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IOT-ENABLED SMART WEARABLE DEVICE ENHANCING CHILD SAFETY

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Abstract: In today's world, ensuring the safety of babies and toddlers is of utmost importance. To address this concern, we have developed advanced "Child Safety Wearable Devices" that are specifically designed to enhance the safety of infants and young children. These innovative devices are programmed to monitor and safeguard the daily activities of toddlers, ensuring their well-being. In the event of any potential danger or if the child ventures into an unfamiliar area, the device will automatically send alerts to the parents' mobile devices. This is made possible through the device's precise geofencing capabilities, which are tailored to the child's daily routines. These wearable devices are particularly valuable for school-going children. They operate using a sophisticated system that relies on magnetic sensors for real-time tracking and temperature sensors for monitoring the child's physical well-being, including body temperature and heart rate. By continuously analyzing the child's daily activities, these devices provide an additional layer of safety and security. In the current era, the number of child kidnapping cases has been on the rise. To address this growing concern, we have introduced "Child Safety Wearable Devices" leveraging the power of the Internet of Things (IoT). IoT refers to a network of interconnected devices and sensors that are connected to the internet, enabling seamless communication and data exchange. IoT technology has found applications in various fields, including self-driving vehicles and home automation systems, making it a global phenomenon. Our solution consists of two key components: the wearable devices themselves and the server-side infrastructure that supports them. These devices are specifically designed to prioritize child safety. They establish wireless and Bluetooth connections to transmit real-time data from the child to the parent, ensuring that parents are always informed and connected to their child's well-being.

Keywords. Arduino, NodeMCU, Tilt Sensor, Lm35.

1. INTRODUCTION

In today's context, child safety has become an increasingly pressing concern due to the rise in kidnapping cases involving children. To address this issue, we have implemented "Child Protection Wearable Devices" utilizing Internet of Things (IoT) technology. IoT refers to a network of interconnected devices and sensors linked to the internet, enabling seamless communication and data exchange. IoT is applied across various domains, including self-driving vehicles and home automation systems, making it a ubiquitous technology.

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Our solution comprises two fundamental components: the wearable devices themselves and the server-side infrastructure supporting them. These wearable devices are purpose-built to prioritize child safety, employing both wireless and Bluetooth connectivity to facilitate real-time communication between the child and their parent. In cases where internet connectivity is not available on the parent's phone, SMS text messages are used to enable communication and provide the child's precise location.

The core technology behind these wearable devices includes a magnetic sensor for tracking the child's position and a temperature sensor for monitoring vital signs such as body temperature, pulse, and more. This multifaceted approach not only identifies the child's location but also assesses their health status, including temperature, pulse, blood pressure, and energy levels. Continuous analysis of the child's position and health status is enabled by these sensors. The devices exhibit qualities such as high reliability, rapid response times, and pinpoint accuracy, making them well-suited to ensure the safety of children.

The application is designed to function on personal home pages (PHP), which is a server-side scripting language used for web development. It encompasses components like geofencing and SMS services to provide real-time alerts and tracking functionality. The system also leverages GPS and GSM technology to track the child's location accurately.

In summary, our "Child Protection Wearable Devices" powered by IoT offer a comprehensive solution to address the growing concern of child safety. By combining real-time tracking, health monitoring, and efficient communication, we aim to provide parents with the assurance and tools they need to ensure their child's safety and well-being effectively.

The Internet of Things (IoT) encompasses a vast array of interconnected devices and systems, bridging the gap between the physical world and the digital realm. These devices, spanning various domains such as smart cars, wearable technology, home automation, and even implantable human devices, contribute to a dynamic IoT ecosystem. One notable inclusion is wearable devices aimed at ensuring child safety in today's increasingly crowded and fast-paced world.

This paper centers on a crucial aspect of child safety – the role of the community in aiding a lost child until reunited with their parents. While numerous wearables currently available primarily focus on tracking a child's location and activity via Wi-Fi and Bluetooth, the reliability of these communication methods remains a concern. In response, this project seeks to establish a more dependable mode of communication by leveraging Short Message Service (SMS), which offers greater resilience compared to Wi-Fi and Bluetooth.

The foundation of this endeavor is the Arduino Uno microcontroller board, featuring the ATmega328P chipset. Additionally, the project relies on the Arduino GSM shield, facilitating functions such as SMS and call handling, as well as internet connectivity through the GSM network. Supplementary modules are incorporated to provide real-time location information of the child to parents via SMS. Furthermore, an SOS light indicator, programmable using the Arduino UNO board and Morse code, serves as a vital distress signal. The wearable device is enclosed within a custom-designed 3D printed case, ensuring durability and protection.

In the event of a lost child, parents can send an SMS to the wearable device, triggering the activation of the SOS light feature. This illuminates the SOS signal, universally recognized as a call for help, alerting those in the vicinity to the child's distress. Additionally, the wearable boasts a distress alarm buzzer, activated when the parent sends the SMS keyword "BUZZ." The loud buzzer is audible over considerable distances, facilitating swift parental response.

Moreover, parents can receive precise coordinates of their child via SMS, enabling them to pinpoint the child's location with the utmost accuracy. Existing initiatives in a similar vein include the Wristband Vital, a low-cost, lightweight solution designed to detect and report hazardous situations. While innovative, it relies on Bluetooth for communication between the child and parent, potentially limiting the range in scenarios with substantial distances.

The motivation behind this wearable device stems from the growing concern for child safety in crowded environments. The utilization of SMS as the primary communication method, coupled with the adaptability of Arduino programming, ensures a secure and reliable means of parent-child communication. Customization of the wearable is also feasible, allowing it to be tailored to specific needs as required.The introduction of automation has significantly impacted various aspects of manufacturing processes. One of the key areas influenced by automation is the reduction in production times. Automated machines have played a pivotal role in achieving substantial reductions in production times. For instance, in the case of machinery and assembly of components, significant time is traditionally required for setting up the operational blueprints and cutting parameters every time a new component is loaded into the machine. This often leads to substantial downtime for expensive machines when transitioning between different product assemblies.

2. SYSTEM HARDWARE

Objective: The primary goal of this project is to create an IoT-based system for monitoring and ensuring child safety.

Implementation: For the implementation of this project, we have utilized Arduino Uno, NodeMcu, and readily available controllers suitable for security applications.

Project Description: In today's world, ensuring the safety of children has become paramount. Therefore, we have embarked on the development of "child safety wearable devices." These devices are designed with the sole purpose of enhancing the safety of children. The system is specifically programmed to monitor the daily activities of children. In case a child enters a potentially dangerous or unfamiliar location, the device is equipped to automatically send an alert to the parent's mobile device. This functionality is achieved by programming the device to recognize specific locations corresponding to a child's daily routine.

These wearable devices are particularly beneficial for school-going children. They operate based on IoT technology, incorporating a magnetic sensor for real-time tracking of a child's location. Additionally, the devices include a temperature sensor for monitoring the child's physical well-being, such as body temperature and heartbeat. This comprehensive approach ensures that children can be located quickly and accurately using wireless communication. The system has demonstrated qualities such as high reliability, rapid response times, and precision, all of which are essential for ensuring children's safety.

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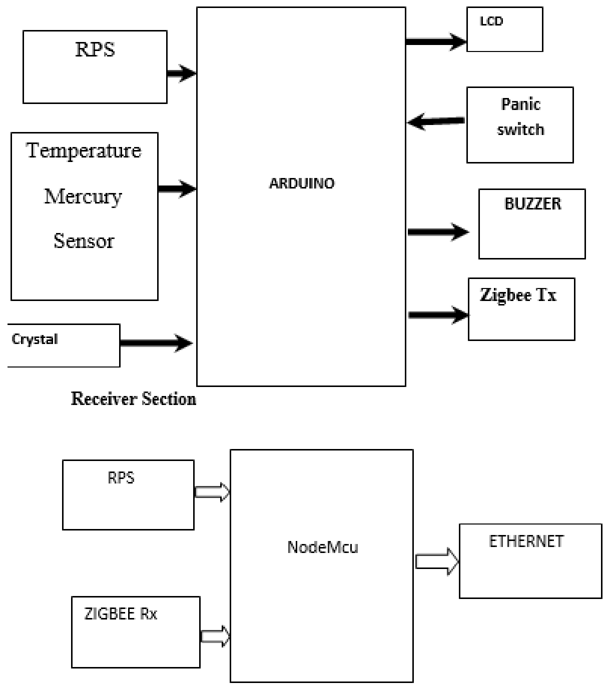
This project aims to address the growing concern over the increasing number of child abduction cases. To counteract this issue, we have implemented "child safety wearable devices" using IoT technology. The term "Internet of Things" (IoT) refers to a network of interconnected devices and tools equipped with real-world sensors that communicate over the internet. IoT can be applied to various fields, including self-driving cars and home automation systems, making the world more connected and smarter. The IoT ecosystem comprises both the physical devices themselves and the supporting server-side infrastructure that facilitates their functionality.



3. RELATED WORK

Gartner has outlined ten crucial advancements and technologies expected to impact IT over the next five years [5]. The internet is extending its reach into various aspects of both corporate assets and consumer devices such as cars and televisions. However, many companies and technology firms have yet to fully explore the opportunities offered by this expanded internet landscape, lacking the operational and organizational readiness. Gartner identifies four emerging usage models: control, monetize, operate, and expand. These models can be applied to people, things, data, and locations, paving the way for the "Internet of Everything" as opposed to the "Internet of Things." The Internet of Things (IoT) encompasses a broad concept where most new objects are interconnected and enabled with features like networked streetlights, embedded sensors, image recognition, augmented reality, and near-field communication. These technologies are integrated into situational decision support, asset management, and new services, offering numerous business prospects while increasing the complexity of IT.

To address the diversity of IoT, various communication technologies must be adapted, taking into account IoT application requirements such as energy efficiency, security, and reliability. This adaptation involves a heterogeneous mix of communication technologies like Ethernet, wireless, Bluetooth, ZigBee, and Z-Wave. Industries like distribution, transportation, logistics, reverse logistics, and field services can leverage data and "things" integration to create new business processes or enhance existing ones, leading to greater efficiency and profitability.

The IoT combines information technology (hardware and software used for data storage, retrieval, and processing) with communication technology (digital systems for communication between individuals or groups). The convergence of these technologies occurs at three layers: the cloud, data, and communication networks, and devices. The access and functionality of data exchange synergize to create significant new opportunities for IoT applications, with over 50% of internet connections already involving or connecting with "things." In 2011, there were over 15 billion connected devices and 50 billion intermittent connections, highlighting the growing importance of IoT.

Key technologies enabling the Internet of Things fall into three categories: technologies that allow "things" to gather contextual data, technologies that enable "things" to process contextual data, and technologies aimed at enhancing security and privacy. The first two categories are fundamental building blocks for infusing "intelligence" into "things," which sets IoT apart from the traditional internet. The third category, addressing security and privacy, is crucial for IoT's widespread adoption. With the rise of IoT in smart factories, the volume and granularity of enterprise data generated will increase. Business models will evolve from single companies to dynamic networks and entirely new value chains. Data generated by smart machines will transcend organizational boundaries, raising concerns about data confidentiality and competitive advantages.

Innovations and regulations will be necessary to safeguard sensitive data, and new business models may require legal safeguards, such as dynamic pricing models to ensure fair data-sharing compensation. One notable application of IoT is enhancing border security through shipment tracking from origin to destination. This involves an internet-based security system utilizing RFID and GPS technologies to identify drivers and monitor cargo integrity in real-time. A centralized database and interfaces between databases and the Automated Commercial Environment (ACE) are established to facilitate these functions.

As IoT continues to evolve, devices with diverse functionalities are becoming available worldwide. Some are geared toward personal safety, while others focus on vehicle tracking. An essential objective is the development of devices to help parents locate their missing or lost children. This project capitalizes on the fact that many children now have smartphones, which can be utilized for location tracking. GPS and GSM, specifically SMS, are integrated into a single device. Parents can send a location request to the child's device, which will then send back the location for display on a map. This communication between the parent and child's applications is facilitated via SMS, allowing the system to function even without an internet connection. This feature ensures that the application can run on smartphones without GPRS, 2G, or 3G internet connectivity. The system sends the child's device location to the parent's smartphone when the parent wishes to check the child's location.

4. ARDUINO

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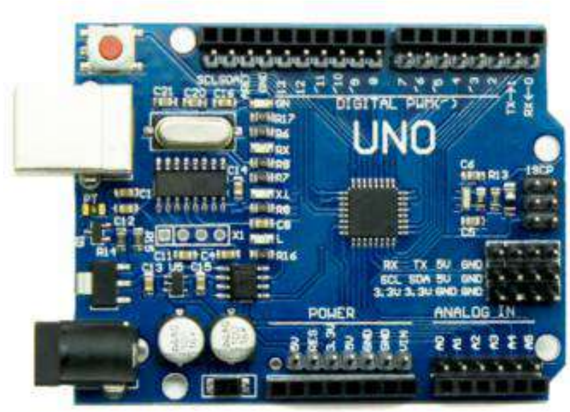

Overview:

The Arduino Uno is a microcontroller board subject to the ATmega328 (datasheet). It has 14 motorized data/yield pins (of which 6 can be utilized as PWM yields), 6 essential wellsprings of information, a 16 MHz artistic resonator, a USB alliance, a power jack, an ICSP header, and a reset catch. It contains everything expected to help the microcontroller; just interface it to a PC with a USB association or power it with an AC-to-DC connector or battery to begin.

The Uno contrasts from every first board in that it doesn't utilize the FTDI USB-to-back to back driver chip. Or on the other hand possibly, it joins the Atmega16U2 (Atmega8U2 up to change R2) adjusted as a USB-to-successive converter.

The Uno board has a resistor dismantling the 8U2 HWB line to ground, making it less mind boggling to put into DFU mode.

The board has the going with new highlights:

pinout: included SDA and SCL pins that are close to the AREF stick and two other new sticks set close to the RESET stick, the IOREF that engage the shields to adapt to the voltage gave from the board. In future, shields will be extraordinary with both the board that uses the AVR, which works with 5V and with the Arduino Due that works with 3.3V. The resulting one is a not related stick, that is set something aside for future purposes.

- Stronger RESET circuit.
- Atmega 16U2 uproot the 8U2.

"Uno" suggests one in Italian and is named to check the top tier section of Arduino 1.0. The Uno and structure 1.0 will be the reference changes of Arduino, pushing ahead. The Uno is the most recent in a development of USB Arduino sheets, and the reference model for the Arduino compose; for an examination with past structures, see the archive of Arduino sheets.

5 NODEMCU

WI-FI: The WI-FI module used in this project is ESP8266. It follows TCP/IP stack and is a microchip which is less in cost. This microchip allows microcontroller to connect to a WI-FI network, by using Hayes style command connections are done or made through TCP/IP connection. ESP8266 has 1MB of built in flash, single chip devices able to connect WI-FI. Espressif systems are the manufacturers of this module, it is a 32 bit microcontroller. There are 16 GPIO pins in this module. This module follows RISC processor. It has 10 bit DAC. Later Espressif systems

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released a software development kit(SDK) which is used to programme on the chip, so that another microcontroller is not used. Some of the SDK's are Node MCU, Arduino, Micro Python, Zerynth and Mongoose OS. SPI, I2C, I2S, UART are used for communicating between two sensors or modules.

Figure : Wi-Fi module

6. IoT Technology and Applications

IoT development speedily assist the IoT application that focused on the heap industry and specific users, while networks and devices allow connectivity of physical things. IoT application gives reliable vital device-to-human and device-to-device communication. IoT device applications need to ensure that information is received and properly acted according to a suitable specific way, a simple example is that of logistic application monitoring that has the transported status of goods such as organic products, fresh products, meat and dairy terms. Furthermore, during logistics, quality control of climate change, shock and humidity is regularly monitored and suitable movements are strategically and naturally made to preserve goods spoilage from a long distance when connection is out of courage. To claimed that "some examples of IoT applications in existence can be found in Smart Environment, Smart Greenhouse, Smart Cities, Smart Water, Smart Metering, Security and Emergency, Industrial Control, Home Automation and Electronic Health". 'IoT' is therefore stationed on devices that can examine sensed data and then transmit it to the user. K. IoT Challenges As stated in a previous study, there are some challenges that IoT design would face in the coming future generation. All the devices, nodes connected in associate in nursing IoT design needs to have terribly low latency over reliable links. Because of the vast variety of IoT devices and the use of various frequency bands, there would be a crisis in spectrum house. Although IoT devices are expanding on a daily basis that consumes terribly lesser power, still there'll be a big quantity of greenhouse gas emission because of all of these devices. Finally, IoT architecture not solely must be price effective however additionally they have to be capable of supporting heterogeneous applications and devices. As stated above on IoT challenges, IoT applications will have some more basic needs to tackle, for example, Device addressing, Security, Scalability, Mobility, Anchor-less sending and so on. As mentioned, IoT applications contains numerous heterogeneous devices, and however, content security is a key concern that plays a great roles. A previous study has indicated the challenges of both IoT and ICN in their past study, this past study endeavours to combine them where IoT illustrate the different challenges and on the other hand, ICN illustrates the positive solutions. Nonetheless, their study explained initially how different ICN features can address IoT issues and after that, some use cases and contextual investigations are examined

7. LIMITATIONS

The system has following limitations:

1. **Compatibility**: As of now, there is no standard for tagging and monitoring with sensors. A uniform concept like the USB or Bluetooth is required which should not be that difficult to do.
2. **Complexity**: There are several opportunities for failure with complex systems. For example, both you and your spouse may receive messages that the milk is over and both of you may end up buying the same. That leaves you with double the quantity required. Or there is a software bug causing the printer to order ink multiple times when it requires a single cartridge.
3. **Privacy/Security**: Privacy is a big issue with IoT. All the data must be encrypted so that data about your financial status or how much milk you consume isn't common knowledge at the work place or with your friends.
4. **Safety**: There is a chance that the software can be hacked and your personal information misused. The possibilities are endless. Your prescription being changed or your account details being hacked could put you at risk. Hence, all the safety risks become the consumer's responsibility.

8. CONCLUSION

The child safety wearable device serves as a multi-functional smart device, offering a plethora of features designed to provide parents with real-time updates and ensure their child's safety. Notably, it furnishes parents with the child's precise location, ambient temperature information, and an array of safety features, including an SOS light and a distress alarm buzzer. These features empower parents with the ability to closely monitor their child's surroundings and, if necessary, swiftly alert nearby individuals for assistance or comfort in times of distress.

As we venture into the future, the potential for enhancing this smart child safety wearable is boundless. One avenue of improvement involves the utilization of highly compact Arduino modules, such as the versatile LilyPad Arduino, which can seamlessly integrate into various fabrics. This innovation opens up new possibilities for wearable design, making the device even more discreet and comfortable for children to wear.

Another critical aspect of future development revolves around achieving greater power efficiency. This entails creating a model capable of prolonging the battery life, thereby ensuring that the device remains operational for extended durations without the need for frequent recharging.

9. FUTURE SCOPE:

1. **Surveillance Capabilities**: A promising enhancement on the horizon is the incorporation of a camera module. This addition would significantly elevate the system's performance by enabling real-time

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surveillance of the child's surroundings. Whether implemented using Raspberry Pi or LilyPad technology, integrating a camera module would provide parents with an invaluable visual perspective on their child's environment.

2. **Energy Efficiency**: A key focus of future endeavors will be the creation of a more energy-efficient variant. This optimized version will boast the capability to sustain the device's battery life over more extended periods. By reducing power consumption, the smart child safety wearable can offer even greater reliability and peace of mind to parents.

In conclusion, the smart child safety wearable device is poised for an exciting future filled with innovations that will further fortify its functionality and practicality. With the potential addition of surveillance capabilities and a relentless pursuit of energy efficiency, this device will continue to be a vital tool for parents, ensuring the safety and well-being of their children in an ever-evolving world.

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