NEXUS Technologies

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PROGRESS REPORT

Over the past month Nexus Technologies has analyzed the requirements for the Prometheus Smart Home System, a programmable power line communication system which can be used to control household products over the internet. Currently, with the completion of the design phase, the implementation phase of the project has begun.

Project Overview:

The project up to now consists of:

1. Requirements Analysis Phase
    a. Background Research
    b. Functional Requirements
        i. Master Controller Requirements
        ii. Power Line Communication Module (PLCM) Requirements
        iii. Device Controller Requirements
        iv. User Interface
2. System Design Phase
    a. System Specification
    b. High Level System Design
    c. Master Controller Design
        i. RS232 Module
        ii. Internet Webpage/User Interface
        iii. Network Module
    d. PLCM Design
        i. Modulator Circuit
        ii. Coupling Circuit
        iii. Decoupling/Signal Conditioning Circuit
        iv. Demodulator Circuit
        v. Safety Issues
    e. Device Controller Design
        i. RS232 Module
        ii. Signal Handling
3. Module Implementation and Testing Phase
    a. Progress
    b. Implementation Issues
4. Budget
5. Future Actions

Requirement Analysis Phase

The power line communication system will be used for home automation, allowing users to control devices in their household over the internet. Nexus Technologies has invested resources into researching similar products on the market identifying key requirements that our product should include. A significant requirement that will make our product standout is the simple user friendly interface. At Nexus Technologies safety of our users is of the highest importance and our engineers are working on adding several layers of electrical safety for the power line communication modem protecting users from potentially hazardous voltages. The entire system is required to be designed for easy installation by the end user. System expandability will be handled by allowing the system to have plug and play capabilities. Nexus Technologies expects that these requirements will create a superior power line communication system product.

System Design Phase

The Master Controller consists of a TS-7200 Single Board Computer, purchased from Technologic Systems. The TS-7200 provides us with a high speed, low powered computing platform which has both Ethernet, and RS-232 I/O. The Ethernet port will be necessary for hosting the webpage, and RS-232 port is used to communicate with the Device Controller. Debian Linux V2.6 is installed on a 2GB compact flash card. This complete Linux suite includes GCC for compiling C programs, and an Apache HTTP Server which will host the webpage. Currently basic functionality of the RS-232 software module, and the Webpage module is under development.

As for the PLCM, the modulator originally consisted of three integrated circuits, a signal generator, a frequency divider and a multiplexer to produce the FSK signal. After some research it was found that a single IC chip was capable of producing an FSK signal. The use of a single IC chip allows us to reduce noise, save space, and costs associated with our design. The modulator design and implementation is completed by using a voltage controlled oscillator circuitry of a phase locked loop integrated circuit. The phase locked loop can also be used as a demodulator by using voltage controlled oscillator, filter and phase comparator to produce a variable DC voltage. The original FSK signal is recovered by using a voltage comparator at the output of demodulator. Both the coupling and decoupling circuits of the PLCM have also been designed using high frequency transformers and capacitors, however, their functionalities have not yet fully met our proposed requirements.

Nexus Technologies decided to use a PIC16F877A microcontroller for the Device Controller, as it is cheap and efficient in terms of memory and processing. For the design of the external circuitry we decided to use an opto-isolator to optically isolate the microcontroller from the high voltage and current of an external device. We have the PIC running with a 4MHz external clock circuit, and have the development environment installed and working with the PIC so that development during the implementation phase can begin right away.

Module Implementation and Testing Phase

Debian Linux V2.6 has been installed on a 2GB compact flash card. This allows code to be compiled and tested on the TS-7200. Programs can be tested by outputting data to the terminal screen which is shown on a computer connected to the TS-7200 by a serial cable. The Serial Module will be tested sending data

from a computer with Hyperterminal, and outputted to the terminal. The Webpage module will be tested by connecting the TS-7200 to a local intranet.

The modulation circuitry was tested and found to be functioning within specification by applying a square wave input to the FSK to ensure that all the corresponding high/low voltage level produced the correct frequency outputs. The demodulator circuitry was tested and functioning correctly by inputting data from the FSK modulator to the demodulator and ensuring the original control signal is recovered. Currently, the coupling and decoupling sections of the PLCM are under implementation and testing. They both seem to be working but very inefficiently and require further research and development.

For the device controller module Nexus Technologies has began software development and has functioning I/O that can control LED's connected to I/O pins as well as a working interrupt service routines, all compiled and running on the PIC. The software development is proceeding with serial communication, though initial tests of communication with a PC are currently not working. Once communication is established then development of the communication protocol can commence. For the external control circuit we have obtained most parts necessary, though we still need to get a relay before we can construct and test the circuit.

Budget

Our total required budget estimation during the initial phase of the project has turned out to be $100 less than the actual required budget for our project. The only cost which was not carefully considered when estimating our project's required budget was the total cost of the master controller which is a TS-7200 Arm Processor. We had not considered the $100 shipping, taxes, and custom costs which would have been included with the purchase of this board. However, all other budget estimations are on schedule and in agreement with our initial estimation.

Future Actions

On the Master Controller the Webpage modules and RS-232 modules will be expanded from basic functionality to a complete suite which will be able to control the Device Controllers.

Design of proper coupling and decoupling circuitry is the next step that needs to be taken to complete the PLCM design. Then, multiple instances of the PLCM should be constructed in order to control multiple nodes or power outlets in a building. In addition, if time permits, all designed circuitry will be laid out on prototype boards and placed in appropriate casings to improve the external appearance of the designed product.

The device controller module still requires its communication protocol to be implemented in software and the main processing loop to be completed. The external circuit for device control must also be constructed. Then the PIC will be connected to the external circuitry and tested before being integrated into the full system.