Development of a Mechatronic system for underground sensor deployment

Overview

It is important to monitor the area beneath and around the Sellafield legacy ponds. Degradation of the concrete walls can lead to radioactive leaks into the surrounding environment with potentially long-reaching hazardous effects. The use of current borehole technology for monitoring radioactive leaks has limitations and therefore an autonomous underground system, capable of mapping the area directly beneath the Sellafield ponds has been suggested. Fig. 1 shows a broad overview of the application.

Technical Challenges

The developed device must be;
• Tolerant to radiation doses.
• Able to penetrate ground of varying densities.
• Navigate obstacles autonomously.
• Communicate with a surface base station.

Radiation Tolerance Experiments

Outputs of electronic components are rarely measured whilst being exposed to gamma radiation. A series of component test circuits were developed with an adaptable radiation tolerant test board. By connecting the circuits to LabVIEW, it is possible to monitor the output of a range of different components whilst being exposed to a Co-60 gamma source.

Environment

- It is important to try multiple mechanical options as underground materials vary significantly.
- A collaboration of current control and burrowing techniques is required to design a device able to navigate, dig and propel itself whilst underground.
- A novel technique for manoeuvrability must be created. Current underground systems travel in a single straight line or have very large turning circles.
- Cheap, quick and easy prototypes can be made using 3D printers.

Experiment Results

Voltage regulators, references and microcontrollers have been exposed to gamma radiation.
• Output voltage of a voltage reference increases with higher dose. (Figure 3)
• Voltage regulators show a drop in output voltage at an increased dose. This occurs at different rates for different currents. (Figure 4)
• 18F4520 microcontroller’s memory degrades at 1000Gy. (Figure 5)

Future Work

Work still to be completed includes:
• Design of additional burrowing mechanical prototypes based on results from the testing of current designs.
• Testing of mechanical parts for suitability
• Design a radiation tolerant voltage regulation circuit
• Analysis of control and navigation systems
• Create a main body for the device

For details contact: Matthew Nancekievill Tel: 07969449570
E-Mail: matthew.nancekievill@postgrad.manchester.ac.uk
Supervisor: Barry Lennox Tel: 0161 306-4661.
E-Mail: Barry.Lennox@manchester.ac.uk

Control Systems
School of Electrical and Electronic Engineering
The University of Manchester