Trusted Wireless Security Environment "turn-on" in Robotics (TWSE)

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Abstract

This paper presents a new model of a security system in which a mobile robot Autonomous-Car (AC) continuously monitors its surroundings while traveling for detecting objects. On movement detection, a warning signal is sent to a computer via Wi-Fi technology. The mobile robot motion is observed with a camera that sends images to the computer controlling the robot remotely. The results indicate that the security system is reliable in 90% of cases.

Keywords: *Robotics, Fuzz-MAT, Wi-Fi, security Aspect, communication.*

1. Introduction

Nowadays, all electronic appliances in a home will be networked: PCs, telephones, stereos, refrigerators and even washing machines. Heating and air conditioning, previously controlled by a single, fixed, manual thermostat, can now be managed by an intelligent controller with remote-access capabilities [1,2]. Recently with increasing living standards and expectations for comfortableness, the use of residential air conditioning is becoming widespread. The control and monitoring of indoor atmosphere conditions represents an important task with the aim of ensuring suitable working and living spaces to people. However the comprehensive air quality monitoring which include monitoring of humidity, temperature, CO_2, flying dust particle density, and etc. is not so easy to be monitored and controlled [3.4].

Considering that a security system must be the least suspect and as mobile as possible, wireless technologies have been categorized as one of the best alternatives for this area of work, as these avoid the use of wiring, allowing an efficient mobility in the security system as well as a good presentation. Mobile robots and wireless communication join to make their presence felt in a satisfactory manner in the situations described before and in situations unrelated to a security system. The wireless communication more used for these types of jobs is given by means of Bluetooth technology, since different jobs and projects in different areas have been performed with the help of a mobile robot and communication via Bluetooth, with efficient results.

For example, Mouta ouakkil et. al. [2] describes several articles related to the use of robotics in security contribution. Abad et. al. [3] described a robotic vision application in MatLab, which created a mobile robot able to move and display a given area using a camera integrated into LEGOs.

All this is developed using MATLAB elaborate programming where you create a graphical interface that enables communication between two devices using the Wi-Fi protocol, Bluetooth technology. The detection of different obstacles or objects that are wished to perceive with the equipment is made through a wireless camera installed on the robot's top, that camera sends the information to the wireless router connected to the computer, and this in turn communicates via intranet with the Control Center from which is monitored all perceived by the robot, using Fixed Public IP.

As above, other papers relating to the use of robotics in various projects as [5], where a robot arm is used in assembly and [6] where techniques of computer vision are used in a system for locating a mobile robot.

2. Current Product

Many companies invest resources and deploy a small army to protect themselves from the many security threats or attacks (wormhole attack) that are found this time. However, these resources results inefficient in many cases in terms of mobility, warning signs, etc.
Most security systems that are deployed today in many homes and businesses are static, i.e. they cannot look beyond their initial limitations, which open the door to insecurity. Also worth mentioning is that many security systems do not send alarm signals but leave this job to the person in charge, which is closely watching what the security system displays, i.e. involving a double job.

3. Proposed Model

The main objective to be achieved by thi s research is to create a security system that allows monitoring every so often a given space and send warning signals to the PC if it detects any moving object.
It is therefore necessary to design and implement a robot, such as the (AC), to be in constant movement and to monitor the surrounding environment, and is controlled remotely by a user or in an autonomous way.
All movements of the mobile robot (AC) will be seen from the computer that controls it through a chamber which is connected directly to the computer.

3.1 Implementation of (AC)

There is a wide range of applications of robotic platforms with which it is possible to develop security systems. These are all valid to a greater or lesser extent, although it is advisable to choose the most versatile.
One of the robots more accessible by its low cost and ease of programming is the (AC) since it offers a multitude of design possibilities in regard to software and hardware, a good rate quality/price and also there is a large number of sensors and actuators as well as different environments and programming languages with high quality [4]. That is why, according to the features offered, the implementation of the (AC) would be well suited for this research.

3.2 Wi-Fi Technology

Wi-Fi is a popular technology that allows an electronic device to exchange data wirelessly (using radio waves) over a computer network, including high-speed Internet connections. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards" However, since most modern WLANs are based on these standards, the term "Wi-Fi" is used in general English as a synonym for "WLAN". Only Wi-Fi products that complete Wi-Fi Alliance interoperability certification testing successfully may use the "Wi-Fi CERTIFIED" trade mark[5,6].

A device that can use Wi-Fi (such as a personal computer, video-game console, smart phone, tablet, or digital audio player) can connect to a network resource such as the Internet via a wireless network access point. Such an access point (or hotspot) has a range of about 20 meters (65 feet) indoors and a greater range outdoors. Hotspot coverage can comprise an area as small as a single room with walls that block radio waves or as large as many square miles — this is achieved by using multiple overlapping access points [7].
Wi-Fi can be less secure than wired connections (such as Ethernet) because an intruder does not need a physical connection. Web pages that use SSL are secure but unencrypted internet access can easily be detected by intruders. Because of this, Wi-Fi has adopted various encryption technologies.

3.3 MAT LAB Implementation

We also want to implement Wi-Fi technology to establish wireless communication between the PC and the (AC). This is feasible, since the robot (AC) supports Wi-Fi on its Programmable Brick, allowing the computer to download programs or information from the (AC), or vice versa, wirelessly, and thus give a good presentation to the design of the (AC), leaving aside the use of wires [7].
There is great diversity of high level programming languages as Bricx [9], LeJOS NXJ [10], NXC [11], among others, that allow programs to build LEGO MINDSTORMS NXT robots.
The chosen language for this work is Mata lab simulator since it is atextual programming software, with free distribution, that allows programming the Mat lab using Java and provides, among others, the following components:

- An enhanced firmware for the Mat lab brick that includes a Java virtual machine
- A Java API to use the Mat lab bricks.
- Wireless Communications with the PC.
- Tools to change the firmware, downloading software, debugging programs and other functions.

Mat lab interface consists of a set of classes where there are defined methods that directly access the functions of each of the devices in the robotics kit [12].

Because of these extensive features offered, it turns out to be a good alternative to implement in the programming of the Fuz-MAT, precisely because we want to communicate with the PC wirelessly.

As for programming environments, could be used either to allow to create Java programs such as Netbeans, JCreator, Eclipse, etc. In this particular case of carried work, Netbeans was used because it has a free edition and turned out to be a development environment very easy to use.

4. Experimental Environment

Communicate with a Fuz-MAT using a PC turns out to be a more complex task than establish a similar connection between themselves. However, the communication between PC and Fuz-MAT opens a wider range of communication possibilities with this type of robots.

A Wi-Fi adapter is necessary in order to communicate any Bluetooth device with the computer, that adapter can be integrated into the motherboard of the PC, or if not embedded, can be purchased separately.

After installing the Wi-Fi adapter on your computer, it is necessary to add the Fuz robot as a new Wi-Fi device, which requires turn it on and activate the Wi-Fi communication in the robot. Once ready the Fuz is necessary to go to Control Panel, Wi-Fi devices in the Devices tab and go to Add, which opens the window of the Wi-Fi Device Wizard, while been there activate My device is set up and ready to be found. Once the Fuz is detected it is necessary to select it, press the next option and choose a proper key (00964). At this step the communication between the PC and the Fuz is ready.

One of the most advantageous aspects in this type of communication implemented is that does not need to run any programs in the Fuz robot, but that all processing is done from the PC, which facilitates many things, from the possibility of wireless communication to the speed to perform complex calculations.

4.1 Configuration

To establish a successful communication between a PC and the Fuz-MAT using Mat lab, is necessary to have the right hardware as well as the correct installation and configuration of software in order to obtain good performance.

Considering that Mat lab allows programming Fuz-MAT robots using the Java programming language, the NetBeans software is used to allow creating Java applications in an efficient way, therefore it is of utmost importance setting NetBeans to program the Fuz-Mat lab. The Matlab communication protocol between PC and Fuz uses the libraries pccomm.jar and bluecove.jar, instead of classes.jar.
Now the environment is ready to write and compile, from the computer, the application for the Fuz-MAT. It is important that within the project code the libraries are imported:

lejos.nxt.*,
lejos.pc.comm.* and
lejos.nxt.remote.MATCommand.

4.2 Security System Application

When running the implementation of the security system the first thing done is the connection between the Fuz-MAT and the computer. In the absence of any connection is sent a connection failed message and the application ends. These connection failures could occur for several reasons, among which are: not having enabled the Wi-Fi, because the Fuz robot is off, not having added the Fuz robot as a Wi-Fi device in the PC, Wi-Fi failures in the Fuz or the computer, among others.

If the connection is successful, the application continues to open a menu which shows the instruction sheet or the options so that a user takes responsibility for handling the movement of the Fuz-MAT from the keyboard, for its navigation. The menu screen shown in Figure 1.

Fig 1. Main menu.

When a valid character of the system is pressed, the associated action is performed immediately and then continues with the previous action that was running before the character was pressed, i.e. if the robot was moving backward when the 'B' key was pressed, then the robot monitors and after that continues moving backward.

To utilize the keyboard the function "key Pressed (Key Event)" is used, that function returns a different value for each character of the keyboard, so the pressed key can be compared with those indicated in the menu, in order to perform some action on the Fuz-MAT. It is important to note that even pressing the key once the key Pressed function takes its corresponding value immediately, i.e., if a character is left pressed for a given time Key press takes the same value repeatedly, which causes that the Fuz-MAT robot gets confused and not do some action, that it does not accept any other option until the number of times the same value was taken finalize, or that the program cycles and therefore be required to be canceled and re-run the application from the start.

4.3 Implemented Algorithm

Pressing the 'B' key the action of monitoring is performed in which the robot is ordered to take measurements from its ultrasonic sensor and make comparisons between those measurements to determine whether there is or not any movement in its environment.

Pseudo code for the monitoring action:

Activate the ultrasonic sensor:

DO

Capturingdistancia1
DO
Capturingdistancia2
If
distancia1 ≠ distancia2
Send alarm to the PC WHILE time <3 sec
WHILE spin < 360º
Deactivate the ultrasonic sensor

The ultrasonic sensor of the robot is activated only when it is wanted to monitor and is deactivated on completing the task.

Monitoring starts at the point where the robot is when the monitoring order is received, the first distance measurement is keep and compared with the following distance measurements. The comparison of measurements is made for five seconds and if exists inconsistency in the distance measurements, a warning signal is sent to the computer, indicating that there are suspicions of insecurity.

If three seconds has elapsed and the distance measurements obtained are the same, the security system assumes that everything is in order, rotates 45 degrees, resets its measurement of distances and takes its new values according to the current position, in order to continue with the comparison. The monitoring ends when 360 degrees are accomplished, i.e., until returning to the place where the process started. Ultrasonic Sensor class has several methods that help to take distance measurements accurately. The method used in this research is "int Get Distance ()", which calculates and returns the distance in centimeters to the nearest object. The maximum value is 350 cm, but often returns this value as error.

The Fuz-MAT ultrasonic sensor has a delay, it means, the first actual distance in which it is currently takes a certain time to be captured by the sensor and sent to the computer,

until it has captured the actual distance, the value taken as distance is 255. To give a solution to this error in this project a timeout has been included in the algorithm to skip the first values until a certain time has passed, in this case wait one second, and then take the first real distance. For several tests it was found that for measurements in the range of one second, there are a wrong value, that is the reason why we chose to take as the first distance the one that is found after one second. After one second the measured distances are reliable.

To send an alarm signal to the computer, the implemented algorithm performs comparisons between the taken distances, which must meet:

1. The current distance is different from the first distance.
2. The difference between the actual distance and the first distance is greater than 3 centimeters.

It was chosen a difference greater than 3 centimeters because of the precision limitations of the Fuz-MAT ultrasonic sensor.

4.4 Autonomous Navigation

The autonomous navigation sets aside the manual manipulation of the Fuz-MAT robot, consists of executing a routine to allow the robot to navigate its environment randomly according to the requirements of the surrounding environment. In circumstances such as obstacles the robot avoids them performing a rotation to another place to continue navigating.

The monitoring action is also randomly activated, that means it is never known when the robot will monitor the environment, since can be done consecutively as well as to wait a certain time to do it again, this was decided so for greater security.

4.5 Fuz-MAT design

The Fuz-MAT robot design has been made taking into account two important points that make a good security system such as agility and discretion. Built design is shown in Figure 2.

Fig 2. Fuz-MAT robot design.

It was opted for a design whose movement is achieved with 3 wheels as this allows greater ease and agility to navigate their environment, streamlining the mobility and speed of the Fuz-MAT robot. The size of the Fuz-MAT robot is designed as small as possible in order to make a security system at least suspect and should be mentioned that the size is a contributing factor in the success of a good security system.

For a good introduction to the Fuz-MAT robot design is to avoid excessive unnecessary parts such as sensors and motors which may contribute to the design class but also affect the size of the robot.

4.6 Webcam Utility

It has been designed a foundation on which sits the webcam, which consists in accommodate the camera on an engine that will be rotating constantly to see the place where the Fuz-MAT robot is in order to control it with the computer, considering the characteristics of its surrounding. This is very useful when the Fuz-MAT is going to places where users can no longer observe the surroundings of the Fuz robot, if the camera is installed in that place, which the user cannot see, this will allow seeing the current position of the Fuz-MAT and thus make a good handling on the Fuz-MAT robot.

5. Tests and Results

After having completed the development stage of the Fuz-MAT robot, for the security system, various tests were made in order to get reliable statistics and see how this project turns out to be as a security system. The tests performed were the following:

5.1 Handling of the Fuz-MAT robot.

The first phase of this test was performed within the same room, i.e. the room where the computer was installed, for handling the security system, was the same place on which it was wanted the robot to surfs. As a result of this first phase it was obtained proof that all instructions told to the robot from the computer such as rotate clockwise, move backwards, monitoring, etc. were performed instantly and satisfactorily, therefore we can deduce that the manual handling of the security system is 100% reliable when the robot is controlled remotely in the same place where is navigating.

In the second and final phase of this test was wanted to get the results of the security system reactions when receives the orders given from the computer while it is located in another area in order to draw conclusions on how to intervene obstacles such as walls, windows, crystals, etc. about communication between the computer and the robot. For this, the computer, which controls the robot, was installed in a room disconnected of those wanted to be navigated. On the start of the test satisfactory results were obtained, i.e. the security system performed the given instructions instantly even when the communication between it and the computer was interrupted by concrete walls, however as the robot was introduced into other rooms, which means greater distance and more obstacles for the communication, the instructions were carried out after a short period after these were given by the user. Thus as a result of this final test phase it was concluded that the success of manual handling is shrinking as the robot is going away and being interrupted by obstacles which affect the communication established between the system and the computer.

5.2 Autonomous mode of the Security System.

In order to test the autonomous operation of the security system it was necessary to position the robot at any point of a room. Once positioned the program was executed so that it can start its work. The results were as follows: the robot randomly monitored and when an obstacle was detected it was avoided by rotating to other direction, i.e. all the tasks to be undertaken by the security system were met but were not satisfactory because the robot was instructed to if it detects an obstacle at 15 cm it should rotate the other direction to avoid colliding with the obstacle, but was found that only 10% of times the obstacles detected at 15 cm were avoided and the other 90% remaining it collided with the obstacle and after a certain time, being over the obstacle, the robot rotates in another direction. It is therefore concluded that the security system in autonomous mode does not result to be effective because it collides with other objects resulting in a bad navigation.

5.3 Controlling of the Security System.

For monitoring tests a person was posing as a thief who enters the room, where is the robot, and performs various movements in order to avoid detection by the security system. Three scenes were simulated: (i) The thief enters the room when you are just monitoring the robot. The results were satisfactory, because 95% identified the person and sent an alarm signal to the computer. (ii)Being the thief in the room, he moves slowly to avoid detection by the security system. The results were 100% satisfactory, i.e. every time the test was conducted the security system sent a warning signal to the computer. (iii)Being the thief in the room, he moves quickly to avoid detection by the security system. The results were the following: 75% of the times the faster thief was spotted by the security system by sending the alarm signal to the computer and the remaining 25% was not detected.
Taking a general result of these 3 scenes was obtained that the monitoring of the safety system responds successfully as long as the movements are not too fast, are in the direction in which the system is monitoring, and are in range of the ultrasonic sensor of the Fuz-MAT, in this case at most 350 cm.

6. Conclusions

A limited set of resources for the project in this paper has allowed to demonstrate in a short time that the implementation of robotic platforms in security systems can be a good choice because in spite of their few chances, against other platforms that can offer more possibilities, was demonstrated that it is 85% reliable, according to the cases that were performed in the tests, which means that if this work were carried out with higher technology resources it could reach 95%. All non-favorable cases obtained in tests of this project were due to limitations of the technology used such as the limitations of Bluetooth causing communication being lost as the distances grow far.

The project results allow us to conclude that the implementation of a good algorithm for robotic platforms is to be a major contributing factor in the success of these. Also worth mentioning that alternative programming languages which allow high-level coding to develop such robots are quite users friendly making it save time and effort when designing, implementing and program an algorithm. It follows that the cost of learning a programming language for robotic platforms is very low and with high efficiency.

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