DIGITAL CONTROLLER CODE ENHANCEMENT (80-050)

Overview:

Applied Sciences Group enhanced an existing Assembly Code program for the TMS320C14/E14 as per the customers' request. Enhancement of the existing Assembly Code involved the following five stage approach:

1. Gained familiarity with existing program code.
2. General "clean-up" of code.
3. Installed and debugged a monitor function for annunciation during development. (This stage provided functionality similar to that of an emulator)
4. Created six (6) discrete functions: Closed Position Loop, Position Response, Integrating Error, Alarm System Bias/Maxstroke Hexadecimal, Switch Adjustments, and Position Monitor.
5. Corrected all "Ripple" effects due to the incorrect architecture of original program.

STAMP MACHINE UPGRADE

Project Description:

One of ASG's customers requested integrating two automated stamping units onto a single rotary station, in order to provide synchronized nests at which the product could be stamped. Each nest contained a different stamping die. The customer wanted the downstream stamp operation inhibited if the upstream stamp operation failed or if there was no product in the downstream nest. Additionally, the stamp machine cycles had to be synchronized so that the table could be rotated as soon as both stamp heads had raised enough for the product to clear the heads.

The machine did not use a PLC but rather, an Hitachi 8-bit microprocessor on a custom motherboard. The original program was written in assembler with no provision for diagnostics or in-circuit emulation. The program had to be burned into EPROM and tested as a black box. There was no provision for external communications other than digital I/O, and there were only two I/O lines available to meet the machine-to-machine communications requirement.

Approach:

ASG decided to use a pulse width modulation scheme on one I/O line to convey information from the upstream to the downstream machine. Pulse durations varied from a few milliseconds to several hundred milliseconds and indicated various machine states (cycle started, head down, head clear, cycle ended). The second I/O line was used to send back acknowledgment strobes from the downstream machine.

Assembler code modules were added to deal with the timing issues associated with the PWM signals. Additional functionality had to be added so that the downstream stamp cycle could be triggered on signal from the upstream machine.

Results:

There was no solution to "black box" problem, so considerable effort was spent during integration testing, using trial and error techniques to work out any bugs (moral: Always include low-level diagnostic functions in any custom-built computer). ASG decided to insert the new code as separate modules so that their functionality could be switched off easily, which allowed us to quickly isolate any problems. This also minimized the iterative process needed to fully integrate and test the new logic.

In today's world, the availability of low cost microcontrollers and PLCs should weigh heavily into any determination of custom versus off-the-shelf solutions. In the machine control environment, our recommendation is to avoid custom hardware, wherever possible.

Redefining CEMA Protocol

Overview:

Applied Sciences Group has redefined CEMA (a wireless protocol) for a local RF Radio Manufacturer. CEMA is used in many diverse commercial applications such as ATM machines, lotteries, and wide-spread computer networks. The customer was disappointed with CEMA's inefficiency and needed to increase the overall bandwidth in its networks. The original CEMA required 58% of available bandwidth for the protocol and left only 42% for the actual data to be transferred. ASG found several reasons for the poor performance of the original CEMA network.

- Due to project-related constraints, the maximum baud rate was limited 19.2Kbps.
- The programs which communicated over the network were compiled with an outdated compiler, causing pauses in network communication due to the slowness of the programs.
- The original CEMA allocated too many contention slots (pauses) to allow other devices connected to the network to request communication time.
- The list of devices waiting to communicate over the network could grow without bounds. Since this list is broadcasted over the network every time it is changed, this waiting list consumed a considerable amount of bandwidth.
- CEMA did not utilize data compression.

ASG programmers rewrote the communications driver for the Motorola 68000 processor in C. We used the Microtec optimizing C compiler to speed up the execution of the communication software. We limited the number of contention slots and the size of the reservation list. A data compression algorithm was also added. The resulting protocol (CEMA 2.0) is 73% efficient. This is much more efficient than the original CEMA.

Wireless Railroad Network

Overview:

Applied Sciences Group is helped build a wireless communication network for a railroad company. The network is designed tell the trains whether it is safe to proceed to a particular track. The trains are equipped with GPS systems which report their location to a control station. The network protocol used was called ATCS (Advanced Train Control System). ASG programmed Z80 processor-based 'radio modems' which are used on the trains. The most challenging aspects of this project were:

- The radio modem is in every sense, a blackbox. There was very little diagnostics information available from it, making debugging the program very difficult.
- ASG had to use a customized assembler to program the Z80 CPU. This prevented ASG from using any standardized software development tools and circuit emulators.
- The modems had to be able to interpret the ATCS in order to break the data up into appropriate transmission packets.

ASG programmers solved these problems by using good 'old-fashioned' programming practices. The entire program was designed conceptually before a single line of code was written. The program was thoroughly tested as each function was added.

Secure Protocol Development for Financial Services Industry

Overview:

ATM and lottery machines require proprietary data formats and extreme reliability in order to maintain customer confidence and transaction confidentiality. These criteria require knowledge of the existing financial communications protocols, security, networking and data encryption. ASG staff members have worked on financial data communications projects as far back as 1988 and have participated in the development of many projects that require reliable and secure data communications.

These projects have utilized numerous programming languages (C, C++, Visual Basic, Java) processing platforms (Intel PCs, Motorola communications gear, custom platforms) and communications protocols (TCP/IP, SDLC, X.25, 3270, asynchronous protocols and many others).

AUTOMATED STORAGE MANAGEMENT

Overview:

The next generation of storage facilities and locker products utilize embedded processors and narrow band communications to monitor locker utilization patterns, payment schedules, safety concerns and other aspects of storage. ASG has been developing Windows CE-based software that provides the user interface, offline control, online (remote) control and data upload/download in support of these "smart" storage facilities. This technology is finding its way into many industries, with the transportation (air, bus, train) and entertainment (ski resorts, amusement parks) industries being the most visible.

INTERNET PHONES

Overview:

There are several Internet Phone products on the market, some of which are meant to replace the standard POTS (plain old telephone service) phones found on most desks. ASG was the prime contractor for the development of a low-cost "telephone" that combines standard POTS and Internet capabilities into a single product for a niche market. ASG was chosen because of its experience in telephony, digital communications and embedded software development. This project is currently on hold pending a change in the customer’s financial ability to back the project.