the pair of electrodes to be subsequently pre-processed
 - Signal conditioning (SPI) - converts the electrical potential difference between the two electrodes into the digital domain (ADC)

SOFTWARE IMPLEMENTATION

- Bare metal implementation using the C programming language
- Modular and scalable architecture based on a cooperative state machine application
- Hardware devices mapped into device drivers software modules
- Optimized implementation for embedded systems of the FAT16 file system

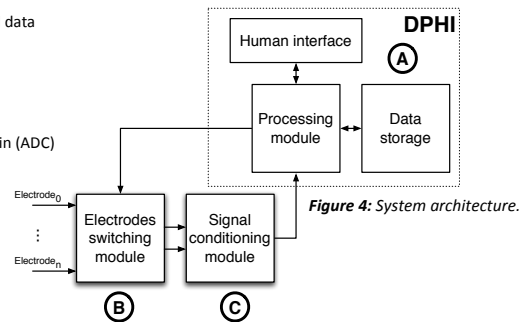
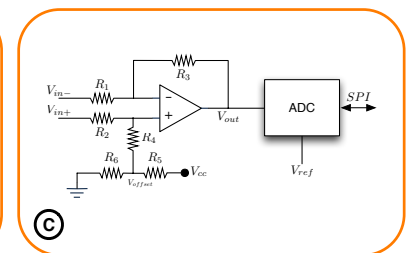
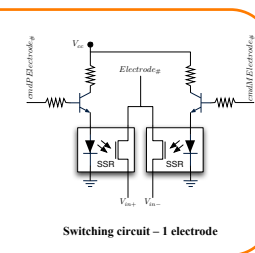
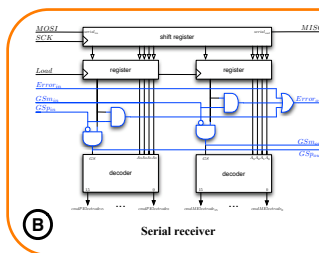
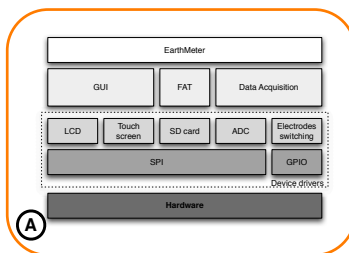


Figure 4: System architecture.



EXPERIMENTAL RESULTS and CONCLUSIONS

The DPHI modules were successfully implemented in the BlueScreen platform, consuming about 80% of the available memory resources (mainly used in the implementation of the GUI module).

The EarthMeter prototype was verified and tested in the laboratory for:

- Functionality** – the processing module is capable of programming the electrodes switching module to implement multiple electrode array configurations, as well as to command it in order to obtain the electrical potential variations reported by the electrodes;
- Detection** – the experimental results obtained for different types of lining systems and defects are consistent and present a relative error of 4% on potential measure.

The proposed system allows not only to significantly reduce the survey time, but also to augment the precision of the defect detection process.

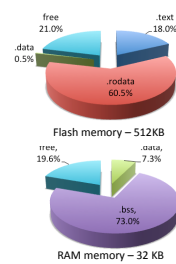


Figure 5: Memory usage.

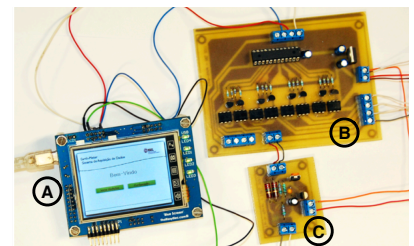


Figure 6: System prototype.

ACKNOWLEDGEMENTS

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