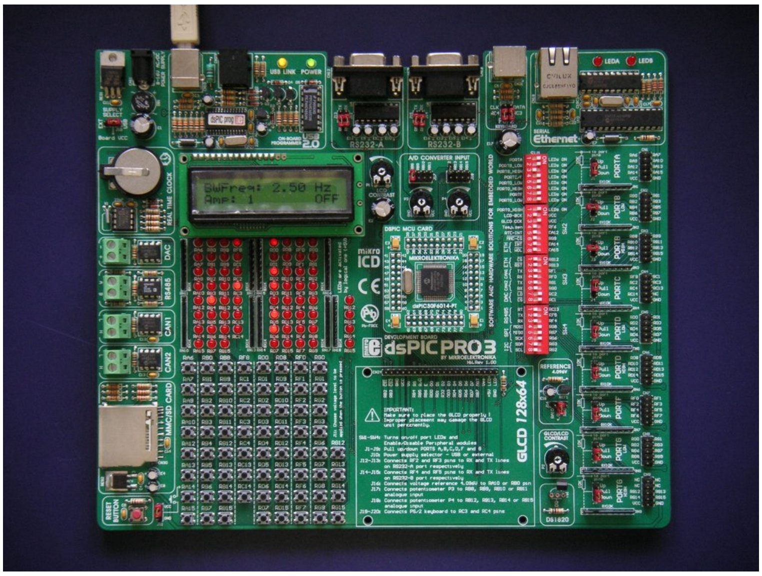
Visitor to

LOXTechnologies

No. 1 Spring 2007

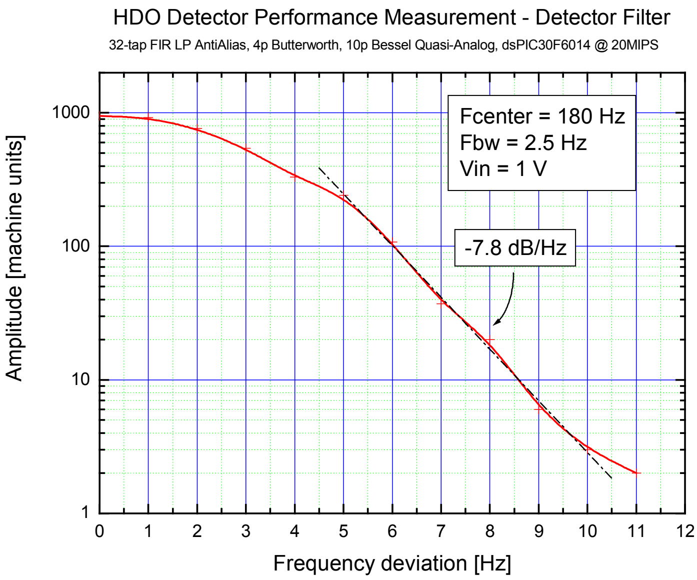
Absolute record: delivery in 3 weeks!

Hot signal processing application for dsPIC served on a big dish



Detecting elusive 230V-line remote control signals using standard analog technology has been proven tedious and unreliable. To strengthen reliability while keeping the solution still cheep and small, LOX Technologies has been asked to develop analog signal conditioning and digital signal processing algorithms for dsPIC-based microcontroller system dedicated to this task. And we done it, in advance!

In the first instance, we designed analog filter for suppressing 50Hz line frequency and its harmonics over the signal band starting at 180Hz, and providing the first analog antialiasing stage as well. One MF10 switched-capacitor filter clocked by dsPIC30F6014A comprises one 3-pole Chebyshev 50Hz-suppressing high-pass, and one 3-pole Butterworth antialiasing low-pass filter. Because MF10 supplies 4 poles, the additional 2 poles come from RC stages that also secure antialiasing for the 90 and 18kHz-switched filter device. Gain setting independent of filter parameters secures glueless optimization of the filter usage for the changing field conditions.



Designing the digital signal processing part on MIKROELEKTRONICA dsPIC PRO3 development board with extensive controls and connectivity has been proven quite efficient, even the included C compiler has its drawbacks and libraries can serve well for demonstrations, but don't score good in performance-staked applications.

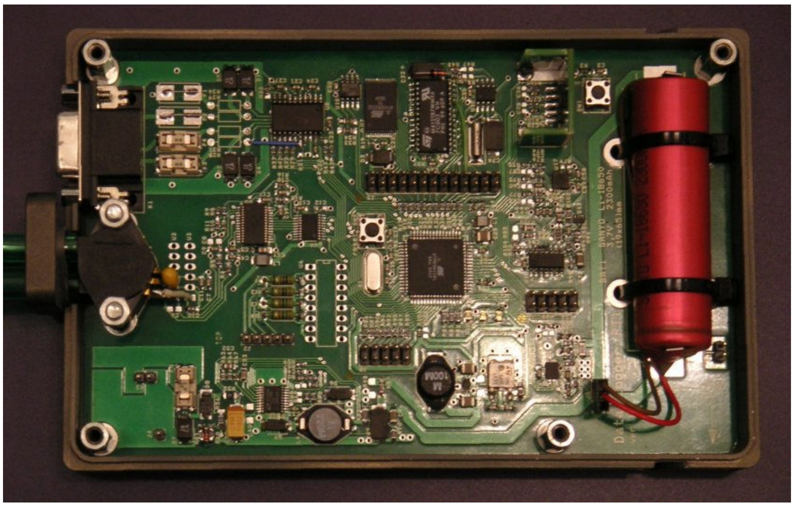
Our solution to the signal processing part relies on principle of synchronous demodulation on the center detector frequency, and subsequent tight bandwidth limitation, derived from maximal impulse repetition frequency. Again, first processing stage is 32-tap antialiasing FIR filter processing 12-bit ADC data and enabling 4-fold decimation of sampling frequency on the 4kHz quadrature demodulator input. Center demodulator frequency can be then chosen from 0-2kHz interval with 1Hz precision. I and Q outputs of the demodulator are led to Butterworth 4-pole low-pass stage comprised of two bilinear quasi-analog filter units with corner at 40Hz. The signal is then re-sampled with 100-1000Hz and subsequently filtered in huge 10-pole Bessel quasi-analog stage to ultimate 1-10Hz bandwidth. This solution eliminated the necessity of on-fly computation of filter parameters due to desired filter bandwidth. Absolute value of the IQ vector, which represents the signal amplitude on the detector center frequency, is then compared with thresholds in amplitude discriminator to acquire Boolean value of signal presence indication, which is led, at last, to signal duration discriminator, to filter-our any transients.

Measurements of partial and overall system frequency responses report near-perfect correspondence of our signal processing solution to theory. dsPIC30F6014A clocked through 8x PLL at 80MHz, with 20MIPS throughput, is loaded with about 30% and can still accommodate additional synchronous detector unit, or other subsequent data processing and control algorithms. Field tests of the prototype system are scheduled for the next development phase.

Strong wings from AERO 2007

Aircraft Data Logger received huge response at this year's Friedrichshafen event

Data Logger is an on-board instrument for small and ultralight aircrafts that records key events during the aircraft flight. It senses static and difference pressure, and converts them into altitude and speed of the aircraft; it also senses 3-axis acceleration, temperature, board power, integrity of encapsulation etc. When defined conditions occur, Data Logger stores the event in a large non-volatile memory with a time stamp to enable later evaluation of the flight profile or eventual mishap. Data Logger is equipped with high-capacity battery for long-term independent operation, and with serial interface for data download and system configuration. Encapsulation of the Data Logger is highly robust to prevent both accidental and deliberate loss of data, with a switch indicating the opening of the case. A PC application for data download and visualization of the flight profile is also provided.



Starting in mid of 2006, LOX Technologies designed first technology demonstration unit for our Austrian contractor with redundant hardware solutions. This BaseBoard is not only test board for technologies headed for the prototype Data Logger; it can also serve for data mining from damaged Data Loggers through dedicated interface to the non-volatile flash memory and device identification subsystem.

The results from BaseBoard testing proved that most of the state-of-the-art hardware is mature for use in the Prototype device. Namely, we found 2A monolithic LiIon charger device LT1769 from LINEAR with on-chip switchers performing with high efficiency with no reported problems during all testing. The external differential 14-bit ADC ADS7874 from TEXAS INSTRUMENTS also performs well, although we found interesting inconsistencies in its datasheet., like the reversed order in documented data bitstream. With pressure sensors connected to the input of 14-bit ADC, and some signal conditioning of accelerometer outputs before the 10-bit AD conversion in the ATMega128L microcontroller, we got 1 feet altitude resolution, precision better than 2% in altitude and airspeed measurement testing on Pitot simulator, and reliable acceleration and vibration data. With the clean design concept, preliminary tests and mostly developed firmware, we turned to the Prototype device production by begin of this year; the result can be seen on the picture above.

Data stored in non-volatile memory contain not only the flight information. There are RTC, indexing, battery monitoring and device identification data either. So, even the data are not scrambled to maintain unconditional coherence and readability, each block is signed in a unique manner which pairs the data irrevocably with the hardware of the device. This avoids any malicious attempts for "cleanups" of the aircraft history: scale down the motor run-hours or discard accidents leading to possible drag damage.

In the end effect, the Data Logger is intended to save resources and, above all, lives. Accidental damage to the light laminate aircraft drag or wings need not be visible; still, it can be lethal for the crew in the next serious situation. With indication of any out-of-limit conditions in the whole aircraft history, flying can become much safer in the small and ultralight aircraft sector, and operating aircraft leasing and purchasing companies can be in turn much profitable. The indications for tremendous interests from experts as from general ultralight fan public for the Aircraft Data Logger system were received on the AERO 2007 exhibition that took place in Friedrichshafen, Germany, in April, as reported by our contractor who actively participated on the event and was able to demonstrate the capabilities of our Data Logger device.

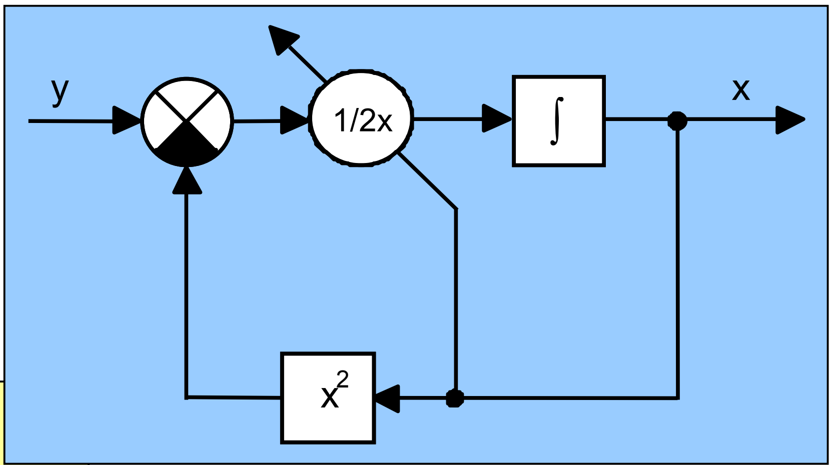
To the roots

Efficient square root computation for embedded world

Differenciating equation $y = x^2$ we can relate the differences $dy = 2xdx$ from which

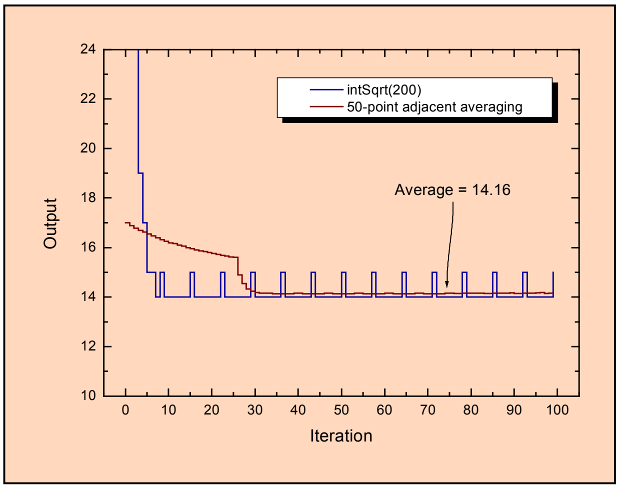
$$dx = \frac{1}{2x}dy \cong \frac{1}{2x}\left(y - x^2\right)$$

that can be then adapted into non-linear circuitry as shown in the picture right. However, this still implies division which can severelly




```
struct intsqrt
{
    long x,x1;
    long dx,dx1;
    long rem,mask;
};

void initIntSqrt(struct intsqrt* S)
{
    S->x = 0;
    S->x1 = 0;
    S->dx = 0;
    S->dx1 = 0;
    S->rem = 0;
    S->mask = 0;
}

int intSqrt(struct intsqrt* S,long y)
{
    int i;

    if(y < 2)
    {
        S->x = y;
        return S->x;
    }

    S->dx = (y - S->x * S->x) >> 2;
    S->dx += S->rem;

    S->x1 = S->x;
    S->dx1 = S->dx;

    S->mask = 1;

    for(i=0;i<32 && (S->x1>1 || S->x1<-1);i++)
    {
        S->x1 >>= 1;
        S->dx1 >>= 1;
        S->mask <<= 1;
    }

    S->mask--;
    S->rem = S->dx & S->mask;
    S->x += S->dx1;

    return S->x;
}
```

disrupt throughput of a microcontroller. Instead of division, one can estimate the denumerator value with the nearest larger power of two, with division realized then by right-shifting the error signal. The algorithm implemented in C finds the square root in about 10 iterations for integer values and even keeps average value of the output approximately equal to the optimum, as seen in the plot with output of computation of square root of 200. Filtering input signal for large steps with an appropriate low-pass filter, the square-root signal can be evaluated even in one pass through the square-root module.



Wanted: freaks for Frames

LOX Technologies wants launch Frame Consortium

In the early times of AI, one thought a single, unitary machine "consciousness" can serve as universal problem solver for any type of task or situation. Now, recent concepts are more down-top oriented and prefer rather more incoherent vision of intelligence as an extensive set of tools, each specialized for a given problem. We do not couple with the recent mainstream in AI research and identify the possible source of notorious incapability in top-down AI in lack of unifying and simplifying the basic realm of machine data processing: the very access to data, availability of methods and symmetries given to data, and existence of coherent, machine-intelligible semantics and data "taxonomy".

Project objectives

- Define and implement generic Frames as encapsulation for virtually deliberate OOP object that embodies universal, explicit, semantic-based and machine-intelligible interface to object's data and corresponding data manipulation methods, in C++, portable to diverse hardware platforms.
- Find and implement closed, recursive set of framed data types – the frame space – that covers any possible outcome of manipulating, interacting or grouping frames, and link the frame types in a logically consistent taxonomy (horizontal inheritance within the frame space).
- Implement mechanisms for channel-based interactions of frames that will allow construction of dependable networks of framed data with embedded resolution for conflicts and deadlocks. Provide an example application with dependable network of framed data.
- Deploy scalable Frame Explorer for Windows capable of constructing and monitoring frames due to user needs, and of manipulation with framed data through intuitive graphic user interface.
- Create extensive algorithm library for framed data with focus in cognitive systems and robotic-specific tasks (digital signal processing, image and video processing, pattern recognition, inverse kinematics, spatial orientation and attitude, optimization, AI algorithms, genetic programming, etc.)
- As demonstration of frame technology capabilities, implement universal Fourier-based correlator as a key algorithm behind multidimensional pattern recognition for deliberate data. Provide example applications of the correlator for diverse target data

We can for example expect machine situation awareness related to visual and audio data with one general analyzer of symmetries in data, which interfaces with data encapsulated in an object with necessary methods which reveal the symmetries and possible transformations, equally for audio and visual data. Such an object must be able to reveal all about the encapsulated data, about its methods (symmetries and transformations), about possible parameters, limitations... it must be simply machine-intelligible. Such an object is what we call *frame*.

Generally speaking, frame is encapsulation of deliberate information structure, e.g. an object consisting of data and methods for their manipulation, with universal, explicit, semantic-based interface to the encapsulated information. In a narrow sense, frame is abstraction over all possible interfaces offered by encapsulated objects, thus, through the universal interface, encapsulated information structure, data and its methods are intelligible and accessible in a universally defined manner and without any supplementary information (in the present time, you cannot go around a binary object without the corresponding header files, which provide some human intelligibility but don't offer much playground for machines).

Surely, advent of frames can have huge impact on several aspects of computing in the very general sense (see the blue box right), however, huge human resources are needed to claim the path for it. To gain enough intellectual and financial resources, LOX Technologies tries to win partners for such a long-term, high-return project. The proposed Frame Consortium, as an ultimate front-line, hi-tech innovator has the best sights to win project funding from 7th EU Research Framework Programme. Please, visit the Frame Consortium site www.framecon.org for further details. And, welcome on board!

Promises of Frames

- Dependable networks of framed data can be much easily established
- Library of true universal algorithms, unique even in their binary form, can be much easily provided and evaluated for trustworthiness
- Frame-based communication over diverse systems allows automated semantics distillation and thus overrides the necessity of accurate protocol formats and guaranties the persistence of information
- Human and machine intelligibility of information with no need for supplementary data or hidden knowledge
- Insightful development tools that allow developer's access to any information at any time
- Automated, intelligent processing of framed data even of previously unknown structure
- Novel interactivity within deliberate data can provide, at last, a mechanisms that allows machine cognitive functions evolving beyond the scope pre-programmed by human developer