

The Design and Implementation of Wireless Ward Call System

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Abstract

Effective communication is the most important part of the healthcare organization. Specially in recent years, with the sudden outbreak of the epidemic, more and more patients are isolated or sick in hospitals, and people are paying increased attention to life and health. As a result, the focus of hospital medical care has gradually moved to suppling high-quality services, prompt responses, and efficient resource management. Along with this, a wireless ward call system for hospitals was created. In a generalized method for implementing of the proposed system, a patient in the ward can use this system to call a doctor or nurse for help by pressing a button. The patient's room number and grade are displayed on the display screen in the duty room simultaneously, and the medical staff is informed of the patient's status so that prompt diagnosis or nursing may be provided via voice broadcasting. The proposed system aims to perfect response times by facilitating quick and efficient communication between patients and healthcare providers. It also enables more flexible and responsive communication, contributing to a patient-centric approach to care. Furthermore, it reduces needless staff movements, improving overall workflow efficiency. Patients can conveniently seek help from anywhere in their room, promoting mobility and accessibility.

Keywords

STM32 MCU; NRF24L01 Communication Module; JQ6500 Voice Chip.

1. Introduction

Technology advancement has had a profound impact on modern society's lifestyle as well as human behaviour and cognition. Technology is continuously evolving, and this is especially true in hospitals, where the quality of life of each patient is directly affected by the information provided about them. The growth of technologies gives a brighter future and the chance to connect various pieces of medical equipment, giving rise to a brand-new system known as the Ward calling system. The ward-calling system, which enables communication between the requester and the recipient of the request, is commonly employed in hospitals and healthcare facilities [1-5]. A ward-calling system makes it simple for patients to get in touch with their nurses and helps hospital staff members, such as physicians, to give their patients the best treatment possible. For patients to call them whenever they need a diagnostic or medical attention, nurses must be able to identify patients' emergency situations swiftly and efficiently [6-9].

People need to be able to access various medical treatments promptly and efficiently in hospitals as the medical system reform continues to develop. The proposed system essential to a patient feeling protected, which is a necessary part of a good recovery, according to research on patients in intensive care units [10]. Patients have been given the assurance that they may ring a bell to get aid at once, giving them a way to keep track of their health. In the case of an emergency or an unmanageable issue, a patient in the ward can use this system to summon a doctor or nurse for aid by pressing a

button. The patient's room number and grade are displayed on the duty room display screen simultaneously, and through voice broadcasting, the medical staff is informed of the patient's status so that prompt diagnosis or nursing may be provided. As a result, the research and development of wireless ward call system has become a hot spot in recent years.

Traditional wired ward call systems meet several limitations, including poor mobility, high installation and maintenance costs, restricted adaptability, and susceptibility to damage. These challenges find effective solutions in wireless ward call systems, using wireless communication technology to seamlessly send call signals between nursing stations and patient beds. Embracing this approach brings forth a range of advantages, including enhanced mobility, reduced installation and maintenance costs, improved staff productivity, increased flexibility, and elevated patient care standards. Furthermore, the adoption of wireless ward call systems contributes to the creation of a more contemporary and technologically sophisticated hospital environment.

By enabling quick and efficient communication between patients and healthcare providers, the proposed system promotes mobility and accessibility and perfect response times. It also allows for more flexible and responsive communication, which contributes to a patient-centric approach to care and reduces needless staff movements, which improves workflow efficiency overall.

2. Main Research Content

Our proposed system design includes two integral sections: the host and the slave. The slave, situated in the ward, consists of the Transmitter module, STM32 module (STM32F103C8T6 microcontroller core module), and a keyboard. On the other hand, the host, found in the duty room or nurse station, consists of the Receiver module, STM32 module (STM32F103C8T6 microcontroller core module), voice module, display module, and Button, as illustrated in Figure 1.

Patient-initiated calls to the medical staff are eased through the slave section, equipped with an STM32 module programmed to transmit data to the receiving circuit via the NRF24L01 communication module. Upon pressing the button on the slave section, the Transmitter module dispatches data through the NRF24L01 communication module. This data is then processed by the STM32F103C8T6 microcontroller, and the receiver in the Host section captures the transmitted data.

Upon receiving the data through the host machine's receiving circuit, the display module in the duty room highlights the patient's room number and grade. Simultaneously, the JQ6500 voice module broadcasts the room number and grade. an alarm lasting longer than ten seconds activates an alert system that promptly notifies the service. Most importantly, the voice module leads this crucial task, ensuring a prompt and efficient reaction to emergency situations and improving overall patient care. We appoint the first class as number one. If there is a more urgent comparison, number one comes first. if there is case from patient number two is presently in the general category, showed by a 'G' following the number. Nurses own the authority to cancel this designation. After the allotted amount of time has passed, things happen.

The host section's button serves medical personnel, allowing them to conclude the ongoing call, as depicted in Figure 2. This wireless long-distance connection between patients and the medical team is thereby proven.

Finally, A report is immediately sent to the server in the event that the current timeframe exceeds the predetermined limit. Next, a notification is sent to the specified cell phone's WeChat public account. This systematic approach ensures an efficient workflow, facilitating timely responses to evolving situations. Beyond that, the proposed system offers useful insights by showing the surrounding temperature and humidity. The hospital as a whole benefit from this feature, which is not exclusive. Sensitive control is ensured by prompt reporting of temperature and humidity increases. This stay remains consistent across various sections, offering a unified and comprehensive solution.

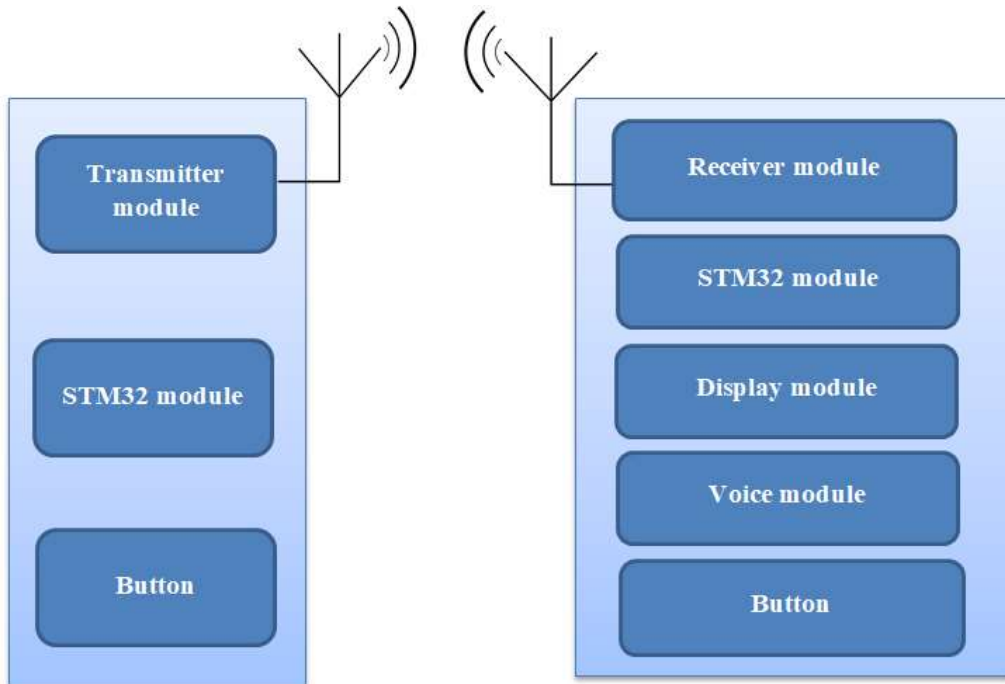


Figure 1. Block diagram proposed nurse calling system

Wards are categorized into three types: regular, medium, and emergency. The program evaluates these grades in a predetermined order. During simultaneous calls from multiple patients, the priority algorithm ensures that emergency patients are prioritized first. Noteworthy advantages of this design encompass straightforward installation, user-friendly operation, and rapid transmission speed.

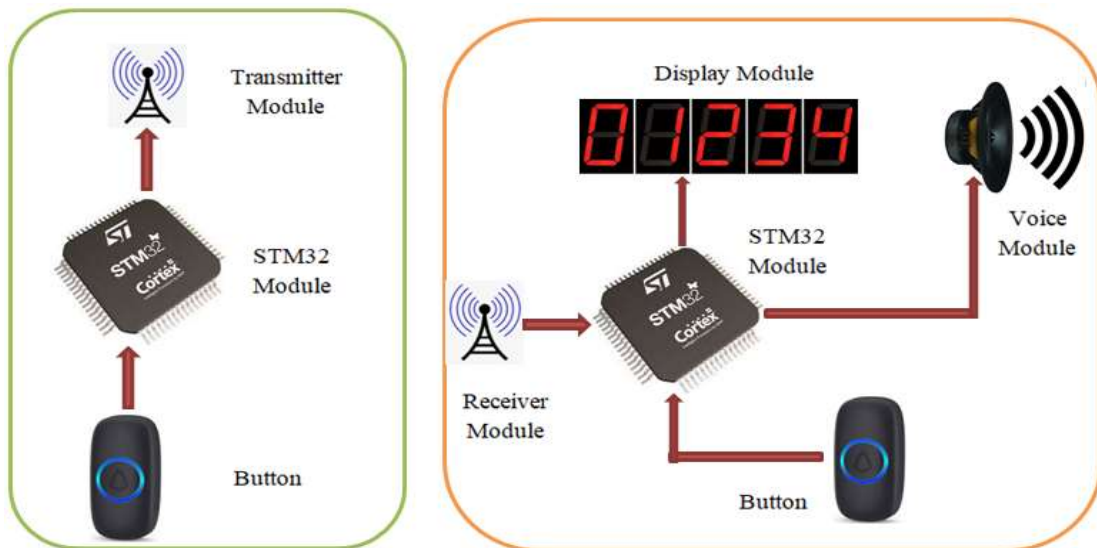


Figure 2. Generalized Layout of proposed nurse calling system

2.1 The STM32 Module

The rapid evolution of electronic science and technology, propelled notably by the advent of large integrated circuits, has ushered in profound changes in people's lifestyles [11]. Single chip microcomputer technology, using the STM32F103 microcontrollers with the Cortex-M3 core running at a maximum CPU speed of 72 MHz, has become ubiquitous across various domains, seamlessly woven into our daily lives.

The STM32 monolithic microcomputers offer a versatile portfolio, featuring motor control peripherals, USB full-speed interfaces, CAN, and Flash memory sizes spanning from 16 Kbytes to 1 Mbyte. This single chip microcomputer, with its substantial market presence, owes its popularity to its capacious internal storage, adaptability to diverse communication modes, straightforward reset mechanism, ample external interrupt resources, and a high-speed 12-bit AD conversion capability.

Notably, the single chip microcomputer claims a significant market share owing to its affordability, mature and reliable technology, making it a preferred choice. The integration of STM32F103 microcontrollers highlights the prowess of electronic science and technology, enhancing our daily interactions with electronic devices and solidifying the single chip microcomputer's pivotal role in modern living [12].

2.2 Wireless Transmitter and Receiver Circuit Design

Wireless applications have always faced difficulties in the design of wireless reception and sending circuits. A high-frequency keyed receiver circuit's capabilities are combined with the wireless receiver module's capabilities to address this problem. By keeping an extremely low profile and being cost-effective, this integration delivers fast transmission performance.

As its principal component, the C8T6 microcontroller powers the wireless working module, which is managed by the MCU's internal module [13]. NORDIC Co. LTD.'s NRF24L01 wireless data transmission chip allows for smooth connection between the slave and master components. Point-to-point or one-to-six wireless data transmission is supported by the NRF24L01, which is noteworthy for its capacity. As Figure 3 illustrates, its wireless communication rate is remarkably capable of exceeding 2M (bps).

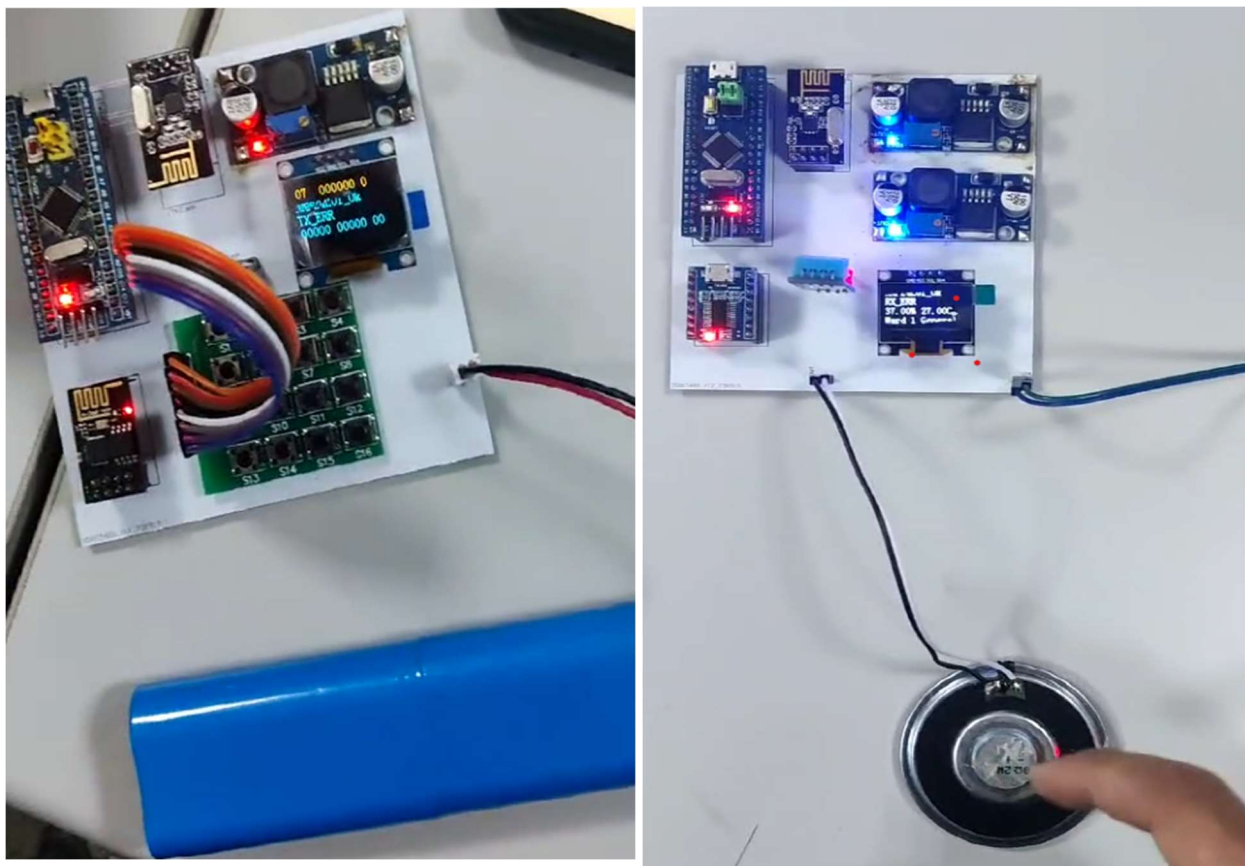


Figure 3. Wireless transmitter and receiver

As we see from the diagram the first line of lave it indicates the patient code, as we know Wards are categorized into three types of Emergencies, Standard, and Medium Information. It should be noted

that the second level serves as an indicator of successful connection establishment, while the third level decides the decision to send data. Successful transmission is clearly signaled by 'c is ok,' while 'er' and 'error' quickly indicate problems if they occur.

2.3 Power Supply Circuit Design

The system power supply module design provides energy for the entire system operation, AMS1117-3.3v is the main voltage regulator chip, and its main function is to convert 5v DC into 3.3v DC for output, supply to STM32, serial communication circuit and other peripheral chips. OLED and a resistor can be connected in series to GND at the power output port of the 3.3V. OLED becomes the showing light to control the power supply of the system. At the same time of normal operation of the power supply system, it generates light.

2.4 Voice Module Design

The call system of the ward not only displays the call information on the display screen in real time [3], but also broadcasts the call by voice to inform the medical staff that there is a patient asking for help. So in order to facilitate medical staff to accurately grasp the state of patients and take treatment methods, broadcast system becomes particularly important. The voice module mainly uses the JQ6500 chip. Because it used to amplify the restored information with high power and pass then entered the STM32. Finally, the ADC in the STM32 converts the voice signal into the actual data through the MIC channel.

2.5 Butten

In electronics, a button typically refers to a user interface element that can be toggled or pressed to carry out a particular task. These buttons have two possible modes of operation: latching, which allows you to switch between the on and off states, or momentary, which only activates when pressed.

2.6 Display Module Design

One of the most used display devices in MCU control system is OLED display. The compatible power supply voltage of OLED is 3.0~5.5V, and it is compatible with 3.3V and 5V microcontroller. It has the advantages of fast response speed, high brightness, rich color and simple structure and wide adaptability.

3. System Process and Key Functional Design

The program design of the wireless ward call system is written in STM32 [5]. The flowchart is shown in Figure 4 Before any function modules in the device begin to progressively power up and the STM32 microcontroller begins to run the software, the power source must first be connected and the power switch turned on. Programs start initializing the STM32F103C8T6, OLED, universal IO port, and other components in the internal environment. Cycle detection is over, and the device starts to run normally when each function module has successfully initialized and connected to a user system, as indicated in the flowcharts in Figure. 4. Start collecting and analyzing data from the data sender when each program's internal resources have been initialized, and if everything is stable, check to see if the patient has made a call. The caller's information, including their ward number and patient grade, is sent by the data sender in case of a call, and the display module displays this information. When there are several calls to the same room, the algorithm figures out the order of priority, with emergency calls receiving top priority. In contrast, the system will return to the data collecting stage if there is no call. After receiving the information to process, the medical staff presses the response button to go back to the starting condition.

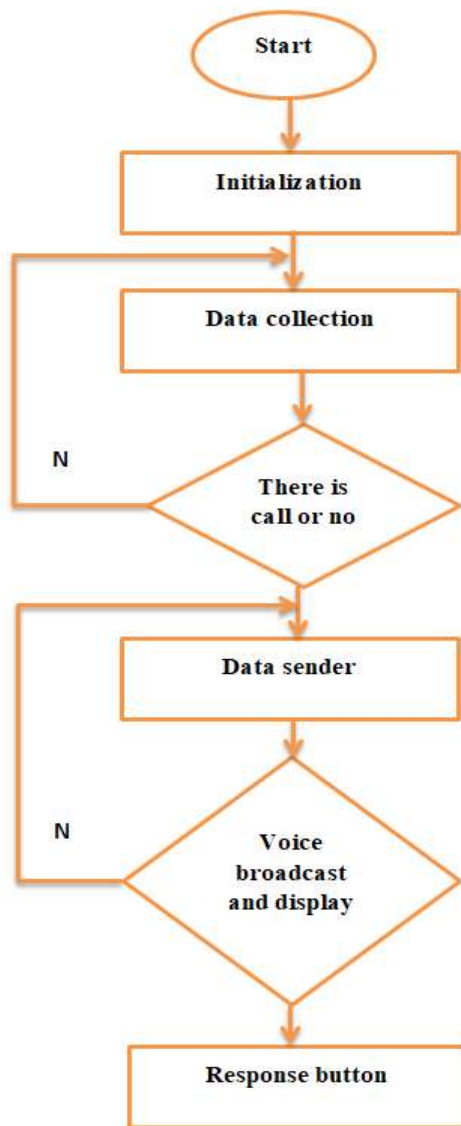


Figure 4. System Process

4. Conclusion

Currently the emphasis on patient care in a comprehensive hospital has increasingly given way to the delivery of high-quality services and prompt responses. In the past, many different research articles were presented at various times in the past but when they were converted into practice, they had many limitations and could not satisfy both the service user and the service provider. Comparing this proposed system to earlier study publications, it is more effective and widely accepted. This proposal it allows us to implement a modern nurse call system and receive calls in a non-fatiguing manner from the nurse's control room based on the request for help and provide assistance to a patient who needs help based on the calls. This means that each nurse can adjust their time usage and spend their time effectively and efficiently on patients who need help. Also, this system of nursing is very important in the intensive care unit of the hospital. In addition to these two benefits, it is also a useful way to manage the human resources in hospitals. It provides impactful measures in reducing the nurse-to-bed ratio and allows one nurse to care for more patients. In addition to meeting the needs and happiness of patients in general, it can bring significant change in managing hospital resources and human resources at a low cost. Our proposed system uses wireless transceiver module circuit of the system can increase the flexibility of the system, avoid the occurrence of failure to call, and enable patients to get the best service.

References

- [1] Hongwei, H., Youzhi, X., Hairong, Y., Saad, M., and Hongke Z., "An Elderly Health Care System Using Wireless Sensor Networks At Home". Third Intern. Conf. on Sensor Tech. and App., pp158– 163, 2009.
- [2] Lahtela, A., "A Short Overview of the RFID Technology in Healthcare", Systems and Networks Communications, pp 165– 169, 2009. doi:10.1109/ICSNC.2009.77.
- [3] Omre, A. H., "Reducing Healthcare Costs with Wireless Technology", Wearable and Implantable Body Sensor Networks, pp 65–70, 2009. doi:10.1109/BSN.2009.68.
- [4] Zhi Li, and Guanglie Zhang, "A Physical Activities Healthcare System Based onWireless Sensing Technology", Embedded and Real-Time Computing Systems and Applications, pp 369–376, 2007. doi:10.1109/RTCSA.2007.10.
- [5] Rantz, M. J., Skubic, M., and Miller, S. J., "Using sensor technology to augment traditional healthcare", Engineering in Medicine and Biology Society, pp 6159–6162, 2009. doi:10.1109/ IEMBS.2009.5334587.
- [6] Klemets, Joakim, and Pieter Toussaint. "Does revealing contextual knowledge of the patient's intention help nurses' handling of nurse calls?." International Journal of Medical Informatics 86 (2016): 1-9.
- [7] Galinato, Jose, et al. "Perspectives of nurses and patients on call light technology." Computers, informatics, nursing: CIN 33.8 (2015): 359.
- [8] Galinato, Jose, et al. "Perspectives of nurses and patients on call light technology." Computers, informatics, nursing: CIN 33.8 (2015): 359.
- [9] Meade, Christine M., Amy L. Bursell, and Lyn Ketelsen. "Effects of nursing rounds: on patients' call light use, satisfaction, and safety." AJN The American Journal of Nursing 106.9 (2006): 58-70.
- [10] Unluturk, Mehmet S. "Advanced nurse-patient communication system." Journal of medical systems 36.4 (2012): 2529-2536.
- [11] Omar Faruk Riyad, Ahraf Sharif, Arif Ur Rahman Chowdhury Suhan, Mohammad Monirujjaman Khan, "An IOT Based Ward calling system for Real-time Emergency Alert Using Local Wireless Network", 2021 IEEE 12th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON), pp.0924-0929, 2021.
- [12] Mohammad Sakib Mahmud, Mahbub Arab Majumder, Abdul Kawsar Tushar, Md. Mahtab Kamal, Akm Ashiquzzaman, Md. Rashedul Islam, "Real-time feedback-centric Ward calling system with archive monitoring using Raspberry Pi", 2017 4th International Conference on Networking, Systems and Security (NSysS), pp.1-5, 2017.
- [13] Xiaoman Chang, Lei Hao, Chong Sun, Shengxia Chen, Yan Wang, Yurong Wang, Xiaosun Tang, "Hospital remote monitoring embedded system and nursing intervention for patients with anxiety and insomnia", Microprocessors and Microsystems, vol.81, pp.103669, 2021.