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BLUE NANNY BASED CHILD MONITORING SYSTEM USING INTERNET OF THINGS

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***Abstract* — Due the frantic lifestyles of parents today, constant supervision of their child can sometimes be demanding. Parents are constantly concerned about the condition of their child. They regularly strive to maintain constant child supervision to prevent them from serious injuries. Even though correct safety measures are being taken to prevent serious child injury, one sudden lapse of concentration, even for a second, can lead to fatal injuries. A large number of reported accidents1 with stoves, hot water, swimming pools, etc., have testified that parents need help. Blue Nanny is the wireless solution to assist all parent or guardians with child minding and child injury prevention. It aims to accomplish this by generating constant awareness of the child's location to the parent. This will hopefully aid to improve awareness of their child and consequently reduce child injuries. Blue Nanny is engineered to *always keep an eye on the children* by combining Bluetooth and proprietary radio frequency (RF) communication.**

The design and implementation of Blue Nanny hardware using Raspberry Pi-3 and RF communication forms the topic of this project. Blue Nanny consists of portable modules to be worn by parent and child. Hardware for these modules will entail voice signal conversion and user interfaces constructed for compatibility with Bluetooth communication. The design of RF beacons employs the use of a grid-based environment in the home. Their hardware and software for operation is all discussed in this thesis with comprehensive implementation description ns reported.

Index Terms— Blue Nanny; Raspberry Pi-3; Bluetooth Communication.

I. INTRODUCTION

Child safety at home has been identified as one of the most important issues that concern parents1. The average home is responsible for the highest number of Injuries amongst young children. This statistic is greater than its nearest competitor by over 5 times. An understanding of how this figure is determined must be continually addressed. Due to the busy lifestyle of today's parents, continual supervision of their children can sometime be demanding. For a serious and sometimes even fatal injury to occur, a sudden lapse of awareness of the child's whereabouts is all that is required and can occur within a matter of seconds. The outcome can range from minor to disastrous, but is an outcome that can be avoided with today's solutions and technologies.

Our product, Blue Nanny, is a home-use system developed to always keep an eye on the children at home. Blue Nanny is a complete wireless system created to assist childminding and reduce the risk of child injury at home. It uses both Bluetooth technology and proprietary RF communication to provide parents with an instantaneous voice communication link to their child with constant awareness of their Childs location. It will alert the parent when children come close to potential dangers. BlueNanny is capable of considering parental needs in varying household environments.

There are already some commercially available products which focus on child monitoring. Digital Angel2 and Kidbug3 are just two examples of these and are looked at in more detail in chapter 2. They have similar functionality to BlueNanny but do not allow any flexibility when personalising system alerts and settings. BlueNanny supports the need for children to learn their boundaries while not strictly confining them. It is a system that can be incorporated into the lifestyle of parents and will promote the freedom of mobility in their daily lives. Hence, allows parents to live their hectic lifestyle whilst always supervising their children.

II. OBJECTIVES

The BlueNanny system proposed above represents a joint effort with two colleagues, Alan Hardcastle and Zon Shih, to form the BlueNanny Team. This project was undertaken to become the final year thesis for the Bachelor of Engineering Degree. The appropriately named BlueNanny system provides parents or guardians, assistance, in child minding at home. Due to the complexity of this task, its sections were divided among team members. The BlueNanny system was also motivated by worldwide competitions that reward the design of innovative products. The Computer Society International Design Competition4 (CSIDC) by the IEEE Computer Society is run to advance excellence in computer science and computer engineering education by encouraging, teams of students, to design and implement computer-based solutions to real-world problems. For entry, a four page proposal of the product was sent by March with selection of participants for the competition known one month later. On selection, assisting hardware and software was donated by the competition sponsors. This package contained Ericsson 101 008 Bluetooth ROK modules5 and Microsoft Windows XP. Due to this equipment, our product design involved to use of these products. A comprehensive 30 page report, which was due in May, was required for entry to the final stages of the competition. Based on progress and results, the report was compiled, by the BlueNanny Team, which contributed to final design specification of BlueNanny

The Young Inventors Awards (YIA), held by Hewlett-Packard Asia-Pacific and Far Eastern Economic

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Review, is the second competition that further motivated BlueNanny. This competition is also run to encourage innovative ideas in the field of computer technology. For entry, a five hundred word outline of the product outline is required and finalists are selected according to uniqueness of ideas. This outline report was submitted in September and selected finalists will be notified at the end of October.

This project discusses and overview of the BlueNanny system which participated in the above competitions. It will include all the work completed by Dimitri Andronikos with respect to the BlueNanny project. This comprises of the design of the voice codec circuit, EyeMod hardware, ParentMod Hardware, software design and any other components of the project aiding the completion of the final product.

III. BLUENANNY SYSTEM

BlueNanny is a wireless Bluetooth-based solution to assist in childminding. It is a system designed for the supervisory user such as a parent or guardian, to supervise children in a domestic environment when they are out of sight. After outlining the main reason for injuries with young children, BlueNanny aims to help prevents such injuries. It operates by providing parents immediate alerts when their child is in a dangerous area. BlueNanny will detect the location of children and provides the parent this information for their utilization. The parent has the option to respond to the alerts and/or contact their child through the wireless two-way voice communication that BlueNanny provides. BlueNanny will succeed to provide constant child awareness to allow peace of mind for any parent.

The BlueNanny system provides parents with information regarding the locations of children by visual and audible alerts. It uses both Bluetooth technology and proprietary Radio Frequency (RF) communication as a means of wireless communication between modules. Alerts can occur if any of the children in the system moves within proximity of an unsafe or restricted area that is predetermined by the user.

System operation begins with the user placing units with embedded RF beacons, called EyeMods, in selected child minding regions within the home. There are three different classes of EyeMods that BlueNanny provides: the Local Eye, Point Eye and Smart Eye. The Local Eye gives identification to a region of metres (suitable for placement in rooms), while the Point Eye identifies a region of 1 meter (suitable for placement neat dangerous objects or areas such as the pool gate). The Smart Eye identifies the potential dangers in its immediate surrounding (suitable for stoves, fireplace, etc).

The Local Eye gives identification to a region of 3 metres (suitable for placement in rooms), while the Point Eye identifies a region of 1 meter (suitable for placement neat dangerous objects or areas such as the pool gate). The Smart Eye identifies the potential dangers in its immediate surrounding (suitable for stoves, fireplace, etc).

The BlueNanny innovative features are:

● Detect children (and notify parent) if a child enters an area where potential dangers are already identified.
● Notify parent if a child leaves a predetermined area.
● Detect extreme temperatures in surroundings and notify parent if determined that potential danger exists.
● Educate children about potentially dangerous household areas.
● Provide a two-way phone quality voice communication.
● Offer adjustable levels of childminding possible demanded by changing parental focus (i.e. age of a child, changing environment).
● Support the need for children to learn their boundaries while not strictly confining them.

BlueNanny is configured using the BlueNanny Application Software (BlueNApp). The system configuration data is transmitted wirelessly via Bluetooth to a parental unit, called ParentMod. The children carry units called ChildMods which dynamically configures from the ParentMod. The EyeMod uses a 433.93 MHz RF signal to communicate to the ChildMod when a child enters an EyeMod region.

Bluetooth technology is used between ParentMod and ChildMod to establish simultaneous data and voice communication. Bluetooth allows for a secure and wireless connection. Figure 2, on the next page, illustrate the overall BlueNanny system and the make-up of each module.

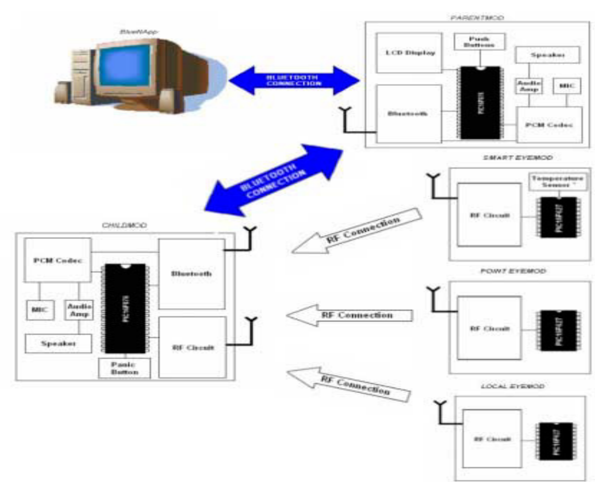


Fig. 1 BlueNanny Block Diagram

IV. PROPOSED SYSTEM

A. DESIGN METHODOLOGY

The project consists of the following modules: BlueNApp software, ParentMod Hardware, ChildMod Hardware, Bluetooth communication and RF communication modules. Working in parallel helps to meet project deadlines. Project modules were all tested either on breadboard or printed circuit board (PCB) before any final integration and testing. The module designs were specified in respect to

IJARMATE
International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. IV, Issue IV, April 2018

product accessibility and developed from the user's perspective to optimise the product application, capability, price and performance. These include choosing a standardised system voltage level at +3V DC to comply with Bluetooth, which helps to attain low power consumption levels for the system. One major constraint encountered which altered the design of the system was the current indoor navigation technologies. The Bluetooth module will not give accurate separation distance between another Bluetooth module. To overcome this difficulty, EyeMods were designed to act as beacons in a grid arrangement. If the grid was pre-defined, any point within the grid will therefore have a location with-respect-to the grid arrangement.
The design of the BlueNanny product was divided into sections and assigned to group members with in the BlueNanny team.
Reference to other sections of the BlueNanny system can be seen below:

- Zon Shih : BlueNApp Software
- Alan Hardcastle: ParentMod Hardware
  ChildMod Hardware
  EyeMod Hardware
  Bluetooth Communication
  RF Communication
- Dimitri Andronikos: ParentMod Hardware
  ChildMod Hardware
  EyeMod Hardware
  RF Communication

B. PROPOSED MODEL

The project innovation is to use today's advance technologies to aid parents in childminding. BlueNanny allows parents to always keep an eye on more than one child at different places at once. Built on the concept of child awareness, BlueNanny has the ability to offer various degrees of childminding levels that could be demanded by children of different ages. BlueNanny focuses on preventing accidents by monitoring and educating children about dangers in the home. This reduces child injury risks and relieves stress for parents. Today, no commercial product offers the same set of features as BlueNanny. The uniqueness of BlueNanny lies in its ability to integrate technologies such as Bluetooth and RF communications in child safety prevention schemes. Additionally, BlueNanny has other unique features such as knowing when a child has left the detectable range or removes their ChildMod. Configuration of the system is user-friendly with a well designed interface and wireless data exchange between the modules. The user does not need to manipulate hardware during the setup.

The figure 2 shows the general overall view of the paper. Based on this the proposal utilizes the blue nanny hardware, RF communications and Raspberry-Pi P3 Model microcontroller for taking the care of child involvements.

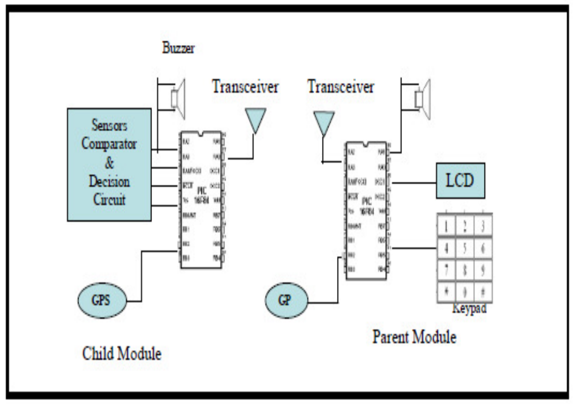


Fig.2: Overall General Description

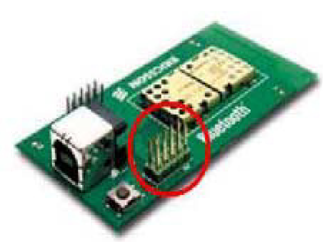
C. REQUIREMENTS

i. Bluetooth Voice Communication

For Bluetooth voice communication, the use of a voice codec is required. A codec (codec-decoder) is used to convert an analog signal into a digital stream. This becomes useful when performing a wireless transmission of an analog signal. As voice is an analog signal a device know as a voice codec can be used to convert this signal into a digital stream to allow digital transmission. Once voice is digitised, it may be transmitted long distances without degradation. A codec is a single device that does both the Analog-to-Digital and Digital-to-Analog conversions.

ii. The Bluenanny Codec

Voice communication between the ParentMod and ChildMod allows immediate interaction between the parent and child. This provides the parent, a direct connection to the child in order to maintain constant awareness and to give any reassurance desired. Our BlueNanny product will consist of the Ericsson 101 007 Bluetooth ROK module which provides the Bluetooth connection between parent and child modules. Since the Ericsson Bluetooth modules supports synchronous voice data transmission (SCO link) a pulse code modulation (PCM) codec chip was used to transmit voice signals between the parent and child modules. There are 'Jumpers' located on the Bluetooth Module to get convenient access to the SCO link. Figure 3 highlights the location of these jumpers on the ROK Module and displays a pin description.



2 PCM_CLK	4 PCM_SYNK	6 VCC 3.3V	8 DETACH	10 GROUND
1 Vin 5V nom	3 WAKE_UP	5 PCM_OUT	7 PCM_IN	9 RESET

Fig 3: PCM jumpers on the ROK Module

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iii. Eyemods

EyeMods are battery operated radio frequency (RF) beacons which are used to transmit their Eyemod ID (EID) to any receiving ChildMods in proximity. The Eyemods will be place through-out the home to regions which the parent desires supervision. Each Eyemod ID (EID) will therefore be designated to the region where the EyeMod is located which will interpret the location, of the ChildMod, with respect to the home. Each EyeMod contains a microcontroller and RF circuitry with the SmartEye having also a temperature sensor. The selected microcontroller for the BlueNanny Eyemods is the Raspberry-Pi P3 Model. The Raspberry-Pi P3 Model features a quad-core 64-bit ARM Cortex A53 clocked at 1.2 GHz. This puts the Pi 3 roughly 50% faster than the Pi 2. Compared to the Pi 2, the RAM remains the same – 1GB of LPDDR2-900 SDRAM, and the graphics capabilities, provided by the VideoCore IV GPU, are the same as they ever were. As the leaked FCC docs will tell you, the Pi 3 now includes on-board 802.11n WiFi and Bluetooth 4.0. WiFi, wireless keyboards, and wireless mice now work out of the box. The headlining feature of the Pi 3 is the built-in WiFi and Bluetooth, but it doesn't stop there. Here is the complete specs for the Pi 3:

- SoC: Broadcom BCM2837 (roughly 50% faster than the Pi 2)
- CPU: 1.2 GHZ quad-core ARM Cortex A53 (ARMv8 Instruction Set)
- GPU: Broadcom VideoCore IV @ 400 MHz
- Memory: 1 GB LPDDR2-900 SDRAM
- USB ports: 4
- Network: 10/100 MBPS Ethernet, 802.11n Wireless LAN, Bluetooth 4.0

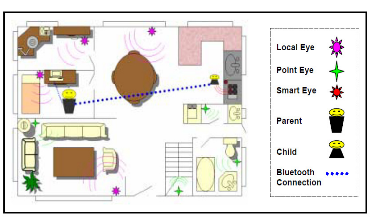

Fig 4: Eyemods employed in a BlueNanny Environment

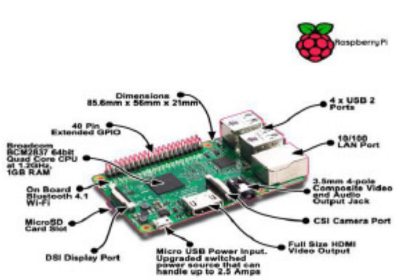

Fig 5: New Raspberry Pi 3 — A 64-bit Pi with Built-in Wireless and Bluetooth LE

iv. RF Specifications And Selection

The Nordic nRF401 is a true single chip UHF transceiver designed to operate in the 433.93MHz ISM (Industrial, Scientific and Medical) frequency band. It features Frequency Shift Keying (FSK) modulation and demodulation capability. The nRF401 operates at bit rates up to 20kbit/s. Selection of the transceiver was made after careful evaluation of many transceivers. The nRF401 was decided upon as it was compatible with the battery supply voltage level of +3V and was supplied with comprehensive support to make them operational. The Nordic website13 supplied us with relevant PCB schematics which require very few external components. Initialising the nRF401 will require the transceiver to be placed in transmitting mode. This is accomplished by enabling the transmitter enable pin (TXEN = pin 19). The transmission channel must also be set. Channel 1 will be used for the EyeMods which transmits at frequency of 433.93MHz. The nRF401 transceivers are controlled by the Raspberry-P3 model through its USART capabilities. As they will only be required to transmit the EID, setting up the receiver side will not be needed. USART works by transmitting bytes through the TX pin (pin 8) asynchronously from the Raspberry-P3 model. This is accomplished after bits have been shifted serially into the USART buffer. On detection of a full buffer, the buffer data will be serially clocked through the TX pin. The Transmit Shift Register Status bit (TRMT) will play the role of a busy flag by going high on detection of an empty buffer. Using this bit as a buffer status bit will avoid corruption of bytes. Before the data is transmitted through the nRF410 transceiver, the data is passed through a Schmitt trigger due to USART supplying an inverted output.

When determining the required baud rate for transmission, the necessity of a fast baud rate needs to be questioned. A delay of half a second may seem fast in real life but actually is very slow when transmitting through RF. Therefore a transmission time of less than one second is more than sufficient for its purpose in this project. Therefore, according to the Raspberry-Pi P3 model datasheet, a baud rate of 2.4kbit/s with a 5.0688 MHz crystal results in a zero error rate. This was the selected configuration for the BlueNanny EyeMods.

The nRF401 must require correct timing for operation. To avoid spurious emission outside the ISM-band when the power is switched on, the TXEN-input must be kept low until the synthesised frequency is stable, as shown in figure 6.

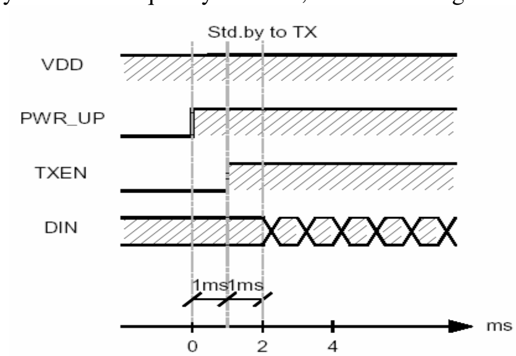

Fig 7: RF Transceiver Timing Requirements

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In order to assure a reliable link, the nRF401 requires oversampling. Oversampling with a rate of 3 times the bit-rate with weighting of the samples, will be noise resistant. However, timing of each sample must be consistent or successful oversampling will not be evident. Conveniently, the microcontroller being used is designed to be compatible with RF transceivers. The Raspberry-Pi P3 Model USART capabilities conduct the sampling of each bit, three times, at arrival. Refer to the Microcontroller selection part of this project in section 3.2.1 for an in depth description of their function in the EyeMods. Figure 3.6 shows the oversampling Algorithm used by the Raspberry-Pi P3 Model.

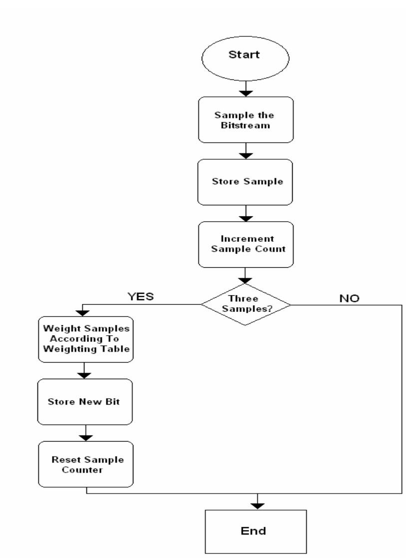

Fig 8: Oversampling Flowchart

v. Packet Format

When setting up the packet format for the EID, the packet is 5 bytes long and must begin with a preamble. The suggested preamble by the nRF401 datasheet13 is 2 bytes consisting of: 01010101 ('55'), to cycle the receiver. The third and four byte in the packet will be used to indicate the start of the packet. The fifth and final byte of the packet will contain information about the EyeMod. Figure 3.7 illustrates the bit details in the fifth byte

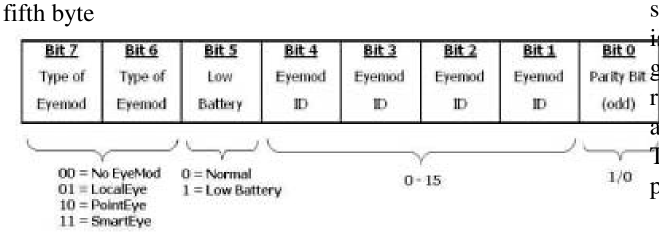

Fig 9: EyeMod ID 5th byte

As shown in figure 9 the EyeMod ID will be assigned one of 16 values. Enhancements can be made by adding an extra byte for the EyeMod ID if more than 16 EyeMods are used. The Parity Bit will provide error checking to detect any bit errors occur after transmission.

vi. RF Antenna Design

The Eyemods in the BlueNanny system all use omni-directional antenna design. Due to the large range obtained from properly tuned antennas, a single wire design proved sufficient with-respect-to range. Therefore a 5cm long dipole antenna transmitted successfully at a range of 3m, adequate for use on the LocalEyes. The PointEye and SmartEye only require a transmission range of 1m to which a 1cm long dipole antenna is adequate. The antenna pattern will diverse in all directions. Shielding of the antenna can allow transmission in one direction. Generally, the omni-directional radiation pattern is recommended. Figure 3.8 shows the vertical radiation pattern of an EyeMod dipole antenna transmitting in all directions.

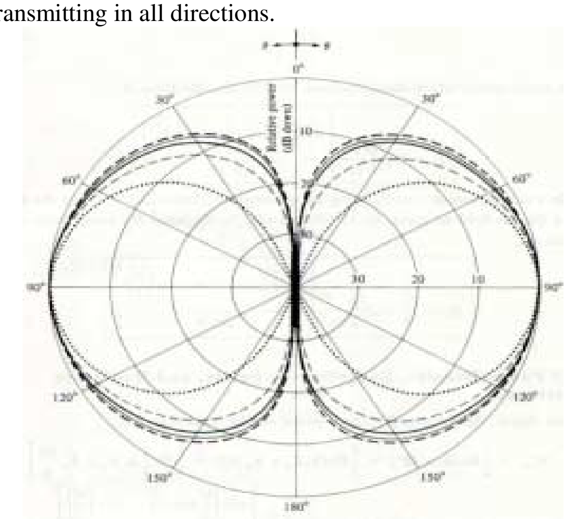

Fig 10: Dipole antenna radiation Pattern

vii. Transmitting the EyeMod Identification

Even though the nRF401 has a maximum data rate of 20kbits/s, a 2.4kbit/s data rate of was selected and mentioned in section 5.4. Each EyeMod ID packet is 5-bytes (40-bits) in length with a packet the format explained in section 5.4.2. At 2.4kbits/s, it takes approximately 420µs to transmit one bit. It therefore takes 17ms to transmit an EID. In order to prevent the RF signals that are transmitting from different Eyes from colliding with each other, each packet is transmitted at times set by a random number generator create from software. This is based on transmitting at intervals of one second, which is generated each time by the Raspberry-Pi P3 Model using a random offset. This gives 60 available transmission slots that a 17ms EID can be sent. A probability algorithm shown in Table 1 is used to determine the possibility of two EID packets colliding.

Table 1: Probability calculations for EID collision

Data	Results
EID transmission time:	17ms
Probability of EID being sent in one of 60 transmission slots:	1/60 = 0.017
Probability that another EID could be sent that will overlap the first:	2/60 = 0.033

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Probability of two EID packets colliding:	0.017 x 0.033 = $5.7x10e^{-4}$

Therefore there is less than 0.06% chance of two EID packets colliding per transmission interval. If it does occur, there is little possibility of a collision during the next second since a random number is used for each EID transmission.

Between transmitting each EID packet the nRF401 can switch to standby mode. To send an EID, 4ms are required for the nRF401 to power up from standby mode and transmit the 17ms packet. Only one EID is sent per second, therefore the nRF401 is in standby mode for approximately 99% of the time, lowering the power consumption of an EyeMod.

The RF signal between an EyeMod and ChildMod has no line-of-sight restrictions. This eliminates restrictions when a user may wish to position an EyeMod. However, a problem may arise if an EyeMod is placed next to a wall and the wall allows the RF signal to be received on its other side. This problem is realized and a possible solution is using adjustable RF shielding on the Eye, as mention in section 5.5, which limits the direction of the RF signal.

viii. Smart Eye Temperature Sensor

Burns and scalds, are one of the top five nature of injury that most occurs to children. The design of a SmartEye incorporates the use of a temperature sensor to rectify this statistic. The SmartEye is designed to be used in temperature influenced environments such as the fireplace, stove, etc. The SmartEye will contain similar hardware to that of the LocalEye and PointEye, but will also comprise of a DS18B20 1-Wire® Temperature Sensor by Dallas. This will allow the SmartEye to react dynamically with the surrounding environment.

The DS18B20 Digital Thermometer18 provides 9 to 12–bit centigrade temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that connects directly to a bi-directional port pin on the the Raspberry-Pi P3 Model microcontroller. It has an operating temperature range of –55°C to +125°C and is accurate to +/-0.5ºC over the range of –10°C to +85°C. For the BlueNanny SmartEye application, very little external circuitry is needed to interface with the DS18B20. Figure 10 illustrates the simplicity of the hardware configuration when using 1-Wire® temperature sensors. The SmartEye will use pin 0 on PORT B of the the Raspberry-Pi P3 Model to provide communication access and power to the DS18B20. Power to the bus is provided through the 4.7kOhm pullup resistor from a 3V supply rail supplied by the 2×1.5V AA battery source.

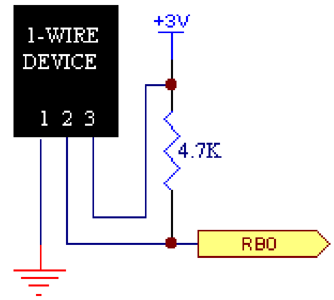

Fig10: DS18B20 Hardware Configuration

With all 1-Wire® interface requirements, accurate timing functions need to be established. A delay function is correctly tuned with the 5.06868Mhz crystal. This delay function allows high and low pulses to occur within a constant timeslot. Firstly, an initialisation pulse will occur to detect the available 1-Wire® device. Temperature conversion is then conducted. The microcontroller must wait for a certain time interval until the conversion is completed (usually approx. 750ms) before the 12-bit temperature value is stored in the scratch pad or volatile memory. This can be read and converted into a decimal value and multiplied by the degree resolution to give the temperature in degrees Celsius. With respects to BlueNanny, we have set the temperature threshold value as 47°C for this as the minimum unsafe temperature for young children according to statistics. Therefore on detection of surrounding temperature above our set threshold, the RF transceivers begin transmitting its EID to alert any nearby ChildMods of this hazardous location.

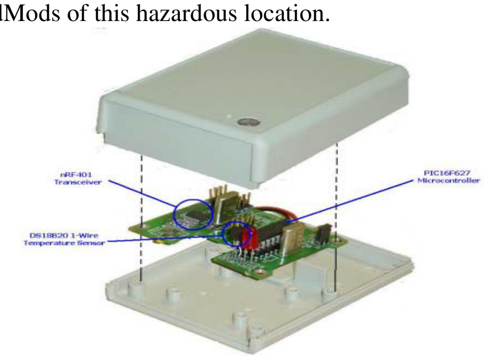

Fig11: SmartEye Mechanical View

ix. LCD Display

To provide the parent user with an easy display interface for the ParentMod, we have included a Liquid Crystal Display (LCD). This display will inform the parent of any alerts from the ChildMod, the location on request of their child and the current status of the ParentMod. The ParentMod has been installed with a Hitachi HD44780-based LCD module with the follow specifications displayed in the Appendix. In order for the LCD display to communicate with the ParentMod's Raspberry-Pi P3 Model microcontroller, a LCD driver, to operate the LCD module, is written in C.

LCD Hardware: The LCD display module is built with a controller that has two 8-bit registers, an instruction register (IR) and a data register (DR). It provides 16 pins for

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interfacing with microcontrollers. Table 2 summarises the 16 pins provided by standard Hitachi LCD module.

Table 2: LCD Pin-out Summary

Pin Number	Symbol	Function
1	Vss	Ground
2	Vcc	Power Supply (+3V)
3	Vo	Contrast Adjust
4	RS	Register Select
5	R/W	Read/Write
6	E	Chip Enable Select
15	A	LED Backlight +
16	K	LED Backlight -

By the register selector (RS) signal, the two registers can be selected. The IR stores instruction codes, such as display clear and cursor shift, and address information for display data RAM (DDRAM) and character generator (CGRAM). The IR can only be written from the microcontroller. The DR temporarily stores data to be written to the DDRAM or CGRAM. When the address information is written into the IR, then data is stored into the DR from DDRAM or CGRAM.

Due to minimal port pins remaining on the PIC16F876 microcontroller, we initially opted to use the PIC16F877 which comprises of 2 extra ports (D – 8 pins and E – 6 pins) for use with the LCD module. Later, after realizing pin saving techniques, the LCD driver was written for the Raspberry-Pi P3 Model microcontroller. The pin configuration is shown in figure 12.

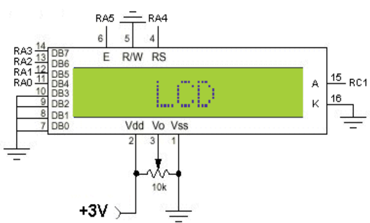

Fig 12: LCD Pin Configuration

The pin saving technique came about from a function which is supported by the LCD module. It allows the microcontroller to sent commands through the data pins at four bits at a time hence reducing four pins. Also, a one pin is saved by routing the R/W pin to ground. This can be perform due to the purpose for the LCD, on the ParentMod, is for only writing to (R/W = 0), not reading from (R/W = 1). Therefore a total of seven port pins were required to successfully interface the LCD to the Raspberry-Pi P3 microcontroller.

<u>*LCD Software:*</u> The LCD driver is written in C and compiled using the Hitech C compiler. Refer to section 6.3 for a more in depth look at the tools used throughout this project. Firstly, the LED module accepts instruction by strobing (low-high-low) the enable (E) pin of the LCD module. Therefore for initialisation, the desired LCD modes need to be selected to determine the display and input format. This is performed by selecting the data register (RS = 0) and writing the required hexadecimal commands. For the ParentMod the LCD is put into 4 bit mode, with a 2 line display and an incremental cursor. The input format may be change later to allow any animation on the LCD display. After correct initialisation of the LCD module, writing the correct ASCII value will result in the character being displayed onto the LCD. The LCD module contains a look-up table to output the correct character display. The LCD module look-up table can be seen in the Appendix. One final function command is coded to allow the user of the driver easy useability. This is accomplished by allowing the user to only input a string in the driver function for display to the LCD.

V. SOFTWARE REQUIREMENT

To program the Raspberry Pi P3 Model microcontrollers, the selection of compiler and transfer software is important for correct functionality of the program on the chip. Either Python Language or With C, the preferred programming language, Hitech C, a quite old but reliable compiler was used for building source code. It will compile, assemble and link entire programs into a hexadecimal (HEX) format file, which is ready for onboard application. The process of transferring this file into the processor requires a python programming board which accepts the HEX file through the communication port of a computer. Software required for transferring operations is PICALL21 which specializes on only PIC processor transfers. Once programmed, a simple breadboard circuit with the processor is adequate for testing and debugging purposes.

VI. CONCLUSION AND FUTURE WORK

BlueNanny has applied today's technology to introduce a new dimension to childminding at home. It provides constant awareness of children with the integration of latest technologies. With the application of BlueNanny (Bluetooth-based assistant nanny) there is always an eye on the children.

Bluetooth technology is used in this project to provide a secure, cheap and power efficient solution to child minding techniques. RF beacons are implemented into BlueNanny to provide a reliable location method. Communication between the network of RF beacons and Bluetooth links will constantly monitor the location of a child. This proves beneficial for the supervision task and acts as an assistant to parents for their child minding responsibilities.

This system portrayed the hardware aspect of the BlueNanny system by accompanying its design solutions. It delved into the development of Bluetooth voice communication and BlueNanny module hardware and also provides the software concepts used for hardware integration. With current trends in market growth, the demand for Bluetooth applications is set to increase. With future revisions of Bluetooth increasing range and number of supported devices, BlueNanny has the potential to be incorporated into large scale uses, such as in hospitals, kindergartens and retirement villages.

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Future development of the BlueNanny design can be implemented by different wireless communications as technology improves. Using RF ID tags, especially passive RF ID tags, as beacons could be just one solution. Passive RF tags will not need a battery power supply, therefore no replacement of batteries will be required. Another solution could be using Ultra Wide Bandwidth (UWB). UWB technology can provide very fine range resolution and precision distance and/or positioning measurement capabilities. This technology could eliminate the need for LocalEyes as distance and location will be known.

This is not to say that Bluetooth is not adequate source of wireless communication. The BlueNanny system designed did have the problem of much reduced range. This is mainly due to the Bluetooth module in use. The latest technology of Bluetooth (Class I) can provide and reliable link at distances of 70m with the aid of an external antenna. Technology like this could prove ideal for the BlueNanny design in all house-holds.

A future development in design could be the implementation of a water sensor into the ChildMod design. This idea was initially suggested, although due to the inability of the Bluetooth module to transmit underneath water, this idea was scrapped. Although, most RF communications are possible to transmit underneath water with a great enough power. Therefore, the inclusion of this feature would prove beneficial to alert parents before their child drowns.

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