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BlueCare

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Abstract

Technology has swelled into this force that keeps pushing our every day life into the next realm of reality. Only in dreams, did many of our current technology exist. Our group wanted to mesh this every growing dream with the daunting problems of life. People are challenged each day with the surroundings of their own home. For some, moving about their own home can be hard, sometimes impossible. These are situations where a device like BlueCare can make a difference.

BlueCare has been developed using Bluetooth technology, donated by CSIDC, to better the lives of those who want to live a free, yet safe, life in their own home. BlueCare is a wearable device that will monitor your current state of being, your environment, and even works as a home automation system. BlueCare will store your medical profile, and if something happens, BlueCare will call emergency personnel. BlueCare even stores patient information such as allergies, medications, and blood type. This way, when the personnel arrive they do not have to hold assistance to ask you questions about insurance, medical history, and allergies. This time is crucial, and should be spent focused on the patient.

This paper discusses our BlueCare project. We touch upon our early project perception, goals, requirements, implementation, palm UI, even setbacks. This paper also entails ambition for the future development of BlueCare. At this stage BlueCare is

still a rough prototype, but with the next few weeks devoted strictly to development we hope to make great progress.

System Overview

BlueCare

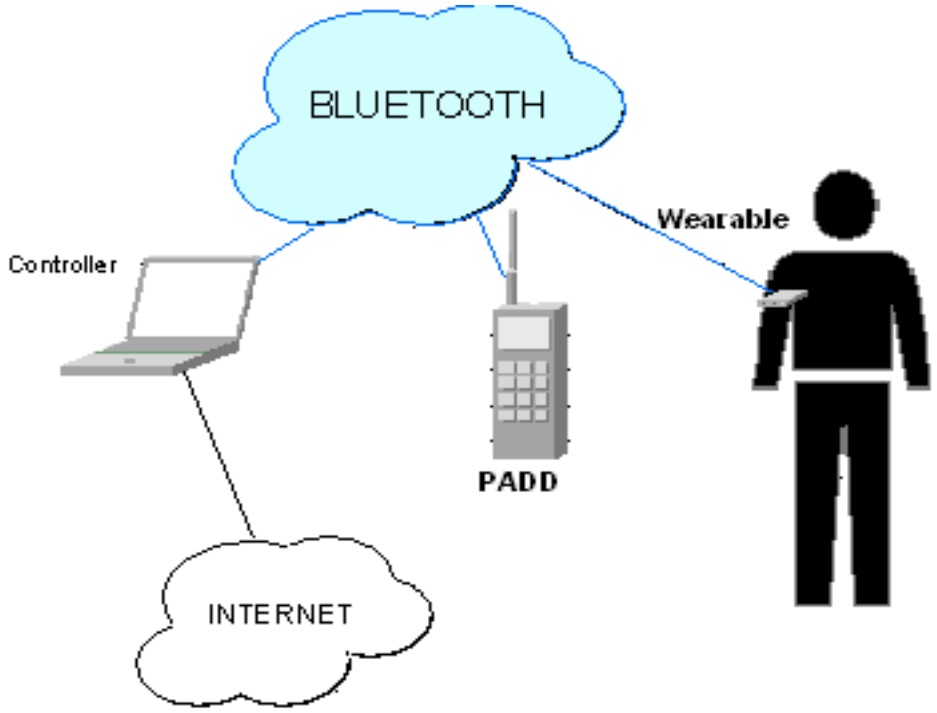
Long-term hospitalization and nursing home care has recently begun to be outrageously expensive. As a result, home-care and assisted living have started to replace the expensive hospital bills. Still, patients will spend many hours alone, which is a cause of much anxiety. BlueCare is designed to help ease the anxiety of a patient who is home alone.

The technology Bluetooth has distributed will allow sensors to connect wirelessly to a wearable monitor. The monitor will also connect to a health monitor that can relay medical information, alters, and emergency calls. This methodology could also extend to personal vehicles to allow for greater freedom. Our project goal is to construct BlueCare, a system that could eventually be configured to raise the standard of living for people whose health is at risk. BlueCare, with added functions, could administer life-saving emergency treatment under remote physicians, or automatically.

Prototype development has been focused on connecting the wearable monitor to a computer, which is connected to the Internet. Again, additional features could be added such as accelerometer, and gyroscopic artificial horizons. We would eventually like to

build BlueCare to tailor to the blind by assisting in their cardiovascular performance while exercising.

We have approached BlueCare with a modular design. Extra sensors and functions can be installed at a later time via “plug-ins” to help propel BlueCare. These functions could include home automation using the command center provided by BlueCare. The command center would send requests to the home environment to adjust HVAC and lighting, audio-visual appliances via X10, and other addable functions. An example of BlueCare in action could be: when a person falls asleep, BlueCare will notice the drop in metabolic rate and dim the lights. Other features could extend to navigation for skiers, order processing for fast food restaurants, even heads-up displays for motorcyclists.



Basic Network Diagram

For the prototype of BlueCare we chose to use a BASIC Stamp II Microcontroller for the wearable health-monitoring device. Remote home automation control is made possible by using the BlueCare PADD (Personal Access Display Device), a Handspring Visor (palm pilot) with a Red-M Bluetooth module. The PADD also allows accessing/changing of health history as well as real-time display of data from sensors connected to the wearable module. Separating the display from the wearable module will allow it to be much smaller and worn on an inconspicuous location since it won't have to be accessed directly. The BlueCare command center consists of an Internet connected, Bluetooth enabled computer running Linux and the BlueCare server. The Command Center also functions as the gateway between the PADD and X10 home automation.

GOALS SSTUD

Our main goals are comprised of five absolute features.

Speed

Security

Transportable

User friendly

Dependable

These five features contribute to the backbone of BlueCare. They are necessary to enable trust. These five features are what each of us look for in our personal physician

which his how we formulated our list. We would all have an near worry free life if each family physician was comprised of SSTUD, unfortunately, until now, that was impossible. With BlueCare you have the second best thing, and with advances in our design and implementation, BlueCare won't be far from have your own personal doctor at home.

Speed is important for the obvious reason that time stops for no one. It is important that BlueCare reacts at the speed necessary to deliver results to keep our customers safe.

Security is a feature that we will continue to perfect. It's important that our personal health files stay exactly that, personal. It is also important that they can only be modified by credible sources, by only those our customers delegate.

Transportable is a feature we take pride in. BlueCare is wearable, thus, can go absolutely everywhere. We hope to make BlueCare small enough so it does not impede on our comfort. It's important that BlueCare can be taken anywhere at anytime, even more important, that is delivers anywhere at anytime. The transportable feature is one we will continue to perfect adding features for those who have active lifestyles. We hope to produce a waterproof BlueCare, possibly even a BlueCare model than can handle extreme altitudes.

Our *User Friendly* goal could be the most important out of the five. BlueCare must be easy to use, bottom line! Our customers must be able to implement desired features on BlueCare without much stress or worry. Besides, BlueCare was designed to help, not hinder our lifestyle.

BlueCare's *dependability* is absolutely vital. Our customers depend on BlueCare, in the case of an emergency, to possibly save their life. A life is nothing to leave in the hands of anyone, or anything, that falls short of the dependable reputation.

BlueCare Requirements

Feature	Necessities	Solution
User Interface	User Friendly, accessible, Concise	Palm Based GUI
Storage	Mobile, Wearable, Inexpensive Accessible	Wearable Device

Interface

BlueCare must be user friendly, easily accessible, and concise in order to provide the level of care BlueCare is capable of. Our interface is based on the Palm GUI, which encapsulates all three of our necessities. The palm has also proved itself to be highly connectable to other, possibly useful, devices. This enables a BlueCare user to fully personalize their unit to their desires.

Storage

The wearable BlueCare device is our storage unit. We used this method because the device was mobile, wearable, inexpensive, and accessible. The fact that this unit is wearable is one of the reasons for BlueCare possible success. A person can easily construct their database, with the appropriate privileges, to their needs.

Progress, Problems, and Setbacks

During the course of BlueCare we ran into many problems that have produced setbacks. This section will be an overview of our group progress and problems.

Our first goal was to figure out exactly how Bluetooth worked. We approached this by using the two Xircom cards, included in the kit, and connecting two laptops running windows. Once problems arose we tried various system combinations including Windows 98, Windows 2000, and Windows XP. Each resulted in an unstable connection with "services" rarely transmitting. Without transmitting services communication between the two laptops was impossible. We were, however, able to detect the presence of new Bluetooth devices but since the services were not exported communication was not achieved. We spent several weeks trying to find the winning combination in order to find the working services. Finally, we contacted Intel, they now own Xircom, and to see if they could possible help us find our missing services. Their rely was of no use since it entailed the exact steps we had been parsing through for weeks. The case of the missing services was our first major setback.

We then tried to create a connection between the Ericsson USB Bluetooth and one of the Xircom cards. The Ericsson module did not install properly in Windows so we emerged in further research. We found that the installation was successful, but their package included drives, but did not include programs to manage the Bluetooth stack.
We then tested the RedM Springboard Bluetooth module for connection to a Windows box, but no reliable connection was made. Again, it was able to detect other Bluetooth modules, but no services were found.

We then postponed our search for Bluetooth services on Windows machines since the server/gateway for the palm and X10 modules would be running Linux. We researched bluez at http://bluez.sourceforge.net/ and added it to our RedHat Linux 7.2 box. This was a painless procedure since we found it available as a precompiled, self-installing package. All we needed to do was find the bluez tools to have a fully functional Bluetooth stack under Linux. These tools were downloaded from the bluez website and installed without much difficulty.

Linux automatically recognized the Ericsson Bluetooth module, and loaded the required kernel modules, after modifying the configuration files for bluez. Once the helper daemons, hcid, sdpd, rfcommd, we were able to connect to the Linux box over Bluetooth from the palm. Bluez exported the server services, including rfcomm, which behaves like a fast serial port. We the set up the Linux box to create a PPP connection over the Bluetooth rfcomm link to enable a TCP/IP link to the palm.

We decided to use Python to write a server application on the Linux box. The server would handle messages from both the palm, and the BlueCare device. We were

able to create a multi-user chat system, which could be easily modified to process commands coming from either wireless device.

Meanwhile, we were investigating ways to program the palm. We decided superwaba, http://www.superwaba.org, would be most sufficient. Superwaba is based on JAVA with built in classes to handle socket connections. After a few days of implementations we were able to program a simple application that would create a socket connection to the python server. The only compiler that we found compiled superwaba correctly was Microsoft visual J++. This was a costly process since because we had to switch between Windows and Linux, in order to program and test.

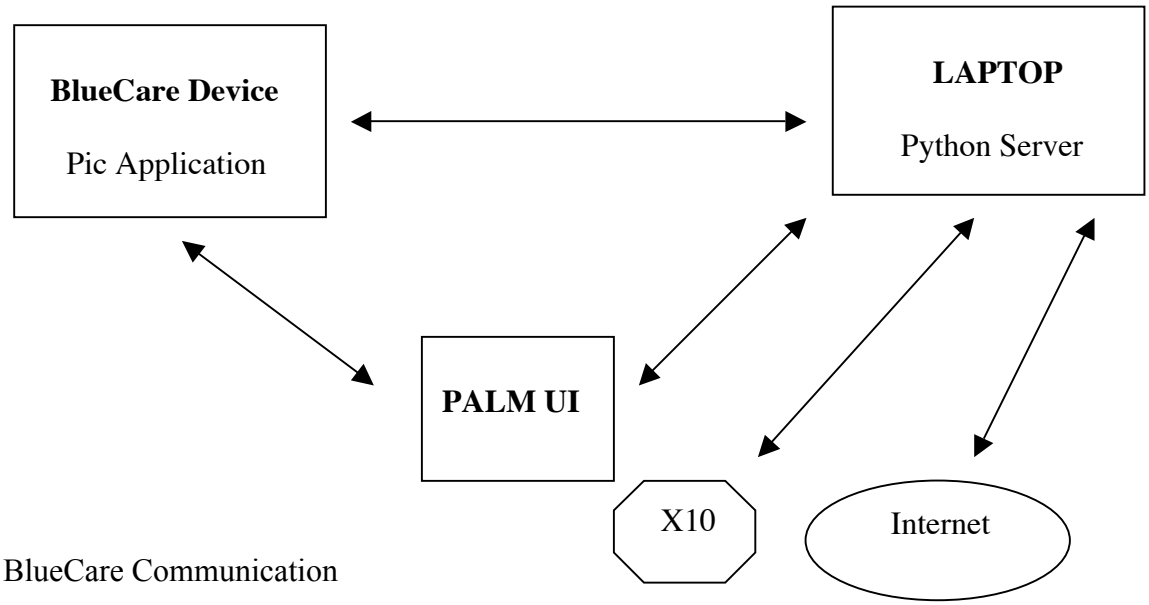
We are currently designing a GUI for the palm that will cleanly display the medical information. This has been no easy task since the palm screen is small. Our GUI can be seen in the section labeled *Palm UI.*

BlueCare Implementations

The development kit donated by CSIDC, Xircom, and Ericsson was used to build the BlueCare prototype along with a Pic BASIC stamp, Bluetooth palm Red-M Blade, and X10 home automation modules. Below is the expense list.

ITEM	**COST**
Development Kits	Donated
Basic Stamp	$45.00
Bluetooth "Red-M Blade" (Palm) **substitute**	$175.00
X10 Home Automation Modules	$25.00
IPu8931 Beta Evaluation Kit	$99.95

The main components used by the BlueCare prototype are the server application located on the laptop, and the BASIC stamp application located on the BlueCare device. The server application was programmed in python. The BASIC stamp application was programmed in PBASIC. The following chart illustrates BlueCare's communication. All lines of communication, with the exception of the laptop to Internet and the laptop to X10, are all Bluetooth.



BlueCare Communication

Bluetooth

Bluetooth was the best technology for our BlueCare prototype. Bluetooth has been redefining the way we stay connected and this revolutionary technology was one we felt was dependable. This section will discuss Bluetooth's advantages and disadvantages.

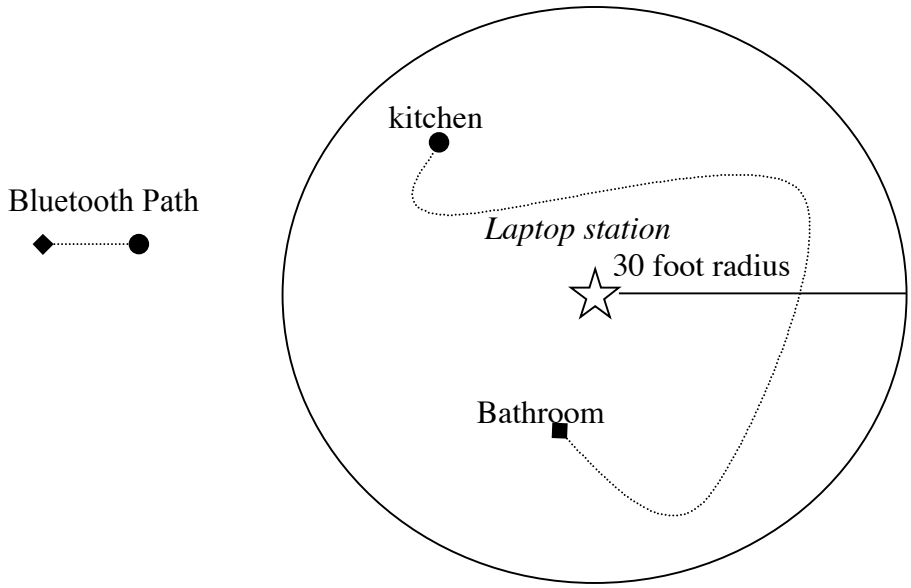
Advantages

- Small Circuitry
- Line of sight is not required
- Wireless
- Low power
- Cost

Small Circuitry is of the essence when designing a wearable device. The small circuitry will be one of the sole reasons BlueCare will be a comfortable wearable device.

Bluetooth does not require *line of sight,* which is of value when considering a wireless home automation unit as well as a personal health monitor.

Bluetooth's *wireless* protocol does away with the needs for cables and connections, making BlueCare possible. Other wireless protocols such as infrared require *line of sight*, which makes Bluetooth technology superior. Bluetooth also operates within a 30-foot radius. This enables mobility while maintaining a stable connection. For example, you've had a health related accident in the bathroom of your house. You contact your emergency personal via Bluetooth and the Internet. Once they are communicating with you they suggest you retrieve something from the kitchen, pills or water, Bluetooth allows this mobility without losing your connection.



Bluetooth, because it is wireless, needs to have a dependable battery life. Bluetooth's *low power* is another advantage. We are using class 2-output power with a max output of 2.5mW. Class 2 has a range of 30 feet, or 10 meters. This power class allows great battery conservation as well as a fitting range. When the device is in idle mode the consumption of power will be notably less. The size of BlueCare will put great constraints on the size and quantity of batteries, therefore keeping the consumption of power as low as possible is a great consideration.

Power Class	**Max Output Power**	**Range**
Class 1	100mW	100 meters+
Class 2	*2.5 mW*	*10 meters*
Class 3	1 mW	1 meter

Bluetooth Radio Power Classes (Bray 11)

Bluetooth is low in cost, which adds to its ease of access. Bluetooth's low cost makes BlueCare a reasonable purchase.

Disadvantages

- Connection time
- Limited bandwidth

Although Bluetooth is a solid product, it is not without it's disadvantages. Since BlueCare will be a life-dependant medical monitor, as well as a home automation system, it is imperative that we consider connection time, bandwidth, and power and range during prototype development.

Radio link can cause connection times to be somewhat lengthy because the transmitters and receivers all need to synchronize before communication can be enabled. There are two types of delays when considering Bluetooth links, device discovery and connection.

Device discover in a neighborhood can take a considerable amount of time, in the tech world. A device must send out an inquiry packet and receive the response packets from the different devices. Once these packets are received the user is than notified. If all devices are set to scan for inquiries, which are not always the case, ten seconds will be consumed before the user knows of all devices. If a device is not set up for inquiry scan the user will never know the device exists. Connection time itself can also take up to ten

seconds. Overall connection overhead can be up to twenty seconds. The basic steps Bluetooth must parse through these basics steps in order to use a new device.

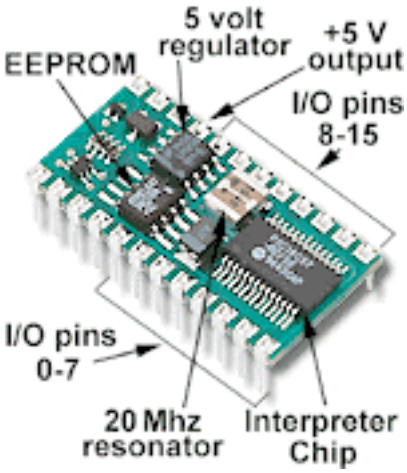
- Device discovery must be performed
- Service discovery to get information on how to connect to services on each new device
- A service must be selected and then connected

These connection limitations could possibly have serious consequence.

Wireless is inherently slower than physical connections. Internet connections via Bluetooth LAN are limited to a data rate of 723.3Kbps over air interface (Bray 9). Even less bandwidth is available after you account for management traffic and headers. These limitations are not suitable for downloading large amounts of data.

We have weighed the advantages and disadvantages and found Bluetooth to be apt for our BlueCare Prototype.

BASIC STAMP II



Basic Stamp

We are using a BASIC Stamp II as our multiprocessor. The BASIC stamp is a small computer that runs Parallax BASIC programs. It has programmable I/O pins that can be used to interface with TTL-level devices. The BASIC stamp consists of a 5-volt regulator, resonator, serial EEPROM, and PBASIC interpreter. The PBASIC program is stored in electrical erasable programmable read only memory (EEPROM),

which can be written to and read from easily, by the interpreter chip. The program can be reprogrammed and programmed as often as necessary because it is stored in EEPROM (parallaxine.com). The BASIC stamp has 16 I/O pins, two synchronous serial pins, holds 500 to 600 instructions, and executes at an average of 4000 instructions per second (parallaxine.com). The BASIC stamp II interpreter firmware is programmed into a PIC 16C57 microcontroller.

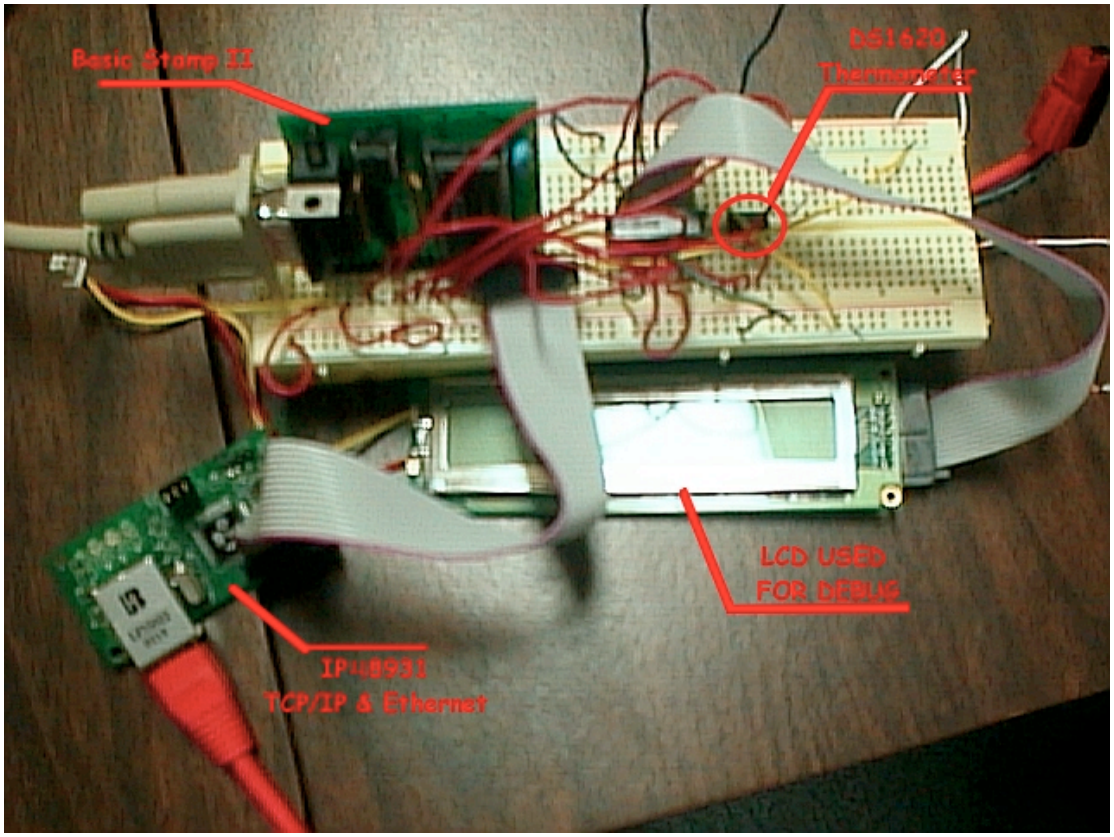
BASIC Stamp II Specifications
(http://www.wirz.com/products/0206/)

Microcontroller:	PIC16C57 surface mount
Speed:	20 MHz / 4,000 instructions per second
EEPROM:	2K bytes (program and data)
Program Length:	500 lines of PBASIC
RAM (variables):	32 bytes (6 for I/Os and 26 for variables)
Input / Outputs:	16 (up to 17 RS-232 communication ports)
Source / Sink Current:	20 mA / 25 mA
Serial Communication:	300-50K baud I/O
Current Requirements:	7 mA running, 50 uA in sleep
PC Interface:	Serial port
Package:	24 pin DIP module
Size:	1 3/16" L x 5/8" W x 3/8" H

BlueCare Design

In designing our device we took into consideration many factors. First we realized that in doing a project like this there would be many obstacles that we were not aware of yet and so we quickly concluded that time would be a factor in implementing the design. Our solution was to make our device as modular as possible. There are a few

advantages to doing this. It allowed us to concentrate on a particular part of the device and get a working prototype. We then could focus on additions to the working device.

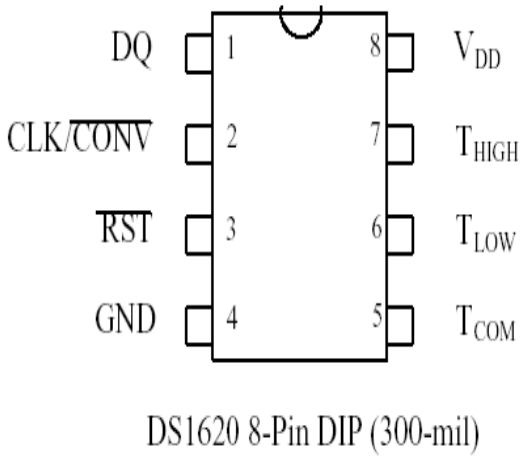


The above picture is the our Bluecare prototype. The pinouts for the DS1620 are seen in figure x.x. The Basic Stamp is connected to the DS1620 by the following pins.

- BS2 Pin 8 DS1620.3
- BS2 Pin 9 DS1620.2
- BS2 Pin 10 DS1620.1

Power to DS1620.8 and the ground to

DS1620.4.



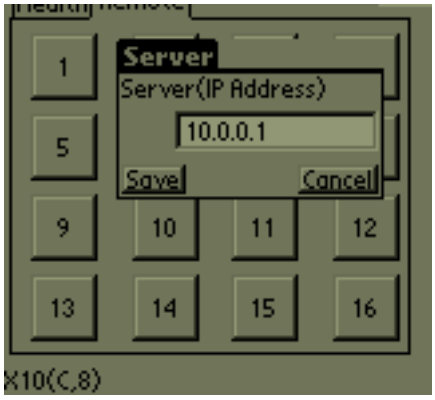
We included the IP-8931 module for a couple of reasons. It includes a TCP/IP Controller that will allow somebody to monitor the BlueCare device that monitors the person, over the Internet. It connects to the Internet with an Ethernet connection however we hope that some day a similar chip will be designed using Bluetooth technology. The IP-8931 also has a I^2C bus that is accommodating to our modular design in that a number of peripherals may be added to the device through the bus. The power for the device is located underneath the board. For now we have 7 rechargeable C batteries attached to the device.

BlueCare Application and User Interface

Using superwabba, which is a Java virtual machine for small devices. The following includes pictures from the palm OS emulator and a brief description of each screen.

When you turn on the palm simply select the BlueCare icon and the newest version of BlueCare will load. The *about* button will generate this screen.

To the left is the first screen you will see when you enter the BlueCare application. The following page includes a screen when scrolled. The information will not be immediately present. The user must first locate and connect to the server. These two pictures illustrate all the basic medical fields that we have saved on the BlueCare device.



To access the server you would press the menu button located on the palm. The user would then enter the server IP address and press save, which will

store the server address. The user would press connect, and then refresh, and the information would be updated and existing.

By switching to the remote tab the user will enter our home automation tab.

The letters on the right corrospond to specific house codes. Each room, or house, would have a corrospond to a different letter. Once the user selectls the current house code they can monitor or control 16 different devices in that specific code (room) as long as it's within Bluetooth's range.

Testing and Evaluating

The testing and evaluating stage is one of the most important stages of the project. Being that our prototype isn't completed yet we have no yet begun this stage. We have however developed some debugging techniques during the creation process. We connected a LCD display to the device in order to obtain readouts. The display is connected to the Basic Stamp and allows us to monitor the different peripherals connected to the device. The Basic Stamp also has with it a debugging serial port to upload the program. We connected to the Basic Stamp with this port using the hyperterminal program that comes with any Windows operating system. As we mentioned earlier this stage is very important and so we have come up with a testing plan, which will be implemented after the device has been finished. The plan consists of a series of tests of each element of the device.

The first test will be to determine the accuracy of the device. Bluecare is a collection of other devices, therefore we will be able to bring in these other devices to compare. For example a thermometer will be able to check the accuracy of the temperature sensor in the Bluecare device. With these comparisons we will be able to make any adjustments needed.

When BlueCare has been finalized we will run through a system of checks that will determine if our goals have been met. Our goals, speed, transportability, user ease, and dependability, will all be gauged in our final evaluations.

Conclusion

BlueCare is designed to take advantage of the bounds we have made in technology to better the quality of human life. BlueCare is ideal for those who, for some reason, cannot live comfortably in their own home. BlueCare provides comfort, with home automation, along with medical safety, BlueCare health monitor. With BlueCare, patients can live their private life, yet feel safe knowing they have medical personnel, literally, at their fingertips.

BlueCare includes

- Development Kits
- Basic Stamp
- Bluetooth "Red-M Blade" (Palm)
- X10 Home Automation Modules
- IPu8931 Beta Evaluation Kit

Future implementations of BlueCare will effectively reach all of our intended goals. Our Patients will be able to comfortable wear the small, portable device and live comfortably in their own home. BlueCare will be able to provide emergency personnel in the case of an emergency, as well as automate an entire home with a press of a button. BlueCare meshes the next wave of technology into our everyday life.

Works Cited

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