

Fourth year Laboratory Projects

Alan Robert Clark

February 23, 2012

2012 Projects:

Anechoic Chamber Automation for antenna measurement and EMC Pre-compliance.

The Anechoic Chamber has obtained a brand new rotator, complete with computer interface. An automation system/software has to be designed and implemented, such that ordinary antenna radiation patterns can be generated, across multiple frequency sweeps, controlling the Vector Network Analyser and rotator equipment. Additionally, for use as a Precompliance facility, calibrated noise sources need to be built and tested with the Spectrum analyser and rotator equipment.

2011 Projects:

Synchronising Clock Network

A really irritating thing about House Clocks, is that they are generally all at different times, and all wrong. For a PC, the solution is very simple: NTP (Network Time Protocol) which can keep computers synchronised to at least millisecond level. This is absolute overkill for a set of house clocks, which literally needs an update once a day to the nearest 30 seconds or so. Assuming the house has a PC running NTP, how do we get the time out of it and transmitted via cheap low-power transmitters/receivers to the various clocks around the house, and using what Protocol? The project involves hardware design, USB interfacing (probably), communication via a cheap RF tranceiver, design of Protocol, and implementation of a simple “receiver clock”, preferably all in PIC and linux, but Bill will do too. Note that the PIC *WILL NOT* be programmed in C!!!

2010 Projects:

On Sabbatical (Yay :-) :-)

2009 Projects:

Trickle-down Solar Water Heater.

Solar water heaters for domestic use suffer from a number of constraints due to their piped nature. A trickle-down collector has several advantages. The project seeks to QUANTIFY these benefits.

2008 Projects:

Blackout Clock

Bedside clocks do not like blackouts: If you remember to put the battery in, they lose time terribly, if you dont, they remember 12:00 very well indeed. Underfrequency (during Eskom High load profiles) also causes time drift. A pic-based REAL time clock is required, with a synchronizing NTP connection, possibly via USB, or any other communication medium. A protocol for house-wide time synchronization must therefore also be designed.

Parabolic Solar Collection, Part the Second.

An offset parabolic DSTV dish, chrome plated, has successfully produced temperatures in excess of 250 degrees C at its focal point. The project now needs continuing: Solar tracking must be implemented and various collector designs must be considered and compared. Temperature measurement instrumentation must be designed and all consolidated into a microcontroller.

2007 Projects:

Solar collection via offset parabolic DSTV-type dishes

DSTV-type offset parabolic dishes are relatively cheap without the electronics. This project will investigate the use of such dishes in solar energy capture. It will involve coating evaluation, solar tracking, precise measurement of temperature and flow, with the aim of comparing one technique to another.

2006 Projects:

Characterisation and automation of the Anechoic Chamber

The Anechoic Chamber requires a re-calibration of the “quiet zone” as a function of frequency (to 6 GHz) and an automation suite is required to cope with both the traditional S21 (Antenna Gain/Pattern) measurements, but also the new EMC initiatives. The project will entail designing, building and testing of suitable antenna systems, calibrating, and a sophisticated software component controlling the automation of positioners, Network Analyser and Spectrum Analyser. Windows-based software would be tolerated, but a Linux-based solution would strongly be preferred.

2005 Projects:

Safe Auto-Recloser for a CBI Domestic “Earth-Leakage” Unit.

Lightning causes a “false” trip to your house mains power on the first day of your three-week holiday. Upon your return, the fragrant state of your new HindQuarter in your deep freeze causes you to become Vegan.

A simple microcontroller-based auto-recloser is to be designed that simply performs the action(s) that your thumb would have performed if you were home: ie absolutely non-invasive to the circuit breaker. The difference between a trip and an overload condition needs sensing and differing algorithms.

An SMS interface to a GSM modem can also be added in the eventual failure of reclosing.

Cheap Solar Tracker

Solar cooking, PhotoVoltaic(PV) arrays, solar water-heating/pasteurisation all benefit greatly from being positioned exactly towards the sun. The alternative, of course, is to move a reflector accordingly. Many methods have been proposed to track the sun's movement and to activate the necessary re-alignment.

The objective is to develop the cheapest possible tracking system, using a PIC microcontroller, with old "computer-scrap" motors. This sort of system is ideal in rural, non-gridded areas, or indeed, in Aceh.

2004 Projects:

Cape-Vulture tracking by GSM

A GSM based tracking system is to be designed and implemented. The information on Timing Advances from GSM base stations can be used to triangulate the position of the GSM modem. This information can be transmitted via SMS to a central location, where the raw data can be processed, and the position computed. It is envisioned that this system will consist of a GSM cell phone module capable of collecting suitable information from surrounding base stations such that its position can be determined by triangulation. This information will be transmitted back to a central server via an SMS, USSD, GPRS or data call. Alternatively a GPS module may be included for greater positioning (and altitude) accuracy. Unfortunately this implies greater cost, power consumption and weight.

In order to conserve power the phone's power supply will be controlled by a remotely (via cell phone) programmable real time clock. In order to achieve a 2 year operational lifespan the system's battery will be trickle charged by solar panel. Basic system or environmental diagnostics would be useful (e.g. battery charge level, charge current, ambient temperature, air pressure). Air pressure could be used to determine altitude.

Automatically Tuned Car Speed Control.

The objective is to design a ****SIMPLE**** cheap "drop-in" PIC microcontroller based speed control system for a motor car. The control loops must self tune to meet the parameters of the vehicle (40kW 700kg Uno, 180kW 1600kg Lamborghini).

Safety issues are critical, and a range of actuators is possible.

A Propellor Clock (on Steroids)

home.epix.net/iracerc/clock.html shows a classical "propellor clock" of which there are many implementations.

In addition to the simple display of analogue or digital time, an attempt must be made to display the school logo.

2003 Projects:

On Sabbatical (Yay :-)

2002 Projects:

Universal Charger

A universal “charging pad” is to be developed such that a suitably equipped portable item can simply be placed anywhere on the pad for charging purposes: eg cellphone, wireless mouse/keyboard etc.

Remote Auction System—Wireless Interface

An interface to an auction system is to be devised so that each bidder can be issued with a standard “garage-door” type remote control to do the bidding anonymously. Careful attention needs to be paid to timing contention issues.

Auction System—On-line Interface

An online interface (web-based) is to be built to the same Auction system above. All bids need to be carefully timestamped and processed by the database.

2001 Projects:

Dielectric Measurement

A dielectric measurement jig has been constructed and used to evaluate dielectric-coated monopole antennas. (Longshaw and Orchard 2000). However, dielectric measurement, per se, was not the focus of their project. The focus of this year’s project is to determine the accuracy of a simpler dielectric measurement jig to evaluate the dielectric constant and loss tangent of various materials that may be used in antenna design.

Antenna Design Wizard(s)

Research, design and implement an antenna design wizard in Matlab. Many antenna types have design rules that are obscure, empirical, or downright thumbsucks. The purpose of the project is to implement a simplified user interface to design various classes of antenna. (The broad structure of the Design Wizards has already been designed). The result is to be compared to the standards in the literature.

Wire antennas on flat dielectric substrates

A post-graduate, Anton Frolich has developed a theory for an equivalent radius of dielectric-coated wires, as used in antennas. This project will assess the usefulness of using SuperNEC for simulating this class of antenna, but on flat substrates (ie PCBs). A design is to be selected, simulated, built and tested in the anechoic chamber.

Sparse Iterative Method Evaluation

The Sparse Iterative Method is a fast means of solving large matrix problems (fast as compared to LU Decomposition). Depending upon the sparsity of the matrix, convergence does not always occur. The stability of the method is to be investigated, with a view to automation of the procedure, and this needs to be evaluated against results for large electromagnetic problems that we have solved (by LU) and against canonical problems in the literature.

2000 Projects:

Indoor Propagation study

Characterise the reflection and attenuation properties of drywalling, whiteboards, filing cabinets and the like in a typical office environment. Using these, compare the propagation predicted by SuperNEC and that actually measured.

MoM/UTD hybrid investigations

Characterise the effectiveness and the accuracy of hybridising a structure into MoM and UTD elements, and compare these against pure MoM and pure UTD. Several Geometries of interest exist for investigation. Of particular interest is determining the boundaries where the methods break down.

1999 Projects:

Project 1: Garden Frame Controller.

A “garden frame” is a mini hothouse sort of thing, where seedlings are germinated, and kept in “ideal growing conditions”. Key elements seem to be humidity, watering, nutrients, and good old fashioned heat. A large part of the problem is that no one seems to be able to quantify exactly what is required for optimal growth.

The project entails the acquisition of the relevant conditions for growth, the construction of humidity/temp/water/heating/ventilating/whatever sensors and actuators, and the programming of a PIC microcontroller (with external ADC's if necessary).

Prerequisites: A keen understanding of Measurement Systems and Electronics!

Project 2: Spice Post-Processor.

Spice is a circuit analysis program which is widely used in academia and industry. Although the original FORTRAN code freely available, many “commercial” versions of it exist—P Spice, MicroCAD, etc etc. These versions are all rather expensive, and really only add pre- and post-processors to the core Spice implementation. The difficulty is that although “student” editions of these packages exist, they are either still rather expensive and reasonably crippled, or free and extremely crippled!

In My Humble Opinion, the input, or pre-processor is of less significance than the post-processor. A user can easily draw a circuit on paper, label nodes, and construct the input deck, but cannot easily visualize results.

The project will entail the writing of a post-processor to Spice in the Matlab language, with the file interface probably being in C++ (a mex file). Only a limited scope is envisaged, to prevent “project runaway”!

Prerequisites: C++, Matlab, spice languages.

1998 Projects:

p10

Evaluation of anechoic chamber quiet zone Background: An anechoic chamber is a room where the walls are fitted with materials which absorb radio waves and hence provides a pseudo "free space" environment for the purpose of EM (antenna) measurements.

Description: This project will involve the measurement of the EM fields within the measurement zone (quiet zone) of an anechoic chamber. It is important to characterise the phase and amplitude distribution of EM waves in the quiet zone of an anechoic chamber, since this determines the size of antennas which can be measured as the measurement accuracy which may be expected. The errors in phase and amplitude can often also be related to specific imperfections in the room and knowledge of such imperfections may be used to improve the measurement ac.

p11

Measurement of test geometries to validated GTD/MoM hybrid program results. Background: The Geometric Theory of Diffraction (GTD) and Method of Moments two computational electromagnetic techniques used for computer simulation of structures. These two methods have been hybridized and a computer program I available which implements the hybrid solution.

Description: A specific type of geometry which taxes the hybrid GTD/MoM theory will be built and its performance will be measured. This geometry will also be simulated to compare results. Conclusions on the applicability of the computer methods and the sources of error must be provided.