IRO Journal on Sustainable Wireless Systems (ISSN: 2582-3167)
www.irojournals.com/irosws/

An overview of NFC Technology for Wireless Communication

N. Krishnaraj

Assistant Professor Senior Grade, Department of Database Systems, School of Computer Science and Engineering, Vellore Institute of Technology, Vellore, India

E-mail: krishna.rajtce@gmail.com

Abstract

This article discusses about wireless communication technologies such as IEEE 802.15.4, Wireless Sensor Network (WSN), Ultra-High Frequency (UHF) and Near Field Communication (NFC) technologies are described. The part of industry and everyday life could be significantly impacted by Wireless Sensor Networks (WSN). A wireless sensor network (WSN) is a collection of sensor nodes that communicate with one another using wireless technologies. These nodes gather data and send it to the gateway across the Internet, the informal cloud. In a WSN, node-to-node communication may be multi-hop or direct. Every new concept or technology attempts to be integrated into the WSN in order to increase efficiency, improve user experience, and consume less power. Near Field Communications (NFC), a type of wireless networking technology allows to establish simple, secure and interactive communication. iPack is a technology that focuses on integrating NFC into pre-existing systems to create a Wireless Sensor Network (WSN) that supports NFC. Furthermore, data from a sensor node can be transferred to devices with a single touch by using this method. NFC with WSN is a single hop communication. The NFC interface also offers a safe wireless connection.

Keywords: Wireless Sensor Network (WSN), Ultra-High Frequency (UHF), Near field communication (NFC), Single touch, sensor nodes

1. Introduction

Wireless Sensor Network (WSN) is described as a small-scale network of sensor nodes to gather, monitor, sense, record, and process data related to an application [1]. As a result, these nodes are resource-constrained and time-dependent based on battery management, storage, processing, data size, and available bandwidth. These nodes are

DOI: https://doi.org/10.36548/jsws.2022.4.005
Received: 11.10.2022, received in revised form: 02.12.2022, accepted: 23.12.2022, published: 04.01.2023

typically fixed in a specific method and left as a node in a remote and inaccessible location in order to carry out tracking and recording of information. The term "wireless" is now used to describe communications wherein electromagnetic waves are employed to deliver a signal overall or a portion of the communication pathway in a non-specific and broadly inclusive manner.

1.1 Overview of NFC

Short-range wireless communication technology called Near Field Communication (NFC) allows mobile devices to communicate with one another when the devices are separated only a few millimetres apart. Given that the two NFC-enabled devices are close to one another, data can be exchanged between them in a matter of seconds. High-frequency RFID and NFC technologies use the same 13.56 MHz frequency band for operation. Active and passive are the two different ways in which the network components can operate. In the active state, both devices produce magnetic fields, whereas in the passive state, only one device does so and the other transfer data through load modulation.

Applications of Wireless Sensor Networks (WSNs) include the environment, healthcare, smart appliances, smart parking, precision agriculture, and others. Sensors are used to gather and relay data about the surroundings. The node permits interaction with a control centre and gathers data from a collection of sensors. The system uses the software to gather and process massive amounts of data.

RF circuits, amplifier, clock, microcontroller, as well as some memories are all included in the NFC chips and are incorporated into NFC-enabled devices to send and receive data. The NFC-enabled devices can be active or passive but there should be at least one active (externally powered) device in the pair. NFC has been created by using wireless connections technology in conjunction with non-contact Radio Frequency Identification (RFID) technology. It offers an extremely secure and quick mode of communication for a variety of electronic devices that become more and more common in our daily life. Radio waves close to the electromagnetic field are referred to as the "near field" inside the NFC. Radio waves adhere to Maxwell's equations since they are electromagnetic waves. When energy is converted during the process of propagating from the sending antenna to the receiver antenna, magnetic and electric fields always alternate and complement one another, as in the case of the radio used in our mobile phones. This concept is used to disseminate the signal, and the process is known as far-field communication. [2]

- **Passive NFC**: This include tags and other smaller transmitters that don't require their own power source to communicate with other NFC devices. These devices can't link to other passive components and don't truly process any information supplied from other sources. These types of devices frequently take the shape of wall-mounted interactive signs or advertisements.

- **Active NFC**: These devices have the capacity to transmit and receive information. Both passive devices and other people can communicate with them. The finest example of an active NFC device is a smartphone. Both touch payment terminals and swipe cards in public transportation are examples of this technology.

1.2 NFC Components

- **NFC Reader**: The key players in NFC transactions are NFC readers. They can interact with NFC phones, read and writes card and tags, and facilitate device-to-device communication.
- **NFC TAG**: The wireless NFC (Near Field Communication) technology enables the exchange of data between two NFC-enabled devices, including text and numbers. NFC tags, like stickers, have tiny microchips with tiny antenna that really maintain a small bit of data for transferring the information to some other NFC device, like a mobile phone. NFC chip, antenna, and a holding mechanism make up the three essential parts of a NFC tag. A tiny microchip called NFC chip with a tiny amount of memory as well as the necessary communication equipment. The substrate is often a thin plastic sheet, which binds it all together. It will contain adhesives on one side of tag with just a sticker so that it can be pasted somewhere.

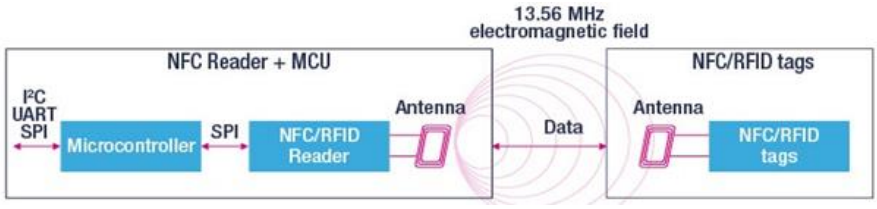


Figure 1. Components of NFC [7]

1.3 Communication Modes

Three mode of communication are available with NFC: Read/Write, Peer-to-Peer, and Card Emulation.

In Read/Write modes, an NFC reader/writer (or a mobile device with NFC functionality that functions as a traditional contactless reader or writer) reads data via NFC-enabled smart objects and makes use of it. Users of an NFC-enabled device, for instance, can instantly connect to websites by using a retrieved URL, send SMS texts without typing, get coupons, etc. by simply touching their smartphone to the object.

Any NFC-enabled reader or writer can exchange data with another NFC reader or writer in peer-to-peer mode with same benefits of read/write mode's safety, security and simplicity. One of the readers/writers acts as a tag to establish a communication link in peer-to-peer mode. For instance, two devices (like smartphones) with readers and writers can talk to one another.

To employ NFC-enabled devices within the current contactless card infrastructure for functions like ticketing, access control, transportation, tollgates, and contactless payments, an NFC device under Card Emulation mode can replace a contactless smartcard. Semiconductor has a wide range of products to facilitate the safe transactions required for this mode.

1.3.1 NFC embedded with microcontroller

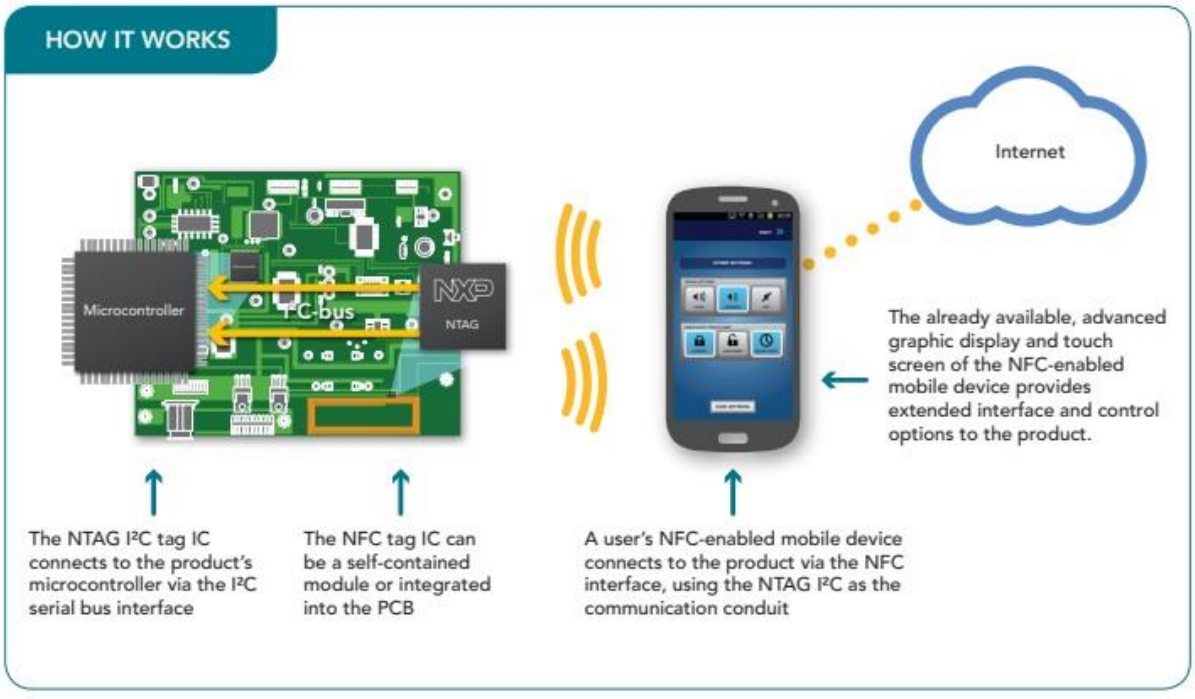


Figure 2. Working of NFC on Microcontroller [14]

NXP's NTAG I2 chip offers the appropriate answer for any item by adding a complex touch display for expanded product functions and further the remote-control capability would destroy the aesthetics, add an unwanted expense to the cost of the materials, or just plain not

fit. An enhanced graphical display and touchpad user interface are made possible by using a dual port NTAG I2 C chip as a link between the microcontroller of an embedded system and a user's NFC-enabled reader/writer device.

2. Recent NFC Technologies in 5G/4G

2.1 Arduino+PN532 NFC Based Payment

NFC is frequently used in network access and payment applications since it works best for securely transferring a wide range of information over short distance. RFID works best for asset management and perform vehicle access control in environments that move quickly and have plenty of moving parts. An Arduino-compatible little development board featuring NFC is called the Maduino Zero (Near-Field Communication). It is made with an Arduino Zero board called the ATSAMD21G18 controller and an NFC chip called the PN532. This board serves as the interface for wirelessly operating motors, unlocking locks, operating relays, and reading temperature sensors. This is due to the fact that it is equipped with built-in NFC connectivity [3].

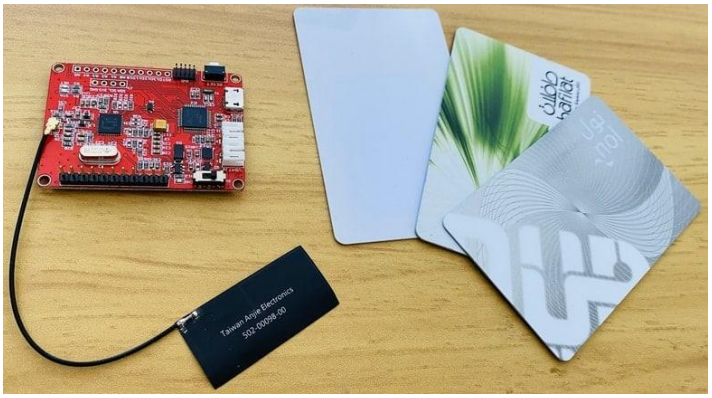


Figure 3. Arduino+PN532 NFC Based Payment [3]

2.2 NFC-Enabled Wearable Technology

A fitness band from Xiaomi called the Mi Band 5 has launched with a number of configurations and essential functions, including NFC connectivity. The post also states that NFC-based payments would be supported by the Mi Band 5 enabling easy transactions using the wearable band. Users won't have to pull out their phones or cards to finish their payments because to the NFC technology built within the band. For Department of Disease Control to monitor COVID-19 victims and those in self-quarantine, Silicon Crafts Technology PLC

(SICT), not merely Xiaomi, has introduced an NFC wearable band. The patient's health is enabled through NFC technology [5].

Figure 4. NFC-Enabled Wearable Technology

2.3 NFC-enabled keycard for phone-free access to home

NFC technology has evolved into the most adaptable product on the market. NFC works similarly to digitize car keys in that it has the ability to unlock doors. Digital locks, often known as smart locks, contain functional NFC chips. A single replacement battery can power an NFC device for extended periods of time because it consumes very little energy. Netatmo has jumped on the bandwagon of smart locks, calling the smart home equipment Netatmo Smart Lock and Keys. The following is the smart lock NFC to safely unlock the door when put into the lock, and it is compatible with Apple's HomeKit standard [5].

Figure 5. NFC-enabled key card access [15]

2.4 Tap to Pay Technology

Apple is developing a new technology that will greatly simplify payments on iPhones. Through the integration of tap-to-pay interface technology through its integrated NFC (near-

field communication) chip, the new feature will turn the iPhone to a payment device itself. A silicon component / Integrated Circuit (IC) called a near-field communication chip offers secure and short-range wireless communications between two devices. Only devices that are physically adjacent to one another can connect by using NFC and including an added layer of protection. Additionally, this technology is utilised in ticket machines, automotive centre consoles, car door handles, and payment terminals. Any iPhone user can utilise the new functionality to make a payment using Apple Pay by placing their smartphone just on backside of another iOS device. The iOS 15.4 beta is now being tested by the tech giant [6].

Figure 6. Tap to pay [6]

2.5 Biomedical Applications

Figure 7. NFC based pressure detection [13]

The functionality of NFC devices is determined by the design, composition, and production methods of the NFC antennas. It outlines the functions and qualities of such devices and discusses the current application methodologies, self-customized health monitoring, applications for drug identification, and disease detection in hospitals. Next, it analyses the standards that are part of the NFC working mode and suggests the specifications

and layout logic of a looping coil antenna for transmitting and receiving power as well as data. This efficient integrated system includes a sensor with NFC technology and a completely integrated sensor for detecting sweat metabolites. A sensor array that combines wireless transmission, field signal processing, with wireless data transfer has been the subject of research. It can power patch with NFC-enabled smartphones wirelessly and collect data via capacitive coupling between antennas. The Ion-Selective Electrodes (ISE) of a sensor are made to be flexible to accommodate changes to the skin and are capable of immediate identification of calcium and chloride ions in a variety of biological fluids [13].

2.6 Smart Home based on NFC

Smart homes have gained popularity in recent years. A smart NFC smartphone can accomplish it; there is no need for complex software or a particular reader with an NFC implant. A growing number of manufacturers are creating NFC-enabled products like stereos and game consoles. The device is turned on by tapping the phone against it, and Bluetooth synchronization enables for smooth music playback. Your home will be filled with joy and excitement in this way [8].

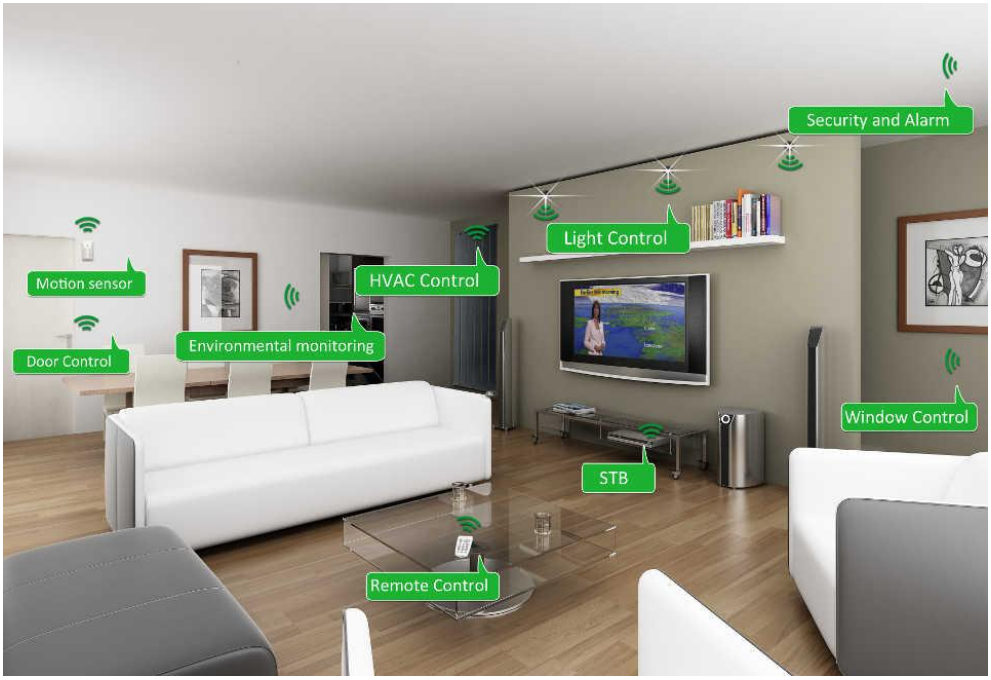


Figure 8. NFC enabled smart home [9]

2.7 NFC in Automotive

Along with low energy Bluetooth and ultra-wideband, smart or keyless access is likely the most well-known application of NFC in automobiles. NFC has significant

applications: if smartphone is really the NFC-enabled gadget providing access, the car can still connect with it even if the battery is dead. Despite appearing to be dead, your device can still recognize you to the automobile. NFC has numerous more automobile applications in addition to access. To begin with, it gives you a quick and safe way to connect your phone to a car's infotainment system. Hold the phone close to the dashboard of the automobile to pair Bluetooth without more fumbling.

Mechanics and auto experts can use NFC to diagnose and resolve issues. An NFC-enabled device can be a helpful tool to display technical errors and diagnostic information as vehicles increasingly incorporate electronics and embedded computers. Battery management is essential in electric vehicles to prolong battery life, maximise charge storage, and hence increase usable range. Environmental data that impacts the batteries, such as temperature, humidity and pressure, can be gathered by a node that includes NFC devices, like NCx3310, as well as other sensors. The nodes can then store this information inside its EEPROM and wirelessly send it to an in-range secure NFC reader. NFC can also serve as a helpful safeguard against imitation automobile parts. Copies of authorised replacement parts, including as tyres, batteries, airbags, brake pads, and many more, are a significant global issue. As a result, consumers receive parts that are probably of lesser quality and could be dangerous [10].

Figure 9. NFC on Automotive [11]

2.8 NFC on Electronic Devices

Controlled access is made possible by embedding a NFC tag chip into electrical items. The NFC interface is used to start conversations amongst the users of mobile devices. Access is only permitted by those with the proper authorization, according to microcontroller software.

2.8.1 Benefits

- Removes the expense of outside access control techniques like mechanical enclosures.
- Increases convenience, particularly when used in conjunction with the enhanced Graphical User Interface (GUI) available on any mobile device with NFC capability.
- The lack of external dials and buttons simplifies the design of the device.
- Flexibility of access is increased (remote access is available).
- Security is improved since items are less susceptible to illegal control.

2.9 NFC in Home Appliances

Global manufacturers of automated systems started to outfit washers with NFC technology, which enables smartphone to manage intelligence, modify the default settings of cleaning modes, and therefore increase washing efficiency, in an effort to make it easier for housewives to make their choice. As a result, the NFC module is turned on, and based on the initial washing set of data in the mobile application, it will alter the cleaning mode. The NFC chip also makes it easier to diagnose a malfunctioning gadget. The smartphone is placed close to the mark upon machine to activate this feature in the same manner, and then the systems verification process begins [12].

Figure 10. NFC based Home appliances [12]

3. Advantages of NFC

- NFC interactions are simple and only need a gentle touch.
- NFC is adaptable and perfectly suited to the widest range of businesses, settings, and uses.
- Short-range NFC transmissions are inherently secure (within a distance of few centimetres).NFC is compatible with current contactless card technology.

- Open and standards-based - The NFC technology's foundational layers adhere to widely accepted standards.
- Technology-enabling - NFC makes it easier and faster to set up wireless technologies like Bluetooth and Wi-Fi.
- NFC is equipped with security-ready features that facilitate secure applications.
- The NFC module's components can be merged onto a single chip, freeing up space that could be used for other essential features while maintaining the tiny and portable size of the gadget.

4. Open Challenges

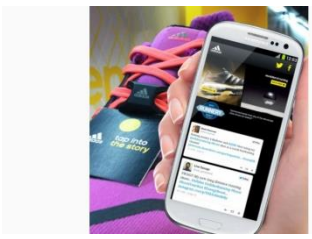
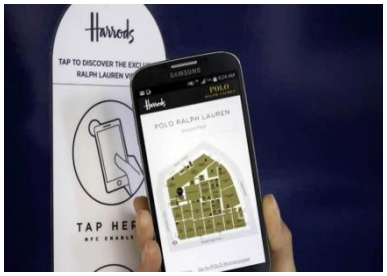
NFC offers a simple-to-use technology that requires minimal, if any, manual effort for both consumers and businesses. Nevertheless, there are a number of possible security risks.

- **Security risk:** NFC technology's potential privacy hazards have generated news about attackers exploiting the technology. NFC transactions do not have the additional step for validation that standard credit card payments do and require the user's signature to match the card number or an EMV chip / PIN payment.
- **Data corruption:** NFC makes short-range data exchange possible but it is easy to tamper with that data if the proper security measures aren't in place, including encryption. Unlicensed card reader devices that interfere in any way with the data flow could potentially cause data corruption.
- **Malware detection:** Data transfers from one device to another can also be made possible using NFC. It is conceivable for a malevolent person or device to try to spread malware that poses a risk to consumer or business devices
- **Materials that restrict NFC:** NFC signals can be blocked by a variety of materials. Wallets that prevent NFC signals incorporate a unique type of material. Additionally, specific NFC-blocking cards exist. These plastic cards, which are the same size and shape as a typical credit or debit card, prevent the transmission of NFC signals. The risk of unintentional tracking or fraud can be reduced by keeping a NFC jammer in a wallet or purse next to NFC-enabled cards or trackers.

As inductive coupling only works over short distances, NFC's operating range is only 10 cm as opposed to Bluetooth's 10 metres and Wi-Fi’s 100 metres. NFC's maximal data transfer rate of 424 Kbits per second, which is inferior to Bluetooth's 3 Mbps and Wi-54 Fi's Mbps, makes it unsuitable for big data transfers.

5. Companies that Power NFC 5G

Table 1. Applications of NFC 5G in various sectors

Companies	Applications	Images
Samsung	Ad campaigns smarter with NFC posters	
KFC	NFC posters on KFC outlet	
Adidas	Tap to learn' with NFC tags on shoes	
Google	NFC chips on the android platform- Google Wallet	
Apple	AirTag,Shortcuts, AppClips,Magsafe, 3rd party NFC app,apple wallet	
Ralph Lauren	Drove customers straight to Ralph Lauren's new launches	

6. Conclusion and Future Scope

Future electronic devices in people's lives are already starting to take on the characteristics of near field communication. It is likely that NFC-enabled mobile phones will become the norm and their uses will become embedded in daily life as chip manufacturing costs decline. Future smart gadgets will unavoidably incorporate NFC tags for further integrated functions, as well as for automated task completion in the manufacturing, shipping, aviation, and transportation sectors. Digital data communication and transactions can be made more convenient, time and energy-efficient, and most importantly, more secure by incorporating NFC technology.

Smart NFC tag can be used to create a variety of customised smartphone applications, including membership access, admittance into a secure area, and obtaining rewards for a loyalty programme. IoT and 5G create a window of opportunity for the emergence of new technologies. For better adoption and efficiency, NFC-devices will be necessary in IoT and 5G networks.

References

[1] R. Watro, D. Kong, S. Cuti, C. Gardiner, C. Lynn, and P. Kruus, “TinyPK: Securing Sensor Networks with Public Key Technolog,” in Proc. ACM Workshop on Security of Ad Hoc and Sensor Networks, October 2004.

[2] https://www.utmel.com/blog/categories/rf/near-field-communication-nfc-explained-working-and-applications

[3] https://how2electronics.com/arduino-pn532-nfc-based-payment-entrance-security-system/

[4] Faiz, Bahaa & Alabassby, Noory & Kadhim, Mohammed & Mahdi, Jinan. (2020). Design and Implementation WSN Based on Raspberry Pi for Medical Application. IOP Conference Series: Materials Science and Engineering. 518. 10.1088/1757-899X/518/5/052022.

[5] https://blog.beaconstac.com/2020/10/nfc-latest-trends/#:~:text=NFC%20technology%20has%20transformed%20itself,NFC%20chips%20inside%20of%20them.

[6] https://economictimes.indiatimes.com/magazines/panache/apple-working-on-new-ios-feature-to-let-iphones-accept-payments-via-tap-to-pay-technology/articleshow/89147415.cms

[7] https://www.st.com/en/applications/connectivity/nfc-rfid.html

[8] https://www.rfidntag.com/21-cool-uses-for-nfc-tags-make-your-life-smart-and-interesting/

[9] http://www.nwclimate.org/automation/nfc-home-automation/

[10] https://www.nxp.com/company/blog/nfc-connects-the-dots-for-automotive-applications:BL-NFC-CONNECTS-THE-DOTS-FOR-AUTOMOTIVE

[11] https://www.nubicom.co.kr/mp/Automotive-solutions.jsp

[12] https://washerhouse.com/en/nfc-v-stiralnoy-mashine/

[13] Kang, S.-G.; Song, M.-S.; Kim, J.-W.; Lee, J.W.; Kim, J. Near-Field Communication in Biomedical Applications. *Sensors* 2021, *21*, 703. https://doi.org/10.3390/s21030703

[14] https://www.nxp.com/docs/en/brochure/75017587.pdf

[15] https://9to5mac.com/2021/12/08/apple-launches-support-for-keys-in-apple-wallet-starting-with-six-hyatt-hotels/

Author's biography

N. Krishnaraj works as an Assistant Professor Senior Grade in the Department of Database Systems, Vellore Institute of Technology, Vellore, India. His area of research includes wireless sensor networks, routing, image processing, neural network design, data processing and IoT.