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A Useful Overview on Remote Sensor Organization and Investigation of Computerized Recurrence Modulator-Demodulator

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Abstract— In recent years, applications of wireless technologies can be seen everywhere in particular the applications of Internet of Things (IoT). The platforms at which wireless sensor networks (WSNs) are composed have witnessed great advances. In this article, a survey on WSN platforms and their characteristics such as hardware components, sensing capabilities, operating systems, programming languages, networking protocols, energy aspects, etc. is presented. This paper presents the synthesis of a digital frequency modulator-demodulator, the design of its main block non-coherent digital frequency demodulator containing a low- pass active filter and an amplitude detector, the performance of simulation studies, implementation of a laboratory model on developed complete technical documentation and presentation of the results obtained by his experimental study.

INTRODUCTION

;Micro-electro-mechanical systems (MEMS) technology, wireless communications, and digital electronics have made WSNs a considerable improvement over traditional sensors in many ways. Design and applications in embedded and wireless networked sensors are gaining tremendous developments integrated with the new era of technologies like "smart sensors", Internet of Things (IoT) and cloud computing [1-4]. It's not uncommon for these systems to be compact, low-cost devices with limited sensing, data processing, and wireless functionality. IoT technology, on the other hand, is defined by the connectivity of many networked embedded devices used in everyday life that are connected to the Internet. Many diverse systems, including as those found in homes and workplaces as well as in the military and transportation sectors are being targeted by this technology [5].

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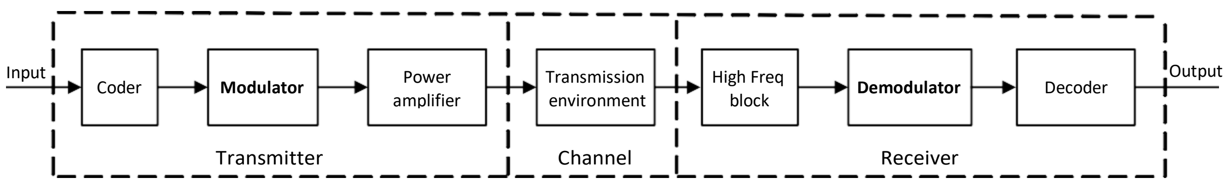
The transmission of information at long distances is related to the use of modulation and demodulation processes and corresponding devices - modulators and demodulators. Initially, the amplitude, frequency and phase analog modulators/demodulators have found a wide application in practice [7]. The improvement of communications systems in recent years has led to their digitization - of the input information signals, their method of processing and their transmission over the communication channel.The block diagram of a communication system as shown in Fig. 1. The Transmitter, Receiver and Transmission environment form the so-called Radio channel or Connection channel. Modulators and demodulators are nonlinear devices that in modern duplex communication systems often merge and form a common module – MoDem [8].The platform of WSNs usually integrated with capabilities such as programming, different wireless communication technology such as GPS, Bluetooth, ZigBee, WiFi, cellular 2G/3G/4G LTE 5G -based IoT, storage, and sensing, and thus allowing researchers and developers to utilize more functionality and build robust systems [4][6]. New significant requirements for size, mobility, cost, network topology, life time, etc. need more investigation and deep research. In order to meet these demands, hardware and software platforms are getting bigger, faster, and more complicated [5]. Through the use of a combination IoT hardware/software (such as wireless sensors and WiFi) billions of data points are generated, which can then be analyzed with the use of sophisticated software tools. IoT devices, on the other hand, can be anything that can transmit and receive data over the Internet and is designed to handle a certain type of data. IoT's potential influence on the Internet, as well as the economy, has been analyzed by a wide range of enterprises and academic groups. While Huawei predicts 100 billion Internet of Things (IoT) connections over the next decade, cisco is predicting more than 24 billion IoT devices by 2019. As much as $3.9 to $11.1 trillion might be generated by IoT by 2025, according to McKinsey Global Institute. [7] The first commercial crossbow Rene platform debuted in the late 1990s. Wec, the sensor node created at the University of California, was the inspiration for it. Later, a number of wireless sensor platform families arose, including Tmote, Mica2, MicaZ, Imote2, and BTnode. The sensor featured low power consumption, hardware write protect, radio signal stability and good performance [8]. These nodes have been widely utilized in commercial and academic applications. Today various commercial platforms with different characteristics are available. A lot of these nodes with their characteristics such as hardware components, software programs and interfacing techniques will be presented in the sequel. The platform of WSNs usually integrated with capabilities such as programming, communication, storage, and sensing, and thus allowing researchers and developers to utilize more functionality and build robust systems. New significant requirements for size, mobility, cost, network topology, life time, etc. need more investigation and deep research. In order to meet these demands, hardware and software platforms are getting bigger, faster, and more complicated [2].In the late of nineties, the first commercial platform called crossbow Rene was appearedWec, the sensor node created at the University of California, was the inspiration for it. Later, a number of wireless sensor platform families arose, including Tmote, Mica2, MicaZ, Imote2, and BTnode. The sensor featured low power consumption, hardware write protect, radio signal stability and good performance [8]. These nodes have been widely utilized in commercial and academic applications. Today various commercial platforms with different characteristics are available. A lot of these nodes with their characteristics such as hardware components, software programs and interfacing techniques will be presented in the sequel. The WSN nodes can be defined in terms of computational resources, sensor interfaces, software architectures, protocol stacks, etc., while it can be used for a variety of applications. WSNs also have a number of advantages, including low power consumption, ease of integration, and support for green applications [9]. These networks are made up of three embedded systems that may interact with their surroundings, process information locally, and wirelessly communicate with their neighbors. Wireless modules or motes, sensor boards, and a programming board are the usual components of a sensor node.

The carrier oscillation parameters in the modulation process change by jumping between two states defined by the digital signal - logical 0 or logical 1. Thus the amplitude, frequency and phase of the carrier oscillation receive discrete values in tact with the modulating digital series. The main types of digital manipulations are: Qadrature-Amplitude Modulation (QAM) is more advanced than Amplitude Shift Keying (ASK), FSK, PSK, and Qadrature Shift Keying (PSK). The modulated signal in frequency manipulation (FSK) is formed as the sum of two ASK signals, each with the corresponding carrier frequency fC1 and fC2.

I. SYNTHESIS OF DIGITAL FREQUENCY MODULATOR-DEMODULATOR - A PRELIMINARY DESIGN

The transmitted information from the signal source to the receiver to be transferred over a communication channel requires it to be modulated and accordingly demodulated. The digital frequency modulator-demodulator is designed for signal formation, their transmission - transfer over the communication channel and reception. The connection channel may be a cable or ethereal (terrestrial , satellite).



Radio channel / Connection channel

Fig. 1. The block diagram of a communication system.

PLATFORMS HARDWARE

The developments of hardware components of each platform depend on several parameters such as size, price, application, etc. . ***General Architecture*** The general architecture of the wireless sensor node must contain the following basic units as shown in Fig. 1. As can be seen in Figure 2, the Tmote node includes a microcontroller, signal conditioner, analogue-to-digital converter (ADC), memory, radio transceiver, and DC power supply as well as other components. The wireless nodes can be divided mainly to sensor nodes and gateway nodes as follows [10].

Generic nodes (take measurements)

To collect data from the field, these nodes measure physical characteristics such as light, temperature and humidity as well as air pressure, velocity and acceleration. acoustics, and magnetic field. To get to the outside world, data must first go via the gateway node and then be relayed back to the nodes. Several sensors are housed in a single node. Gateway (bridge) nodes Their primary function is collecting and transmitting sensor readings to the base station via radio waves (laptop or computer). They'll need more processing power, more battery life, and a longer transmission range. These gateway nodes are depicted in Table 2 with a few of their properties. Non-coherent demodulation of binary FSK modulated signals can be performed by frequency discrimination as shown in Fig. 3. Two parallel-connected circuits transmit one of the two frequencies fC1 and fC2 and form the amplitudes of the signals from the demodulation performed. The output digital frequency demodulated signal is formed by comparing the two Um1(t) and Um2(t) signals, which can be performed by a comparator.

In the non-coherent FSK demodulator (Fig. 4), as frequency/amplitude converter, will be used two identical series connected units of low-pass active filters (LPAF) to be able to provide the corresponding voltage transmission coefficients in the course of the AFR for the frequencies fC1 and fC2. The output amplitude-demodulated signals should be submitted to a voltage comparator with positive feedback and a hysteresis zone of its switching Ux and the input digital modulation signal carrier of the information appears at the output. The choice of drop of the amplitude-frequency response of the LPAF used is of great importance. The analytical expression of the transfer function (AFR) is the type

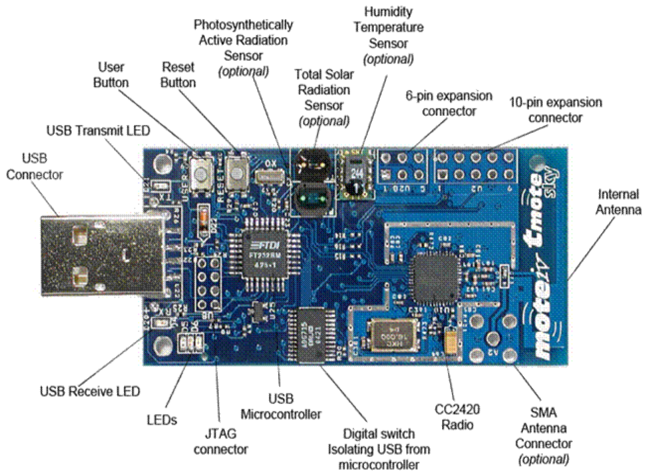


Fig. 2 Picture of Tmote node (top layer) [10]

Hardware Platforms Classification

Generally, the sensor node hardware platforms can be classified as [28]. System on chip platforms Microcontrollers, MEMS sensors, and a wireless transmitter are all included in these systems. They have minimal power consumption and are tiny in size. Embedded sensors platforms The chips used in these systems are off-the-shelf generics. Since there are so many of these components in use, their production costs are low. The oscillogram of signals in nodes 4 (FSK modulated signal) and 16 - after both low-pass units are shown in Fig. The latter appears to be the input for the FSK demodulator (U4). The obtained oscillogram of the signals in nodes 4 (FSK modulated signal) and 21 - after the FSK demodulator is presented in Fig. 9. Since the output signal of the comparator of the FSK demodulator continuously switches with the frequency of the amplitude demodulated signal with the greater amplitude (Fig. 9) available at logic 1 of the input modulation signal which requires its smoothing. For this purpose, the structure of the FSK demodulator envisages the use of a full-wave rectifier D1 (Graetz circuit) and a pulsating smoothing capacitor C8. Transceiver The widely used transceiver is that one from Chipcon which comes with different versions CCxxxx. It is used in motes listed in Table 4. It has an embedded antenna with frequencies 2.4GHz and 310.433MHz. The transmitting range is 30 to 125 m. The network protocol for this transceiver is the well-known IEEE802.15.4.

There's another chip called Zeevo (model Zv4002) used in BTnode rev3. This chip utilizes three frequencies and it depends on Bluetooth IEEE 802.15.1 protocol for network communications. Table 5 depicts some characteristics of this transceiver used by different wireless sensor nodes. Interfacing and Networking Peripheral controllers, such as USART, UART, ADC, I2C, SPI, and camera, are currently supported by the platforms' present implementation. Data from the physical world must be collected using a platform that can accommodate diverse sensors. The data acquisition card in each platform is characterized by number of channels, sampling rate, and resolution for either its ADC or DAC.Multiple interfaces, such as Ethernet, WiFi, USB, or serial connections, are available on some platforms, making it possible to link various mobile devices to a company network or a local PC/laptop network. There are two main uses for these boards: programming the rovers and collecting data from them [29]. The use of 6LoWPAN-based technologies to link all networking devices, including tiny sensor motes, to the Internet is now a hot topic. Even if supplying an IPv6 stack to every mole provides some advantages, the substantial memory and code size overhead of address compression algorithms may result in just a tiny amount of space being available for user application code.

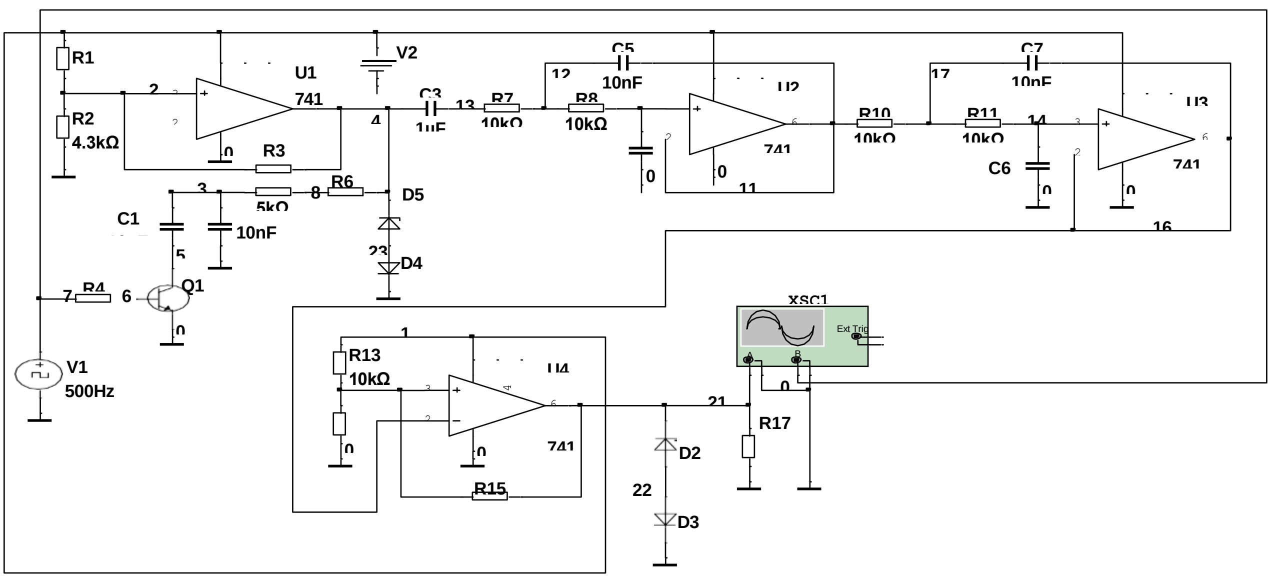


Fig. 7. Circuit for simulation study of the synthesized FSK modulator-demodulator.

EXPERIMANTAL STUDIES OF DESIGNED DIGITAL FREQUENCY MODULATOR-DEMODULATOR

Table 1 presents the measured DC voltages in the respective nodes since some of the FSK modulator- demodulator circuits have a DC operating mode, for example, the reference levels (voltages) of the non-inverting inputs of the Schmitt-triggers U1, U4 and inverter U5 (nodes 2, 9 and 24 in Fig. 10). They are compared to the simulated ones and the relative error between them is determined.

Node	2	9	24
Usimulation, V	3,60	5,95	2,89
Uexperimental, V	4,39	5,67	2,89
ε, %	18	4,9	0

The behavior of the synthesized circuit of a non-coherent digital frequency modulator-demodulator during the simulation and experimental studies is analogous while preserving the form and character of the intermediate signals in the individual nodes. However, there are minimal differences in both the operating frequencies and the amplitudes of the intermediate signals.

A. *Operating Systems*

Because of the restricted resources of the nodes, the operating systems have been specifically designed for them. Because of the lack of strong task scheduling, memory management, and file system support, their framework does not constitute a comprehensive operating system. TinyOS is one of the most widely used operating systems. nesC [10] was used to write it, which is an extension of the C language. Using TinyOS, you may configure components to do a specific action when an event occurs, such as when a sensor reading rises over a threshold. It is possible to deconstruct a program into smaller, more manageable parts. Through the use of interfaces, they communicate with each other by exchanging messages. One of the operating systems that may be utilized with wireless sensor nodes is called Contiki [11]. Since memory, computing power, and communications bandwidth are all highly restricted, this software can only run on a limited range of hardware. A typical Contiki system contains several kilobytes of memory.

TABLE 6 MISCELLANEOUS DATA FOR SOME SENSORS

Sensor Node		**Tmote**	**Mica 2**	Imote2
Power supply	Voltage(v) min,max	2.1, 3.6	2.7, 3.3	3.2, 5
	Current (mA)			
	min, max	21.8, 1.8	39, 12	44-66, 31
Battery life	Year	< 1	1	>1
Dimensions	W x L x H cm x cm x cm	6.6x3.2x0.7	6.6x3.2x0.7	4.8x3.6x0.9
On-board sensors	Physical quantity	Temp., Humidity,	Temp., Humidity,	Temp., Humidity, light
Manufacturer	Company	Moti	Cross	Crossbow

		ev	bow	
Prices	$	8 0	90	170

For usage on wireless devices, LiteOS is an RTOS created specifically for LiteOS [31]. On sensors with limited memory, it is possible to run LiteOS, which is a UNIX-like operating system. UNIX-like capabilities are provided by this operating system, which enables the usage of wireless networked sensors. For those who are familiar with UNIX and threading, LiteOS provides a familiar programming environment. Event-driven and thread-driven programming modes can be used in the same program. A C-based open source sensor networking framework for the Atmel-based MicaZ and Mica2 etc. ***Programming Languages*** The programming language that used in most platforms is C language. System integrated in a network An event-driven, component programming language called C (nesC) is used to construct TinyOS apps. In order to run programs on TinyOS, nesC is designed as an extension of the C programming language. Some platforms, such as Telos B, are written in C#, but Iris mote is written in C++. Java is also used to program the wireless platforms such as in Nymph mote. Table 7 illustrates the programming languages for different reviewed sensor nodes. ***Simulators of WSN Platforms*** There are many simulators can be used to simulate the deployment of platforms to conduct the analysis and expect the performance of the sensor nodes in the network. NetSim is a well-liked network modeling program that's frequently employed in academic and industrial settings alike. WSN, WLAN, WiMAX, TCP/IP and other wireless technologies are covered in the NetSim simulator. Another wireless sensor simulator is OMNeT++. Discrete event simulator framework based on component-based, modular, and open architecture. OMNeT++ is most commonly used for platform simulation. NS-3, Castalia and OPNET are simulators for wireless networked platforms used widely with similar characteristics of others. **APPLICATIONS OF PLATFORMS** A wide range of applications are possible with wireless systems, from simple monitoring duties to full-scale facility management. Seismic, magnetic, thermal, visual, infrared, acoustic and radar sensors can be used in WSNs to monitor a wide range of environmental conditions, such as temperature, humidity and pressure. They can also measure speed and direction of movement and light, as well as the composition of the soil, noise levels and the mechanical stress on attached objects. It is possible to use it in many different ways. Applications include homeland security, monitoring of space assets for potential and human-made threats in space, ground-based monitoring of both land and water, intelligence gathering for defense, environmental monitoring, urban warfare, weather and climate analysis and prediction, battlefield monitoring and surveillance, and exploration of the solar system and beyond.

CONCLUSIONS In this study, it has been noticed that wireless sensor network platforms can be used in everyday life. It is developing rapidly due to its large number of applications based on Internet of Things (IoT) technology that it can be used. The important issue that needs more research and development is the data transmission. However, it yet consumes the large amount energy which leads to decreasing the life time of the node and the overall life time of sensor network. The synthesis of a digital frequency modulator- demodulator is related to the development of a preliminary design in which are presented the requirements for the individual component blocks and the possibilities for their choice and implementation. The design, simulation, and experimental study of a digital frequency modulator with a timer-module 555 and a Schmitt-trigger has been carried out. Among the choices of FSK demodulator - coherent, differential-coherent and non-coherent, the latter is chosen because its implementation is not related to the use of specialized integrated circuits such as PLL and DSP. It was synthesized by LPAF - a two Sallen-Key topology units and an amplitude detector (Schmitt-trigger comparator). The simulation and experimental studies were performed for all composite modules as well as for the entire synthesized non-coherent digital frequency modulator-demodulator by presenting the results obtained which visualize the processes in progress.

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