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Advanced Object Monitoring Using Wireless Sensors Network

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Abstract

The Wi-Fi becomes very common in different environments today. The availability of control and local wireless LAN in addition to supply a communication channel makes the Wi-Fi the choice of many domestic services and personal applications. This paper proposed a design and implementation of new controlling and monitoring system that used Wi-Fi technology as a network infrastructure topology to connect its parts. This design provides an appropriate interface to the sensors and actuators of the desired environment and provides scalability and flexibility that can manage many hardware interfaces as long as it exists on the range of the Wi-Fi network coverage. The presented system support many environments like home, medical, educational and industrial. Provide monitoring and control using many sensors and actuators. The evaluation shows that the design provides many benefits like, reduced installation costs, where single Wi-Fi system can accomplish many functions with minimal hardware setup. In addition, the presented system is easy deployment, installation, and coverage.

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Keywords: Wi-Fi, Wireless Sensor Network, WLAN, Object Tracking ;

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1. Introduction

Wireless is a great technology; it is the information transfer over a distance without using any type of conductors or wires or any solid media. There are a lot of different standards and protocols for wireless communication, such as: radios, cellular telephones, satellites, and wireless networks. These wireless communication and mobile networks have been widely used nowadays [1]. It is said that new wireless networking technology has been considered as one of the most important technologies that is changing our daily life. Due to the importance of wireless communications networks in computing and industrial area, many universities provide courses on wireless related subject in undergraduate and graduate program. Wireless communications provide improvement of engineering technology in many areas and environments [2].

The development of wireless communication is noticeable in the second-half of the 20th century till today. Recently, mobile communication networks carried a large amount of data. Development and the widely use of wireless communication systems makes huge change in our life styles.

Telecommunication, electronics and computer engineers made and still try to provide brilliant effort to develop various technologies of digital communication, which aim at approaching the performance close to the perfect approaches. In the 1980s, digital wireless communication technology was used in the satellite communication systems for International Telecommunications Satellite Organization (INTELSAT) to achieve increased system capacity in the situation where demands in satellite communication were increasing rapidly. Then it was used to cell phone systems, and led the significant growth of cellular market. Today, wireless communication technology is used in a plenty of systems. Besides global networks (GANs), metropolitan area networks (MANs), wide area networks (WANs), and local area networks (LANs), it is also used in personal area networks (PANs), including dedicated short-range communication (DSRC) for intelligent Transport Systems and Services (ITS), radio frequency identifications (RFIDs), wireless sensor networks, and wireless cards[1][3].

Wi-Fi is the most popular wireless network technology, which is used anywhere and every day. It is defined in the IEEE 802.11 specifications as a family of standards for wireless network. The standard was evaluated and recommended by the Wi-Fi Alliance.

Wi-Fi used a radio frequency to provide a wireless network to the devices as an alternative to the wired network. Wi-Fi technology is an open international standard able to work with different wireless technologies such as 3G, Bluetooth, and other wireless technologies that use different IEEE specifications [1][4].

The use of different types of wireless local area networks (WLANs) that use the 802.11 family specification called Wi-Fi (wireless fidelity). It's the most widely used wireless communication technology. This standard allows deploying a local area networks (LANs) without wires for client devices, which reduces the costs of deploying the network [5]. Spaces where cables can't be run, such as outdoor areas and historical buildings,can host wireless LANs. [1] [6].

1.1 WSN application examples

There are so many fields in our life have been covered by the implementation of various kinds of WSN.
Here we present some examples of them:

- ***Radiation Sensor Network:***

Radiation prevention help authorities and security forces to measure the levels of radiation of the affected zones without compromising the life of the workers. Figure (1).

Geigger counting - each node acts as an autonomous and wireless Geiger Counter which measures the number of counts per minute detected by the Geiger tube and send this value using ZigBee and GPRS protocols to the control point.

Emergency radiation sensor network. If a radiation leakage occurs in a place where there is not a previously installed radiation sensor network, an emergency deployment can be done in just a couple of hours. Security corps just need to spread the sensor nodes on the ground at certain places.

Fig 1. Radiation sensors network

- **Smart Parking:**

Traffic monitoring - to calculate the average speed of the vehicles which transit over a roadway by taking the time mark at two different points.

Flow and congestion control. – Understand the flow and congestion of vehicular traffic for efficient road systems in cities: reduce journey times, reduce emissions and save energy. Figure (2)

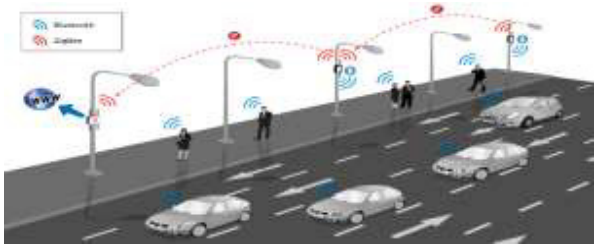

Fig 2. Smart parking network

- **Natural Environment Protection**

Detect and prevent forest fires. Detect flames, heat and gases that help to identify the molecules of chemical compounds generated during combustion (CO and CO2). With GPS, allow the exact geolocation of the nodes.

Prevention. After installing the WSN, the network can also acquire the daily values for temperature and relative humidity in order to determine the likelihood of a fire in each zone under surveillance.

Alarm. Send an alarm indicating the status of the fire or the probability level and the area. Figure (3).

Fig 3. Natural environment protection network

1.2 Problem statement

Wireless networking is significantly slower than wired networking when transferring files over a local area network, another problem appeared when you have a busy network or if your signal strength is weaker than optimal. It uses radios to transmit signals and just for 100m range, this provide a limited number of channels, connections full and

slow down or fail to work issues. This radios used to transmit data will interfere with cell phones, walls, microwave ovens and large pieces of metal.

Wireless and Wi-Fi connection go through the air, the person interested to stealing the data needs a Wi-Fi receiver, software, place to work where he can receive the signal and the network can cracked.

This paper presents a flexible and multipurpose design that can almost fit and work in any environment of Wi-Fi. It can work in educational, industrial, healthcare, and home applications.

This paper presents control, monitor, automation and observation functions to many environment by manipulating the system inputs measured by sensors like temperature, force, and smoke sensors which used here as examples for most popular application and processed by simple microcontroller then the data sent and received between the microcontroller and the user device which could be a microcontroller or personal smart phone, to deal with data and perform the monitoring and alerting if need. The technology used to transfer data is the Wi-Fi standards using the WIFLY module.

1.3 literal survey

The various environments automation and control systems based on wireless technology are used more and more frequently these days. They provide more comfort when employed when wires cannot be used. Automating and controlling systems that are installed in different environments increase the comfortability and allows centralizing the control of heating, humidity, fire detection, air condition and lighting. This makes the design provides an overall cost reduction and energy saving which consider as a great issue now days.

In recent decade, the past few years, wireless technologies reached their glamour. Every time and anywhere, wireless based systems are used, from wireless home networks to mobile networks and satellite networks.

Nowadays, few comparative research of wireless control, monitor and automation standards are conducted. This kind of research provide a valuable information to those who are looking for the suitable systems for different requirements. It is used to provide the key features of wireless protocols. In the past, any system control and automation process has been developed worldwide into very attractive research area, it is corporate with several modern disciplines, such as communication, data information, computers, control devices, sensors, and actuator leading to new significant solutions with better performance and fully independent systems[6].

The networks and take advantages of its services could be accessed without cables. This technology growing fast, providing the flexibility and mobility, reducing the cable restriction is one of the benefits of wireless. Moreover, wireless networks include the dynamic network formation, low cost, and easy deployment and expansion [7].

Wireless fidelity (Wi-Fi) includes IEEE 802.11a/b/g standards for wireless local area networks (WLAN). Wi-Fi allows the users to use the Internet at broadband speeds when connected to an access point (AP) or in ad-hoc mode. The IEEE 802.11 architecture involves different components that interact with each other in order to provide a wireless LAN that supports station mobility transparently to upper layers [1][8].

New phase, Wireless Sensor Technologies are entering. Recently, offers many opportunities for research and development. Consequently, it decease the costs of ownership, increasing the technology of smaller sensing devices and achieving high level in radio frequency technology and digital circuits [2].

2. Methodology

The proposed system of the Multi-Functional Wi-Fi based system consist of hardware and software components that cooperate together to perform the requested task of the presented system here.

The block diagram of the presented design is being illustrated in figure 4. The core microcontroller (PIC MCU) is the core control and processing unit of the system. The wireless fidelity is being achieved through the Wi-Fi module. The computer interface is being performed using VB.net language. In addition to that, an amount of sensors are being used to be controlled and logged to the PC via the Wi-Fi module.

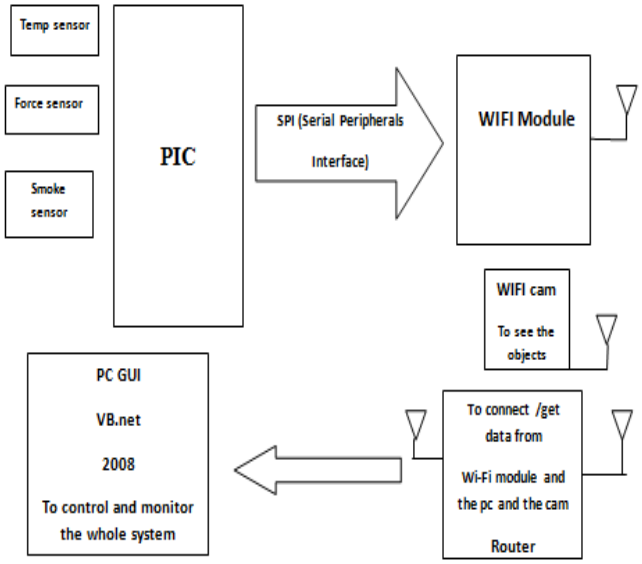

Fig. 4. Block diagram of the presented system

The main hardware requirements used to design the Multi-functional Wi-Fi based system are the microcontroller that provides the control and perform the processing task for the whole system, force sensor, smoke detector, temperature sensor, dedicated Wi-Fi module, camera, PC, and network router.

The Multi-functional Wi-Fi based System data flow is illustrated in figure (5). The data flow description of how the components communicate with each other and how data sent and received between the hardware and software.

Once the system on the personal computer turned on and the power turned on for the microcontroller, the microcontroller starts collecting information and logging from the connected sensors in the system environments and updates the measurements to the personal computer systems that are logging the measurements.

The system on the PC ask for the value each specific time period chosen based on the application and how the importance of the changes in the input value over the time, the microcontroller sends the value over the RS232 port to the Wi-Fly module which send it to the connected router, now the router send the data for the PC system which on or / off the alarm based on the critical constant value selected to the application.

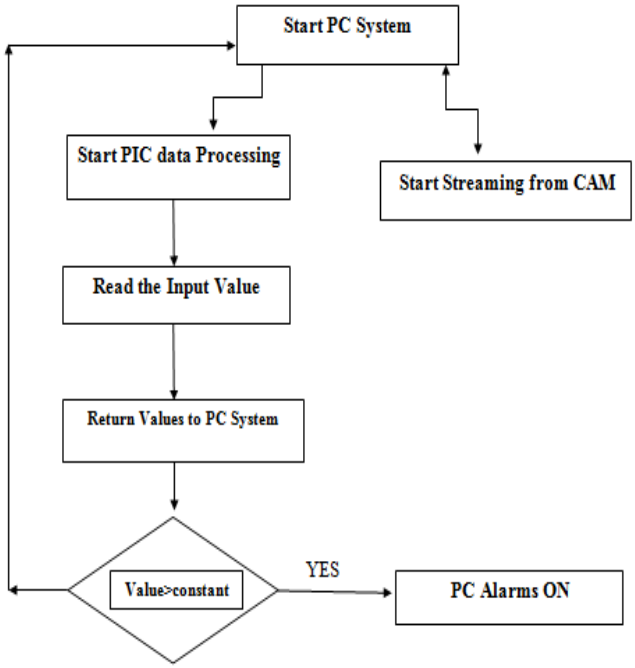

Fig. 5. Flow diagram of presented system

The communication process, sending or receiving accomplished by the Wi-Fi technology using the router and the Wi-Fly module and the PC, this provide flexibility and mobility for the control and monitor the environment which used the multi functions Wi-Fi based presented system.

The PC system communicates with the Wi-Fi CAM throw the router. Both are using route to send and receive the streaming video an images to control and monitor the objects selected. The system develops a sequential transmitting of the logged data from sensors and camera to the network router continuously through the Wi-Fi module. Through the dedicated Wi-Fi, the system is supplied by the internet and the data is being logged and transmitted through the same Wi-Fi too. In addition to that, the camera system is connected though the same Wi-Fi system achieving different various functions though the same wireless connection system. The accuracy of system handling multi-functional tasks should be very accurate and the system handling precision is the criteria of the system performance along the different working conditions and measurements types. The sensors and camera system control, in addition to the measurement is the task of the dedicated presented system, which should be performed in high precision and reliability.

Nowadays home, building, and many environments automation, control, and monitor systems are being used more and more. They provide more flexibility and mobility to ordinary complex life application, and this presented system which based on the wireless Wi-Fi technology provide the centralized control of heating, air condition and lighting, and provide decreasing on the overall cost and energy saving which now considered as main issue nowadays.

Wireless systems like Wi-Fi based systems have become more and more in home networking, building automation, health care systems, animals and agriculture and food industry, factory control and automations, industry automation, military systems and special needs care systems.

3. Results

The main design screen is illustrated in figure (6). Illustration messages where design to prompt the status of the system to the user continuously.

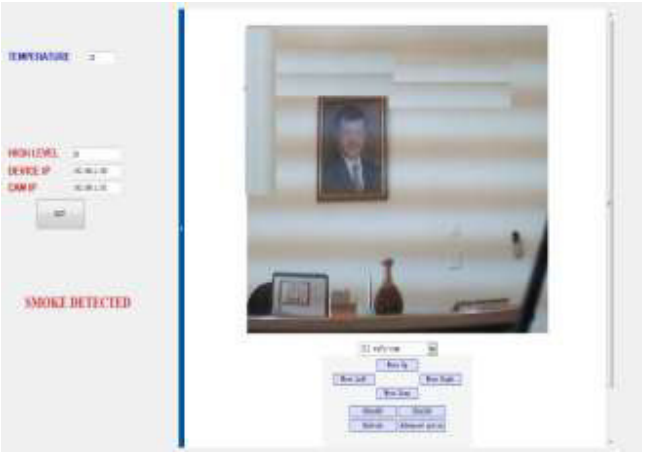

Fig. 6. The main design screen of presented system

The system was tested and measured using different criteria. The main criterion of system performance is the network connectivity where the different functions should keep in track with different environment conditions. Table (1) illustrates the connectivity duty cycle with different conditions

Table (1) illustrates that, the system achieved high reliability across different environments and processing loads. In normal conditions, the system was perfect where it tested over the presented system components and data flow. The system connectivity becomes lower when the temperature goes lower, where in such; all electronic system performance goes lower. In addition, the high processing traffic of the system make the connectivity just few lower. But in all conditions, the performance is optimal.

Table I. Results of connectivity duty cycle at different conditions

Conditions	Connectivity duty cycle
Normal running of all system in the room temperature about 20 C	100%
Running of the system at temperature around 0 C	97%
Running with high traffic vision at temperature around 20 C	96%

The transmitted data quality goes larger than 95% in all testing conditions with different functionalities conditions. This quality represents high reliability and accuracy in the presented system.

4. Conclusions

The Multi-functional Wi-Fi based system has been experimentally proved to work correctly by connecting and testing the system in different environments, which will give a flexible and elastic system, can fit different environments for control and monitor based in the great Wi-Fi technology.

The proposed system achieved the target to control, monitor, security, and cost effective design, the proposed design provide better form for scalability and flexibility comparing with other designs.

The system was presented many benefits like, reduced installation costs, where single Wi-Fi system can accomplish many functions with minimal hardware setup. In addition, the presented system is easy deployment, installation, and coverage. Wireless nodes can be mounted almost anywhere. In adjacent or remote places, where cabling may not be feasible at all, connection to the home or any environment network is established bay simple amount of nodes in the area. Wireless technology also helps to enlarge the covered area. The deployed wireless network is especially advantageous when, due to new or changed requirements, extension of the network.

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