Metsähovi antenna control system upgrade

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Introduction

An ongoing major project at Metsähovi Radio Observatory aims at replacing aging 1970-vintage analog antenna control electronics with more modern hardware. At the same time the control software environment is being changed from a centralized MicroVAX-VMS-based system to a distributed network of Linux computers with common conception of UTC time in hardware.

Overall Architecture

The overall architecture of the upcoming observation system is presented in Figure 1. The main objective is to offload observation/measurement tasks across multiple industry-standard PCs running the freely-available Linux operating system. To attain high time accuracy,the common station UTC time is distributed with 5MHz and 1pps signals to all participating computers. Hardware clock counters are used to make precise common sub-second time easily available in all PC Linux software, and higher-level common UTC time is distributed from GPS monitoring subsystem using "`xntp`" Network Time Protocol software package.

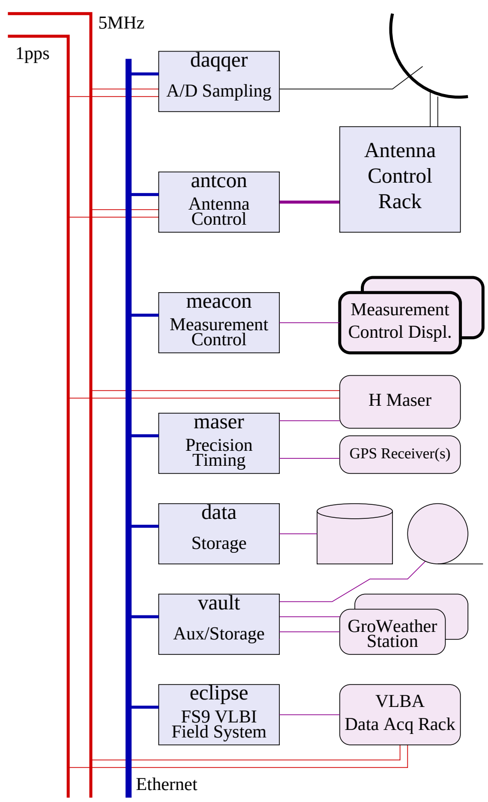

Figure 1: Distributed antenna control computers

Several rack-mounted Linux PCs (see Table 1) for antenna control were acquired and mounted in our control rack.

Table 1: Antenna control Linux PCs.

Name	*Function*
`antcon`	Antenna pointing control.
`daqqer`	Analog data acquisition/sampling.
`vault`	Archive DAT, ADAM/NuDAM, weather.
`data`	On-line data archive.

The existing "single minicomputer" approach to making astronomical observations is illustrated in Figure 2. All timing and device control is performed by a monolithic control program running with pseudo-real-time requirements under VAX/VMS operating system.

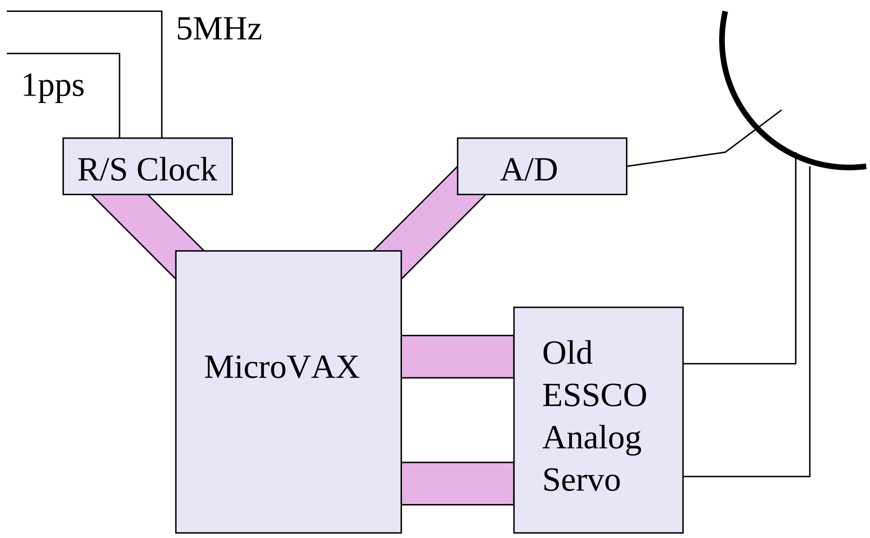

Figure 2: Existing single minicomputer-based antenna control

"Phase 1" Encoder Upgrade

Currently we are running a slightly upgraded variant of the VAX-based system. The differences are depicted in Figure 3. Both old Inductosyn encoders and old pointing error calculation electronics has been replaced with new Heidenhain RON806 optical encoders and an embedded PC. This arrangement has been in use since 1996 and it has given us the benefits of a tenfold improvement in encoder accuracy when compared to old Inductosyns. RON806s exhibit very little periodic/geometric distortions and they deliver noise-free and repeatable sub-millidegree accuracy.

Unfortunately the old (1970's) analog servo masks out much of the benefits of new encoders. It was designed to maintain tracking at the level of a few millidegrees only.

"Phase 2" Digital Servo Upgrade

To enable a new digital servo system to be implemented driving antenna DC motors must be moved to the same PC computer which already receives RON806 encoder signals. This setup is presented in Figure 4.

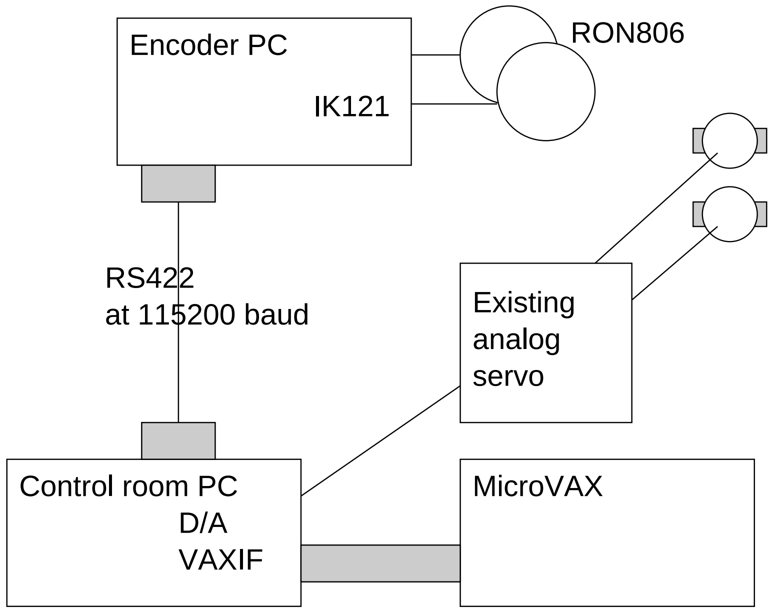

Figure 3: Intermediate encoder replacement solution

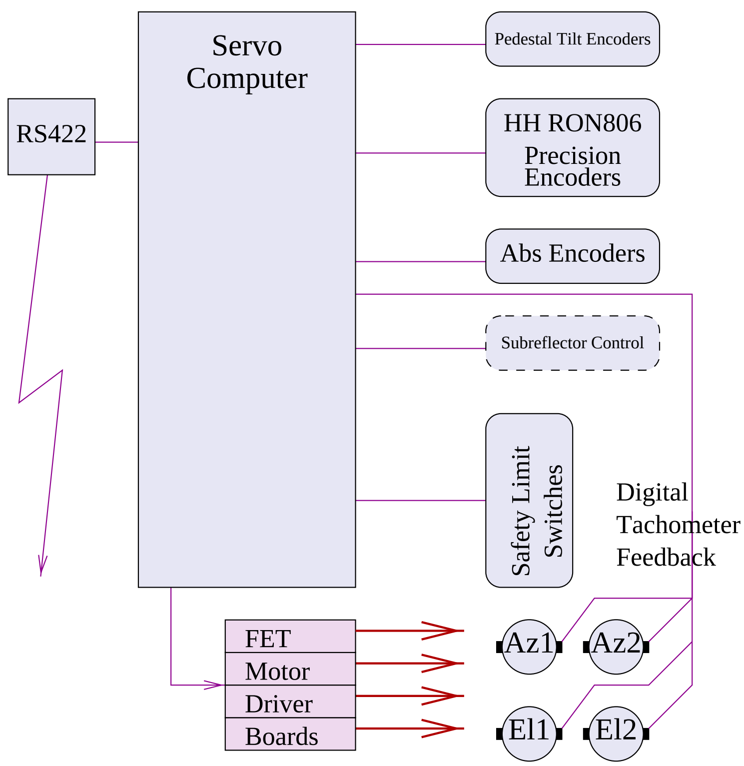

Figure 4: Embedded antenna servo rack in antenna tower

Our "FET30 DC" motor FET driver board has been rigorously tested and developed to its third prototype stage. Testing has ensured us that we have achieved robustness against motor and software failures. We currently support both plain PWM and locked anti-phase drive capability on the same board—the latter delivers higher torque at slow tracking speeds.

Data Acquisition Architecture

For analog data acquisition a Datel PCI-416M 4-channel 200 kHz simultaneous sampling 16-bit A/D converter board was purchased and installed in "`daqqer`". An alpha prototype of a 5MHz synchronized 10 kHz sampling clock board has been built and tested using the DOS-based software of the A/D board, but a new time-synchronization board and corresponding Linux-based data acquisition software will be required before the board can become useful in astronomical measurements with the A/D converter.

Conclusion

The upgrade project has mainly been motivated by the practical necessity to replace hardware before failures become too common. Special emphasis has been put to ensure that resulting systems can be realistically maintained for approximately ten years, minimum.