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Smart System of Firefighting Based on IoT for Smart Cities

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Abstract*—Early detection of the fire which produces a rapid action is essential in any firefighting system. A suggested smart system based on Internet of things is presented. Arduino Mega 2560 with the flame sensors is the core of the proposed system to detect the fire. The entire city is monitored remotely via the Internet by the smart center of firefighting, which is distributed in various locations. DeviceBit and Blynk platforms have been used for monitoring and sending notification immediately with the fire location to the smart center of firefighting. The proposed system is designed and implemented to be flexible, efficient with low cost to be practical and applicable.

***Index Terms*— IoT, Embedded system, Arduino Mega 2560, Device Bit Platform, Blynk Platform, Ethernet Shield, CC3000 Wi-Fi Shield.**

I. INTRODUCTION

The early detection of fire could save people and building and reduce the losses as much as possible; in addition, primary procedures might be taken in the fire place until the arriving of the firemen to the place of fire. Perhaps a small act can prevent major disasters, fire often occurs in different places of the city, such as houses, factories, commercial complexes, hospitals and other public places, so there has been an urgent need to propose a smart system of firefighting in cities based on internet of things. The first appearance of the term internet of things was in 1999 by the British scientist Kevin Ashton [1]. It means the new generation of the internet, so that all things in our lives can be connected to the internet, and thus will have the ability to communicate and interact with each other to send and receive data to perform specific functions through the network [2]. The rapid development in the field of information technology and communications makes the connection of anything and from any place and at any time (Anything, Anytime, Anywhere - AAA) with other things connected to the internet is possible [3], the concept of the internet of things is removing the boundaries and assist people who want to connect and interact with objects around them from the constraints of time and space. According to

CISCO, it is estimated that 50 billion devices will be connected to the internet by 2020, the number of devices will exceeded the population of the globe [4]. Internet of things is a new technology, which might be suitable in the firefighting applications, because IoT has high degree of smart, high scalability, high resource sharing capabilities and other characteristics [5]. The proposed system has the ability to deal with the fire event as soon as getting the data to reduce the damage caused by the fire, which may not only be material losses, but may be even worse to be the losses of life. The smart firefighting center will take necessary procedures and actions in the case of fire by sending directly the firemen to the place where the fire occurred. This produces fast response which prevents spreading the fire. Indirect benefit of the smart firefighting system is reducing the air pollution by smoke that caused by fire, which lead to thermal pollution, especially if the fire is large. The paper is organized as follows. In Section II, the system design is presented showing and describing the main electronic components that have been used in this paper. Section III describes the results and the discussions for the experiments that have been conducted. Finally, in section IV we draw conclusions and discuss the direction of future work.

II. SYSTEM DESIGN

The proposed firefighting smart system based on IoT is presented in this paper and including two parts: the first part is the location of the fire, which represents a smart environment that can detect the fire immediately via the use of flame sensor, figure (1) shows the sensor that is used [6].

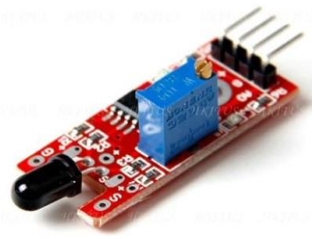

Fig 1: Flame Sensor [6]

The flame sensor is connected to the Arduino Mega 2560, which is an open source device with an open source development environment, programming is done in C language and interfacing is quite easy using arduino since manufacturer itself has tested arduino by interfacing it with large range of communication modules [7], figure (2) shows the development board that is used [6]. At the moment of the fire happens in any place in the city, the smart center of firefighting will be informed immediately with the location of the fire. Procedures and preliminary work will be done to combat the fire, the alarm bell will ring inside and outside the building to alert the people in the building to evacuate the place immediately and to inform those around the building in order to provide assistance, there will be also a number of LEDs installed inside and outside the building, these LEDs

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will be flashed when the fire occurs, they will serve as a visual warning for the deaf and dumb people.

Fig 2: Arduino Mega 2560 Board [6]

In addition, the automatic fire extinguishing system will be operated automatically (water sprinklers that will operated automatically). The external doors of the building will be opened automatically. One of the requirements of the proposed system is to have a large central screen installed in the maintenance and control room of each building to present the addresses of all the places of the building which may be (residential building, commercial complex, hospital, parking, hotel, residential complex, etc.), if a fire occurs in one of the apartments belonging to one of the residential buildings, the central screen will display the number of the floor and apartment, where the fire occurred, this will save the time needed for the maintenance and control staff. The longer delay in the response to the event, the less chance to control it and prevent it from spreading, determining the location of the fire in the building at the moment of its occurrence will enable the staff of the maintenance and control room to provide immediate assistance to the people in the apartment where the fire occurred and work to extinguish the fire with the available fire extinguishers that must be available in each building. This should be easily accessible, this is considered as important issue of the public safety procedure, if the fire is combated or the fire did not take place, the phrase "You are Safe", will be displayed on the central screen, figure (3) shows that.

Fig 3: The Central Screen

The components of the proposed system are connect through wire to the internet via an Ethernet cable (RJ45) by connecting the Ethernet Shield (W5100) to the arduino board, or the proposed system is connected wirelessly to the internet using Wi-Fi technology, this is achieved by connecting the CC3000 Wi-Fi Shield with arduino. The second part of the proposed system is the smart center of firefighting, which includes several units, including the control unit, that is responsible of monitoring the area which is within the responsibility of the center, if the smart environment that the fire occurred it, connected to the Internet via wired, then the Device Bit platform will be used for monitoring through the computer or smart phone, if the smart environment is connected to the internet wirelessly, the Blynk platform will be used for monitoring via smart phones, figure (4) illustrate the parts of the proposed system.

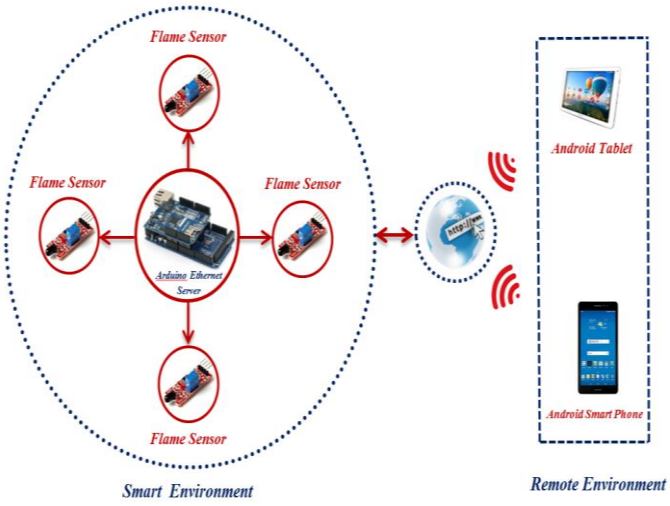

Fig 4: The parts of the proposed system

At the moment of a fire occurred in somewhere, the proposed system will send immediately a notification to the smart center of firefighting. These notifications could be sent as short message or emails, one to the center's email, and the other will be sent to the person's email that responsible of the place where the fire happened. The staff of the monitor unit in the center can recognize through notifications and emails, the full address of the location of the fire which lead to immediate actions by sending the nearest firefighting team. This will make it easier for the firemen to perform their task and thus reduce the wasted time to minimum. The time to response and identifying the exact location of the fire are the main factors that must be taken into account in the subject of firefighting. This will reduce the material and human losses that resulting from the fire. The full address of the place which the fire occurred is presented in the following format: (quarter number - street number - building number, house number or place number). The number of smart centers of firefighting in the city will depend on the geographical area; it is natural that the number of centers will be increased in the big cities. Figure (5) shows the real parts of the proposed system which have already been linked for observing four different places of the city.

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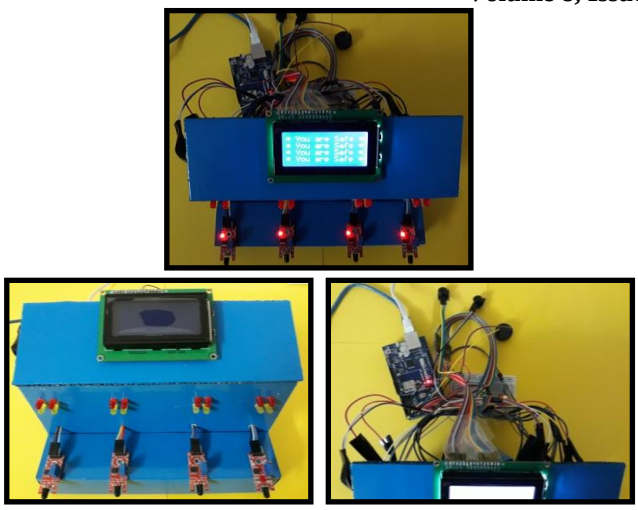

Fig 5: Real connection for the proposed system

III. RESULTS AND DISCUSSION

The proposed smart system of firefighting in this paper uses two platforms for monitoring on the internet to detect places of a fire in the city, one of them is the Blynk platform, and it is an application installed on the smart phone. The whole city is monitored over the internet through the application installed on the smart phone, a fire can be detected somewhere in the city through the application. In the application, each place in the city will have a scale, the name of the scale will represent the full address of the place, if the color of the scale is red, it indicates that the fire occurred in that place of the city and the reading of the scale will be equal to (1), in the absence of a fire in the place, the color of the scale will be green and the scale reading will be equal to (0). This information will be saved in the smart firefighting center for further analysis. Figure (6 a, b) shows the results obtained.

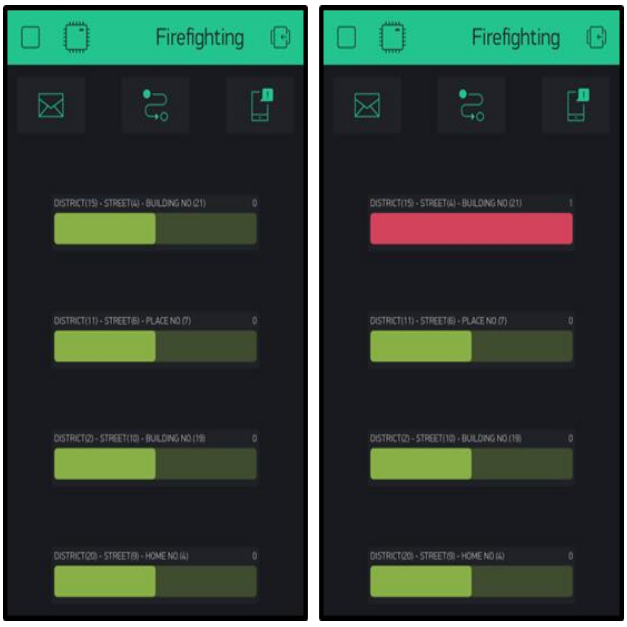

Fig 6a, b: Results on Blank platform

When the fire occurs somewhere in the city, the proposed system will send notification to the smart phone of the fire monitor Unit's staff to notify them of a fire in the place called, for example (District (2) -Street (10) - Building No (19) in addition to determine the precise location of the building where the fire occurred, figure (7) shows this.

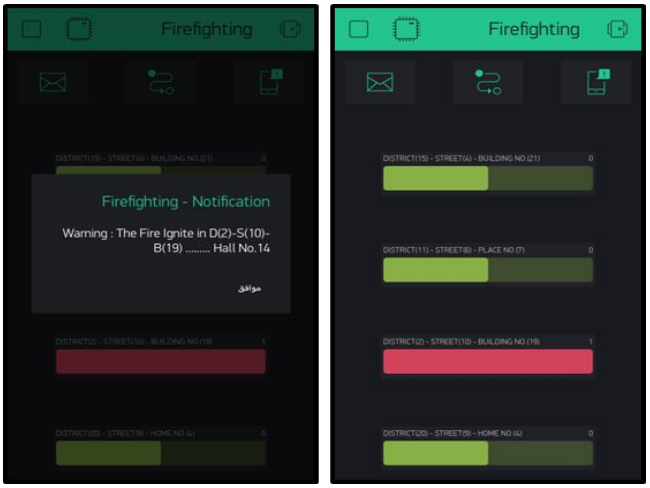

Fig 7: Fire in District (2) -Street (10) -Building No. (19)

The proposed system will also send an email to the firefighting center, this email represents a warning message and a notification of fire, and in addition, it will be considered as a temporary archive of the center. This email will be documented based on the addresses of the places that the fire occurred, in addition to the date and time of the fire, this information will be used later to find out the most places vulnerable to fire for identifying the causes behind the repeated incidents of fire in these places. The email will be sent to the responsible person of the place where the fire happened, the content of the message includes the exact address of the place where the fire took place and in which part of the building specifically. This is necessary, because a person might be responsible for two different places, for example, a home owner and an engineering office. Figure (8) shows the two emails.

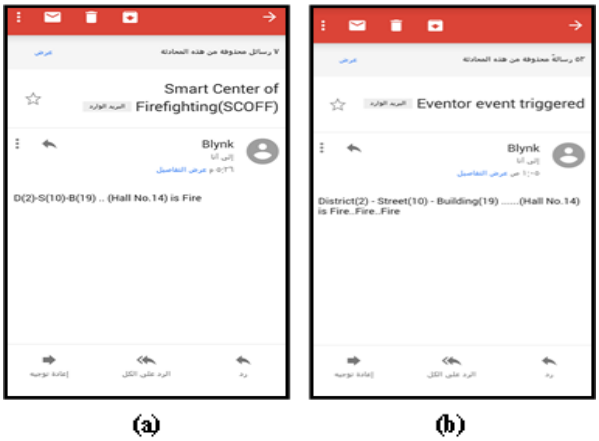

Fig 8a, b: Sending email to the smart center and to the person responsible of the place

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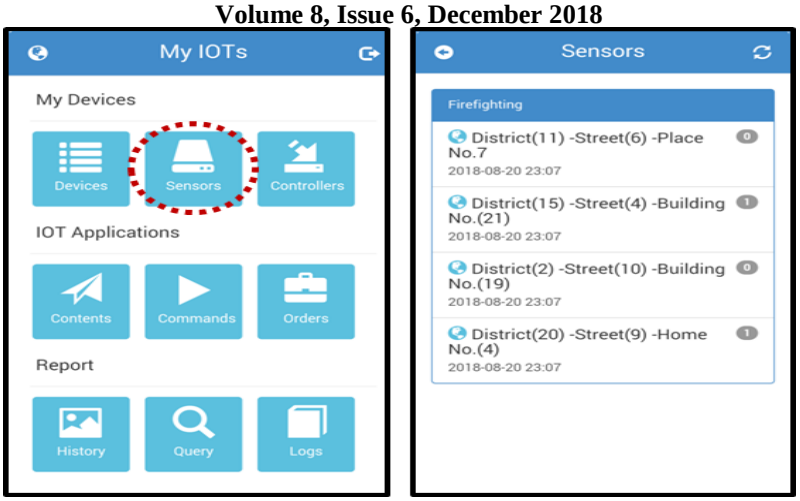

Fig 9a,b: Results on Device Bit platform on mobile phone

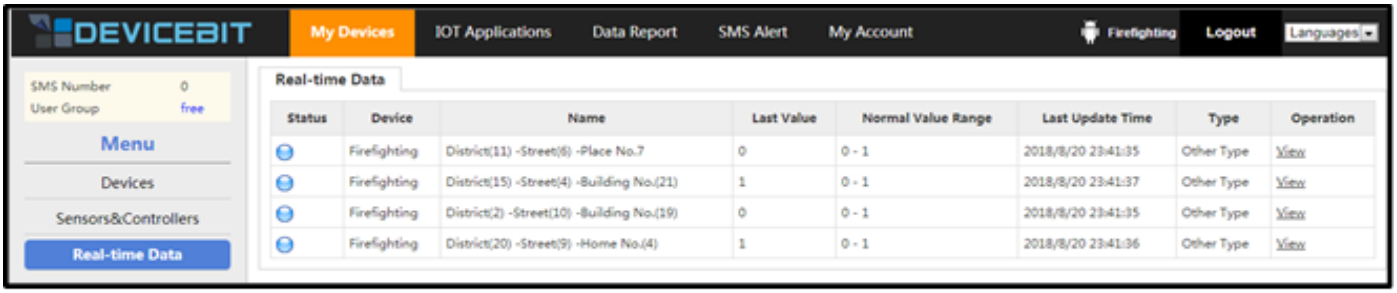

Fig 10: Results on DeviceBit platform on PC

IV.CONCLUSION

The proposed smart firefighting system in this paper is flexible, efficient, and low cost and can be applied to cities using simple tools. This system allows the possibility of monitoring the whole city through the internet and has the ability to detect the fire places in the city in real time. Immediate response to the event can be provided to take series primary procedures at the scene of the fire. This system provides the information to the firemen to respond quickly and controlling the fire which prevent it from spreading. This will prevent the significant losses of life and property; reduces air pollution from the smoke that resulting from the fire and eventually keep the environment clean. The proposed system will overcome the problems of the traditional firefighting system including the late response. Future work may include adding more to the system such as monitoring the traffic to give directions to the firefighting to reach the fire place quicker.

The other platform used is Device Bit; it is used for monitoring through the web page that can be displayed on computer screen or smart phone screen. The detection of the fire location could be through the web page, if a fire occurs in the place, the value (1) appears beside the name of the exact place that the fire happened, otherwise the value (0) will be appeared, figures (9,10) show the results obtained.

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