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IoT-Enabled Personal Safety Device for Women and Children

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ABSTRACT

The Internet of Things (IoT) has emerged as one of the most influential technologies in recent years and is expected to play a vital role in everyday life, particularly with the support of 5G networks. Despite existing challenges, IoT devices now integrate a wide range of sensors and communication interfaces, enhanced by algorithms that enable them to function as intelligent systems capable of interacting with one another. In this context, a smart safety system for women has been designed and implemented. The system incorporates a fingerprint sensor, a GPS receiver, and an ESP8266 NodeMCU microcontroller, operating on an Android platform. Once activated, the device automatically transmits the user's location along with a pre-defined alert message to registered contacts. Additionally, the system continuously scans the user's fingerprint at regular intervals. If authentication fails, the device assumes a threat situation and immediately alerts authorities by forwarding both the warning message and the victim's real-time location

Keywords: Blynk platform, Cloud computing, Internet of things, Women's safety system.

Introduction

The Internet of Things is an ecosystem in which physical objects are linked to each other or to larger systems (Bröring , *et.al,* 2017). This network collects billions of data obtained from many different devices that we use in our daily life. It collects and converts them into usable information. Many devices and machines we use today, in which we live in the age of technology, can be easily monitored and controlled from remote points with different units, especially smart phones and tablets (Shah, *et.al.* 2016; Gupta, *et.al.*2018). Embedded system microcontroller manufacturers increasing day by day, the number of these products increasing, and the prices of these products are also decreasing rapidly. On the other hand, as android and IOS interface development programs become user friendly, smart application examples are increasing rapidly with IoT(Mahindar, *et. al,* 2018; Bohora, *et.al,* 2016). According to projections, while there were 500 million devices interacting with each other in 2003, it is estimated to be around 20 billion devices today, and this figure is expected to increase to 50 billion devices by 2030(Evans, 2011).

This shows that the cities we live in with IoT in the coming years will turn into smart cities that keep up with a more fast paced and planned life. This transformation will provide us with many opportunities that make human life easier. Today, when personal needs are increasing rapidly, migration to city centers where the rate of meeting these needs is quite high. The world is entering a new era and it is predicted that in the near future, the majority of the world's population will spend their lives in smart cities and smart homes (Gökozan, *et.al,* 2017). A multidisciplinary approach is needed in these cities to meet the challenges, support sustainable urban development and improve the quality of life of citizens (Lynggaard & Skouby 2016). A smart city is a sustainable and efficient residential center that provides its residents with a high quality of life by managing energy resources and time in the best way. Energy management is one of the most challenging issues in such urban centers due to the complexity and vital role of energy systems(Calvillo, *et.al,* 2016). Smart Home, lighting, heating, air conditioning, TV, computer, entertainment, audio-visual systems that can communicate with each other, It is

the term commonly used to describe a living space with security and camera systems (Harper, 2006). Our sound and visual system works with our home entrance, lighting and electrical devices can be controlled remotely (Taştan & Gökozan 2018), the heating system automatically changes its settings according to the regional weather conditions (Kulkarni & Mukhopadhyay 2018), monitoring and controlling the energy consumption of devices such as refrigerators, air conditioners, and ovens (Stojkoska, & Trivodaliev 2017), taking into account the moisture of the soil, not the time when watering your vegetables in your garden (Kamienski, et.al. 2019), people who have health problems that require constant monitoring, lead a reliable life with wearable medical devices, smart agricultural practices, smart environment, smart transportation. The number of IoT-based technology applications that increase the quality and comfort of our lives in many areas.

The use of the Internet of Things in public safety applications allows the most vulnerable groups in the general population such as women and children to increase their sense of security. Although safety is everyone's concern, safety has become more urgent for women and children because they are most vulnerable to crimes such as violence, harassment, and trafficking. It is estimated that, globally, 35% of women have experienced violence at some stage in their lives. Although strict laws prohibiting violence against vulnerable groups have been enacted and implemented, these shocking figures underscore the need to strengthen security measures. Incorporating the Internet of Things into public safety can provide a huge leap forward for law enforcement agencies to minimize general criminal behavior and ensure the safety of women and children.

When girls and children are not at home, understanding their whereabouts can be a challenge for parents. This is especially challenging when they disappear without warning. Tags or wearable devices that support the Internet of Things can allow law enforcement to track missing persons and ensure their safety at all times. The entire response system of security and law enforcement agencies can be interconnected using the Internet of Things. Governments of various countries are already using big data for law enforcement, collecting data from different sources, and analyzing it to find a model that allows them to respond in a timely and effective manner (Stojkoska & Trivodaliev, 2017). The Internet of Things can enhance this process by providing large amounts of accurate structured data collected in real time. Real-time data collection and analysis can enhance the capabilities of law enforcement agencies, not only to make short-term tactical decisions in response to emergencies, but also to help them formulate long-term strategic plans to maximize the efficiency of their personnel.

Related Work

While applying the Internet of Things to improve public safety, the adoption of a wider range of methods will improve the overall level of public safety, including the level of public safety for women (Taştan & Gökozan 2018). However, women's safety issues still need to be addressed separately, especially in underdeveloped and developing regions. Combining technology with the correct guidance and decision-making of law enforcement authorities will ultimately lead to a society that is equally safe for men and women.

Kulkarni & Mukhopadhyay 2018, developed a safety device which uses GPS track the location of the person and GSM module to send the information of the person to their family members, giving the current location and the alert message. This device is developed using the Microcontroller ATmega 328. A stand-alone system built, it can voice of the victim, sends the distress message, the device uses switch, accelerometer to sense if the device is thrown, can start functioning and it will give information of location to the family members and friends.

Kamienski, et.al., 2019, proposed the safety system, whenever triggering the warning, the system send the alert message to family members also alert the surroundings, by initiating the sound buzzer. Proposed method uses fingerprint-based, GPS interface to the device on Blink platform. The whole idea is to send SMS with GPS information to the people and police whenever there is no fingerprint verification on the IoT device for a certain period of time, thus giving an alert signal without requiring human intervention for activation of the device.

System Design

Development of safety device, ESP8266 module has been used, designed by Systems, which has embedded system architecture and internal WIFI module. This 32-bit controller, specially developed for IoT applications, is highly preferred due to its low cost and high performance. The temperature and humidity information of the environment is taken by the DHT22 sensor, which has high accuracy with its digital structure. With its dual core structure, ESP8266 has many embedded features such as WIFI, Bluetooth, CAN, Ethernet, temperature sensor, magnetic field sensor and touch sensor needed for wide range of applications.

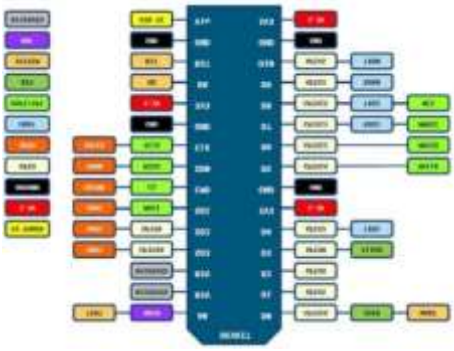

Fig.1. Node Micro Controller unit pin description.

The ESP8266 module, whose pin structure is shown in the Fugure 1. It has 18x12 bit ADC and 2x8 bit DAC pins. ESP8266 includes a Harvard Tensilica Xtensa LX6 32-bit Dual Core processor that can operate at a frequency of up to 240 MHz [23]. The ESP8266 module can be easily programmed by languages such as C, C++ and Lua, which can be used free of charge, thanks to the micro USB port on it. Node MCU is a single board Micro Controller and which is very affordable with open source IoT platform as shown in the Figure 2.

Fig. 2. Node single board Micro Controller unit.

ESP8299, which contains many sensors needed for IoT applications, has wireless communication features such as Bluetooth, RF and IR as well as its internal Wi-Fi module. DHT-22, which is used in real-time remote monitoring and control system, consists of two parts, capacitive humidity and thermistor temperature sensor. The DHT22 temperature and humidity sensor is an advanced sensor unit that outputs a calibrated digital signal. It has an 8-bit microcontroller and has a short response time.

3.1 NEO-6M GPS Module:

The Global Positioning System (GPS) is to determine the longitude and latitude information, through various satellite signals which reaches the receiver. The device is freely reachable to anybody with a GPS receiver and unobstructed line of sight to at least 4 of GPS satellites. A GPS receiver calculates its function via exactly timing the alerts dispatched through GPS satellites. GPS is at present extensively used and additionally has end up an indispensable section of smart devices. Here we are the usage of NEO-6M GPS module due to the fact it is a well-performing whole GPS receiver with a built-in 25 x 25 x4mm ceramic antenna. A whole GPS module with an lively antenna integrated, and a built-in EEPROM to retailer configuration parameter data. Figure 3. Shows the GPS module.

Fig. 3. GPS Controller unit.

3.2 Internet of Things:

The Internet of things, or IoT, is a device of interrelated computing devices, mechanical and digital machines, objects, animals or humans that are furnished with special identifiers (UIDs) and the potential to switch statistics over a community except requiring human-to-human or human-to-computer interaction. An element in the net of matters can be a character with a coronary heart screen implant, a farm animal with a biochip transponder, an car that has built-in sensors to alert the driver when tire strain is low or any different herbal or man-made object that can be assigned an Internet Protocol (IP) tackle and is in a position to switch information over a network.

The software required for the ESP32 module in the proposed system is written in C language using the Arduino IDE. With the Arduino IDE, it is possible for writing codes for many controllers from different companies such as ESP32, ESP8266, STM32 and Intel, especially Atmel based kits such as Arduino Uno, Leonardo, Mega and Arduino Due. Also compiling the written codes and uploading the compiled codes to the controllers via the USB port . In this application the control is done via mobile devices to IoT application. There are many free options that allow us to develop application for Android device by using Blynk.

Blynk is a new platform that lets in you to rapidly construct interfaces for controlling and monitoring your hardware initiatives from your iOS and Android device. After downloading the Blynk app, you can create a venture dashboard and organize buttons, sliders, graphs, and different widgets onto the screen. Using the widgets, you can flip pins on and off or show statistics from sensors.

Fig 4. Blynk Widget Boxes of the interface developer.

These Widgets; Features such as button, led, slider, LCD, timer, display, joystick, notification, e-mail, twitter, GPS, light sensor, gravity sensor, acceleration sensor and proximity sensor bring versatile flexibility to applications. Thanks to the Blynk cloud service, numerical data such as temperature, humidity, current, and voltage related to the system are stored and can be obtained via e-mail from the cloud server at any time. The real time clock, which is needed in many IoT applications, can be used with the Blynk widget feature. The time update is done automatically by the server by selecting the time zone of the current region.

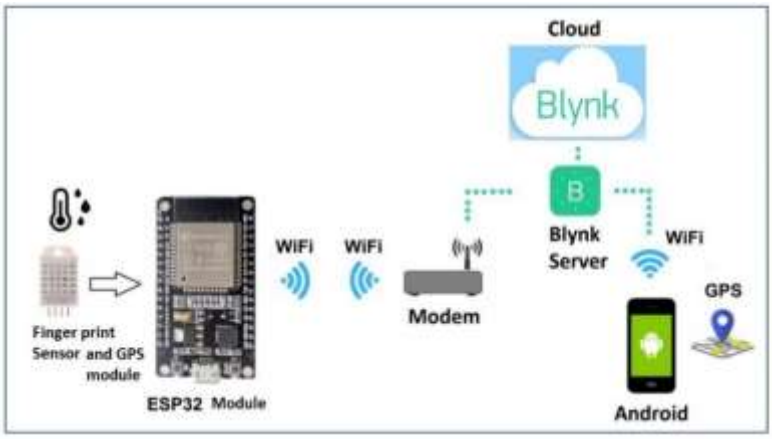

Fig. 5. System implementation diagram.

The general structure of the system realized for the smart safety device application is shown in Figure 5. This system basically, consists of ESP32 module, which can communicate with finger print sensor, measuring the finger pattern of the person, GPS module for location information and Blynk interface. Blynk server communicate via Wi-Fi, modem to Blynk server-cloud. ESP32 module with embedded WIFI module sends data from finger print to Blynk server every 10 seconds. Virtual pins are used to read digital information from sensor and send this information to Blynk server. In the application, V5 virtual pins are used for sending finger print data and V6 virtual pins are used for sending location information. In the Blynk application, besides the use of all digital and analog pins of the selected controllers, many (0-127) virtual pins can also be used. In particular, widgets such as display, terminal, LCD and gauge are used with the help of virtual pins that can carry large amounts of data without any practical restrictions. Figure 4 shows the gauge widget setting window, which displays the victim's information through finger print and location data through GPS module.

Conclusion

Nowadays, where many services are provided over internet technology, the number of applications using this infrastructure is constantly increasing. IoT technology, the infrastructure of which is the internet, meets the increasing comfort of people to a large extent and uses the demand for smart and autonomous devices to increase constantly. The concept of IoT, which has made a rapid entry into our lives, is expanding day by day and includes different sectors and applications. In this study, a women safety system aimed at providing security to women is proposed by using IoT based new generation ESP32 module and the user interface created by the Blynk android interface developer. The developed system can be run thru the SOS command and it can alert in emergency conditions for ladies or children. authorities are informed about imminent danger. System will send pre-generated message and the real-time location of the victim to authorities. Also, by using Blynk cloud service, changes of location information are continuously recorded and sent by the server to the email address whenever it is required.

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