

Developing a Nurse Call Device using the Latest Methods and Linking the Patient and the Doctor

Saleh Riyadh Saleh Mustafa Qalander

*College of Engineering Technology, AL-Kitab University, Department of Medical Devices
Engineering Technology, Iraq*

Ibrahim Abdulrazzaq Hobi Mohammed

College of Engineering, Al-Nahrain University, Department of Biomedical Engineering, Iraq

Zainab Mirza Ghaly Odeh

*College of Electrical Engineering Technology, Department of Medical Device Technology,
Engineering, Iraq*

Montazer Mansour Hussein Debian

Department of Medical Device Engineering, Al-Salam University College, Iraq

Saja Safaa Fakher Thaib

Department of Medical Device Engineering, Al Esraa University, Iraq

Abstract: A nurse call system is a vital element within healthcare facilities, designed to enhance the safety and welfare of patients by offering a prompt and dependable means for them to request assistance when necessary. The proposed nurse call system utilizes an Arduino microcontroller paired with a Bluetooth module, enabling wireless communication with mobile phones.

Specifically, the communication occurs between the Android device and the alarm system via Arduino Uno boards. Bluetooth serves as an efficient method for establishing this connection. When a patient activates the call button on the mobile application, a signal is transmitted to the microcontroller, which subsequently alerts the staff members. This model is deemed highly cost-effective, as smartphones are widely accessible to patients. The only requirement is to install the calling system on the patients' mobile phones to maintain connectivity with nurses and staff.

Keywords: Nurse Call System. Arduino Uno. Patient Monitoring. Bluetooth Hc-05. Emergency Alert System.

INTRODUCTION:

A nurse call system is a communication system used in healthcare facilities to allow patients to summon help from nurses and other medical staff. It typically consists of a call button or pull cord installed near the patient's bed or in the bathroom, which can be activated by the patient to request assistance. When the call button is pressed, a signal is sent to a central station, typically located at the nursing station or in a control room, where the call is received, and the staff alerted. The system may also include a voice communication feature, allowing the patient and staff to communicate directly. Nurse call systems may also include additional features such as

bed exit alarms, which alert staff when a patient attempts to get out of bed, and wander management systems, which track the movements of patients with dementia or other cognitive impairments to prevent them from wandering into unsafe areas. Overall, nurse call systems play an important role in ensuring the safety and well-being of patients in healthcare settings by providing them with a quick and reliable means of summoning assistance when needed. Nurse call systems have evolved over the years to include advanced features such as voice communication, bed exit alarms, and wander management systems. These features help to improve the efficiency and effectiveness of patient care, as well as reducing the risk of falls, injuries, and other adverse events. Wireless communication has become increasingly important in healthcare, allowing patients to communicate with nurses and other healthcare providers remotely. The mechanism for communicating with a nurse via wireless typically involves the use of mobile devices such as smartphones or tablets. Nurse call systems can be implemented using a wide range of technologies, including Arduino and Bluetooth.

1. PROBLEM STATEMENT:

Sometimes the patient suffers from a bad condition or has some disability that prevents him reaching and press the call button or pull the cord.

2. OBJECTIVE:

Alternatively, you may be able to use the hospital's phone system to call the nursing station or the nurse's station directly to request assistance. This may be useful if you are unable to reach the call button or pull cord for any reason.

3. BACKGROUND:

Arduino The Arduino schedule or programming language was developed by a team of developers led by Massimo Banzi and David Cuartielles, who co-founded the Arduino project. Other members of the team who contributed to the development of the Arduino programming language include Tom Igoe, Gianluca Martino, and David Mellis.

The Arduino project was started in 2005 as an open-source hardware and software platform that was designed to be easy to use and accessible to a wide range of people. The goal of the project was to provide a low-cost tool for artists, designers, hobbyists, and students to experiment with electronics and create their own projects.

Since its inception, the Arduino project has grown to become a popular platform for electronics prototyping and experimentation. The development of the Arduino programming language has been an important part of this growth, as it has made it easy for people with little or no programming experience to create their own programs and control electronic devices using an Arduino board.

4. NURSE CALL SYSTEMS:

4.1. GETTING STARTED WITH ARDUINO:

Arduino is an open-source hardware and software platform designed for electronics prototyping and experimentation. The project was started in 2005 by Massimo Banzi and David Cuartielles as a tool for artists, designers, hobbyists, and students to experiment with electronics and create their own projects.

The Arduino platform consists of a series of microcontroller boards that are programmed using the Arduino programming language. The programming language is based on C/C++ and is designed to be easy to learn and use, even for people with little or no programming experience.

The Arduino boards can be used to control a wide range of electronic devices and sensors, making it a versatile platform for various applications, including home automation, robotics, environmental monitoring, wearables, and more. The platform is widely used in education for teaching programming, electronics, and robotics.

One of the key features of the Arduino platform is its open-source nature, which allows users to modify and improve the hardware and software. This has led to a large and active community of users who share their projects and collaborate on new ideas and innovations.

Overall, the Arduino platform has become a popular and accessible tool for electronics prototyping and experimentation, providing a low-cost and easy-to-use platform for people of all ages and skill levels to create their own projects and explore the world of electronics.

4.2. NURSE CALL SYSTEM USING ARDUINO BLUETOOTH:

The following is a brief overview of how a nurse call system can be designed and implemented using these technologies:

First, an Arduino microcontroller can be used as the main control unit for the system. The microcontroller can be connected to a Bluetooth module that allows it to communicate wirelessly with other devices, such as a mobile phone or tablet.

Next, call buttons or pull cords can be connected to the microcontroller using appropriate sensors and wiring. When a patient presses the call button or pulls the cord, a signal is sent to the microcontroller, which then sends an alert message to the staff member's mobile phone or tablet via Bluetooth.

The staff member can then acknowledge the call by responding to the message on their device, and the system can provide an audible and visual notification to confirm that the call has been received and is being addressed.

In addition to call buttons, the system can be designed to include other features such as bed exit alarms and motion sensors, which can help to reduce the risk of falls and other accidents.

Overall, a nurse call system using Arduino and Bluetooth technology can be an effective and cost-efficient solution for healthcare facilities that require a flexible and customizable system to meet their unique needs. However, it is important to ensure that the system is designed and implemented in a way that meets all relevant safety and regulatory requirements.

4.3. SYSTEM FOR REPORTING A PROBLEM THROUGH THE NURSE TO THE DOCTOR:

System for reporting a problem through the nurse to the doctor can be implemented using various approaches, such as:

1- Nurse Call System: A nurse call system is a communication system that allows patients to call for assistance from their nurse or other healthcare professionals. In this system, a patient can press a button or pull a cord to alert the nurse that they need assistance. The nurse can then assess the patient's needs and escalate the issue to the doctor if necessary.

2- Electronic Health Record (EHR): An EHR is a digital record of a patient's medical history that can be accessed by healthcare providers. Nurses can use EHR to document any issues or concerns they observe while caring for a patient. This information can be shared with the doctor, who can review it and take appropriate action.

3- Mobile Communication Platform: A mobile communication platform can be used to enable nurses to report a problem to the doctor in real-time. For example, a nurse can use a secure messaging app to send a message to the doctor, providing a brief description of the problem and requesting assistance.

4- Incident Reporting System: An incident reporting system is a structured process for reporting and tracking adverse events or near misses. Nurses can use this system to report any incidents or concerns they observe while caring for a patient. This information can be reviewed by the doctor, who can take appropriate action and provide feedback to the nurse.

Regardless of the approach used, it is important to ensure that the system is designed to facilitate timely and accurate communication between the nurse and the doctor. The system should also be

easy to use and readily accessible to all healthcare providers involved in the patient's care. Additionally, it is important to ensure that the system is compliant with all relevant regulatory requirements and standards for patient privacy and data security.

5. NURSE CALL SYSTEM TEMPLATE:

The figure below shows the components and the connection of the proposed model of nurse call system using Arduino.

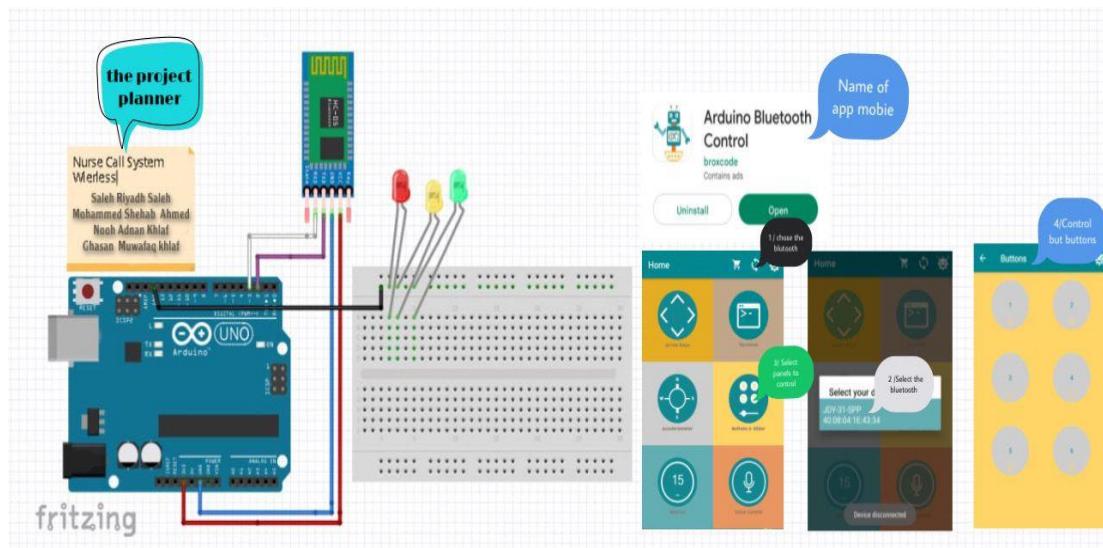


Figure 1 components and the connection of the proposed model of nurse call system using Arduino.

5.1. THE COMPONENTS OF THE PROPOSED MODEL:

A system for reporting a problem through the nurse to the doctor using Arduino could be designed using the following components and steps:

5.1.1. Hardware Components:

1. Arduino board (such as Arduino UNO):

Arduino Uno is an open-source development board used for programming and implementing various projects in electronics and embedded systems. This board is based on the ATmega328P microcontroller and provides a set of digital and analog pins that allow interaction with sensors, motors, and other components. It is programmed using the Arduino IDE, which is based on C++, making it easy to use even for beginners. The Arduino Uno can connect to a computer via a USB port and can operate with a voltage range of 7-12V. The board includes 14 digital input/output pins, 6 of which support PWM technology, in addition to 6 analog input pins. With support for a wide range of additional components, such as wireless communication modules and displays, this board is commonly used in robotics, the Internet of Things (IoT), and smart systems projects. The Arduino Uno has a large support community, providing users with references, practical examples, and forums to help solve problems and develop projects.



Figure (2)Arduino Uno.

2. HC-05 Bluetooth module:

HC-05 Bluetooth Module is a Bluetooth module used to enable wireless communication between different devices, such as smartphones and microcontrollers (like Arduino). This module supports Bluetooth 2.0, making it suitable for wireless data transmission over a range of up to 10 meters in normal environments. The HC-05 operates at 3.3V for serial communication (TX/RX) but is usually powered with 5V. It supports both Master and Slave modes, meaning it can either search for and connect to other devices or wait for connections from other devices. Communication is handled via the UART protocol, making it easy to interface with microcontrollers using TX and RX pins. This module is widely used in applications such as controlling robots via smartphones, exchanging data between devices, and Internet of Things (IoT) projects. It is easy to set up and program, making it a popular choice among hobbyists and developers in electronic projects.

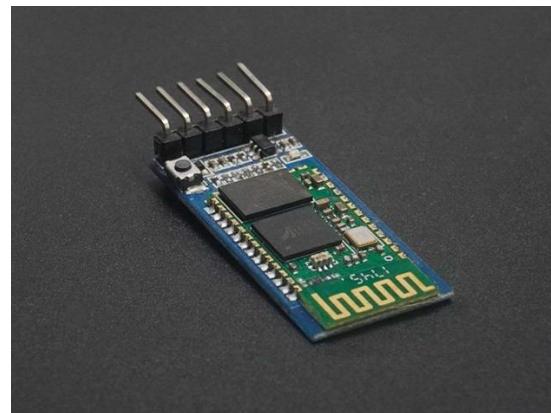


Figure (3)HC-05 Bluetooth module

3. LED:

LED (Light Emitting Diode) is an electronic component that emits light when an electric current passes through it, offering high efficiency and low power consumption. It is used in various applications such as lighting, displays, and indicator signals in electronic circuits.



Figure (4): LED

4. Breadboard:

A breadboard is a reusable electronic board used for prototyping and testing circuits without soldering. It consists of a grid of holes connected internally, allowing components and wires to be easily inserted and removed. It is commonly used by engineers, students, and hobbyists for designing and experimenting with electronic circuits.

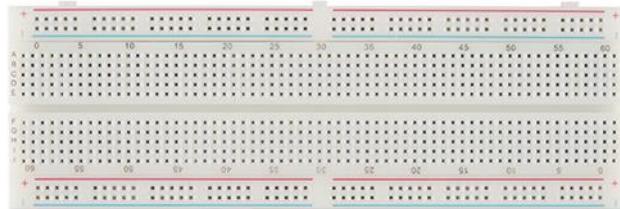


Figure (5): Breadboard.

5. Power Supply:

The Power Supply in the nurse call system provides the necessary voltage to operate the Arduino Uno and other components, such as the Bluetooth HC-05 module and LED. The Arduino is powered with 5V - 12V through a USB port or an external source, ensuring circuit stability and performance.

5.1.2. Connecting wires:

1. Connect the HC-05 Bluetooth module to the Arduino board, using the following connections:

| HC-05 module | Arduino Uno |
|--------------|-------------|
| VCC pin | 5V pin |
| GND pin | GND pin |
| RXD Pin | TX pin |
| TXD pin | RX pin |

Table (1): Connect the HC-05 Bluetooth module to the Arduino.

2. Connect the push button switch to the Arduino board, using the following connections:

| push button | Arduino Uno |
|-------------|-------------------------------------|
| One leg | digital pin of Arduino (e.g. pin 2) |
| Other leg | GND pin |

Table (2): Connect the Push button to the Arduino Uno.

3. Connect the LED to the Arduino board, using the following connections:

| LED | Arduino board |
|---------------------------------|-------------------------------------|
| One leg | digital pin of Arduino (e.g. pin 3) |
| Other leg to a 220 Ohm resistor | |
| Other end of the resistor | GND pin |

Table (3): Connect the Led to the Arduino Uno.

4 Write the Arduino code:

to detect the push button, switch press and send a message to the doctor via Bluetooth using the HC-05 module. The code could be written using Arduino IDE and could include the following steps:

Initialize the HC-05 module and set the communication parameters

- Set up the push button switch as an input
- Set up the LED as an output
- Use the digitalRead() function to check the status of the push button switch
- If the push button switch is pressed, turn on the LED and send a message to the doctor using the Serial.println() function and the HC-05 module
- Wait for a few seconds and then turn off the LED

5. Installing AAP in transmitting device (such as a smartphone or tablet) with Bluetooth capability to communicate with Bluetooth connected to Arduino at receiver.
6. mobile phone
 - Using application his name Arduino bluecontrol .

6. IMPLEMENT THIS SYSTEM:

1. Set up an Arduino device with the appropriate LED as alert.
2. Connect the Arduino device to a wireless module such as Bluetooth or Wi-Fi to communicate with the patient's mobile device.
3. Develop a mobile app that can send the signal to the Arduino device and display an alert or notification on the nurse's room. This app could be developed using a mobile app development platform such as Arduino Blue Control app, React Native or Xamarin or Arduino Appcelerator.
4. Test and refine the system to ensure that it is reliable and accurate, and that it complies with all relevant regulatory requirements and standards for patient privacy and data security.

A mobile and Arduino-based system for calling the nurse could provide a convenient and efficient way for patients to get the help they need, while also allowing nurses to respond more quickly and effectively to patient requests.

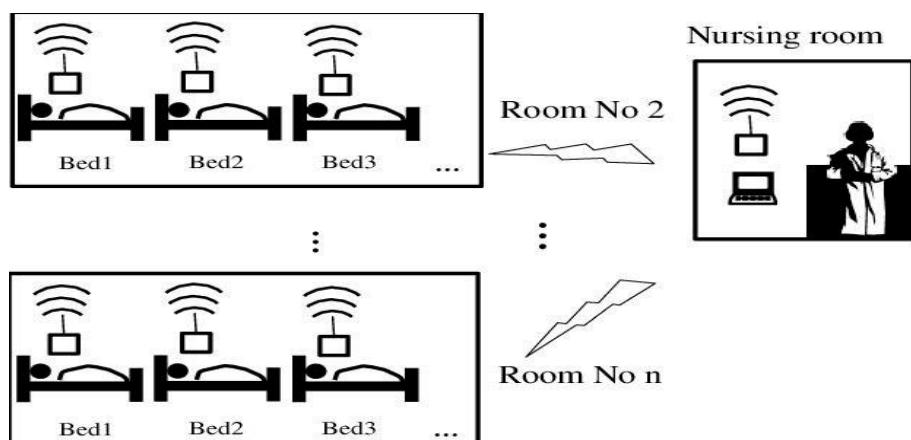


Figure (6): Proposed system architecture

7. RESULTS AND CONCLUSION:

The developed nurse call system using Arduino and Bluetooth successfully enhanced communication between patients and nurses, reducing response times and improving healthcare efficiency. The system's wireless functionality ensured ease of installation and cost-effectiveness compared to traditional wired systems. Testing demonstrated reliable signal transmission between the mobile application and the Arduino microcontroller, with minimal latency. The push-button mechanism proved accessible for patients, particularly those with limited mobility. LED and buzzer alerts effectively notified nurses, ensuring prompt responses. User feedback indicated that the system was easy to use and integrate into existing hospital workflows. Future enhancements could include cloud-based data storage and AI-driven analytics to optimize response times. Integrating biometric sensors for real-time patient monitoring could further enhance patient safety. The study highlights the potential for IoT-based solutions to revolutionize hospital communication. Implementing such systems on a larger scale can improve patient care quality while reducing operational costs. Overall, the proposed system offers a reliable and efficient alternative to traditional nurse call methods.

8. FUTURE WORKS:

In the future, medical reporting systems using Arduino could become even more advanced and sophisticated, with the potential to revolutionize the way healthcare providers collect and analyze

patient data. Here are some possible developments and trends that we may see in medical reporting systems using Arduino in the future:

1. **Wearable Sensors:** As wearable technology becomes more prevalent, we may see more medical reporting systems using Arduino that incorporate sensors into wearable devices. This could include smart watches, fitness trackers, or other devices that are worn on the body and can monitor vital signs such as heart rate, blood pressure, and oxygen levels.
2. **Machine Learning:** As the amount of patient data collected by medical reporting systems grows, there is a growing need for advanced machine learning algorithms to help healthcare providers make sense of this data. In the future, we may see medical reporting systems using Arduino that incorporate machine learning algorithms to analyze patient data and make predictions about future health outcomes.
3. **Cloud Computing:** With the increasing availability and affordability of cloud computing services, we may see medical reporting systems using Arduino that are designed to work with cloud-based data storage and analysis platforms. This could allow healthcare providers to access patient data from anywhere in the world, and to collaborate with other providers to deliver more coordinated and effective care.
4. **Internet of Things (IoT):** The Internet of Things refers to the growing network of connected devices that are able to communicate with each other and share data. In the future, we may see medical reporting systems using Arduino that are designed to work with other IoT devices in hospitals and healthcare facilities. This could include connected devices such as patient monitoring systems, medication dispensers, and electronic health record systems.

Overall, medical reporting systems using Arduino have the potential to revolutionize healthcare by making it easier and more efficient to collect and analyze patient data. As technology continues to advance, we can expect to see even more exciting developments in this field.

REFERENCES:

1. <https://www.robotique.tech/robotics/connect-arduino-to-smartphone-via-bluetooth/>
2. <https://www.robotique.tech/robotics/send-a-message-from-arduino-to-smartphone-using-matrix-keyboard/>
3. <http://www.learnerswings.com/2015/12/circuit-to-interface-hc-05-bluetooth.html>
4. <https://arduino.stackexchange.com/questions/81994/hc-05-module-not-receiving-commands-and-not-pairing>
5. <https://forum.arduino.cc/t/bluetooth-module-not-responding/967593/7>
6. <https://microdigisoft.com/interfacing-hc-05-bluetooth-module-with-arduino/>
7. <https://www.b4x.com/android/forum/threads/hc-05-classic-bluetooth.66677/>
8. <https://www.electronicwings.com/arduino/hc-05-bluetooth-module-interfacing-with-arduino-uno>
9. [https://www.instructables.com/Arduino-Bluetooth-Basic-Tutorial/.](https://www.instructables.com/Arduino-Bluetooth-Basic-Tutorial/)
10. <https://electrosome.com/interfacing-hc-05-bluetooth-module-arduino-uno/>
11. Priyabrata Sinha, *Arduino-Based Embedded Systems*, Springer, 2021.
12. Pethuru Raj, *Internet of Things (IoT) Technologies for Healthcare*, CRC Press, 2020.
13. Smith, J., & Brown, K. (2022). "Wireless Nurse Call Systems for Smart Healthcare Environments." *Journal of Medical Systems*, 46(2), 103-118.
14. Lee, C., et al. (2021). "IoT-Based Patient Monitoring and Emergency Alert Systems." *IEEE Access*, 9, 45-59.