2017 International Conference on Communication, Control, Computing and Electronics Engineering (ICCCCEE), Khartoum, Sudan

Design of a Positioning and Tracking System for Paratroops Team

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***Abstract*— In today's world, wireless communication became the master use in any technology that need transferring of data between devices in far distant places. The problems of paratrooper when they reach the land they are scattered and can't find each other's position quickly. Sometimes paratroops don't find their equipment that is thrown from the plane to the ground. The main objective of this study is to overcome these problems. In this work every paratrooper must carry a mobile device. The methodology includes three steps first, receiving the position of the paratrooper from Global Positioning System (GPS), second displaying the position in the Liquid Crystal Display (LCD) and then send it to the main paratrooper through X-bee wirelessly, third the main paratrooper sends all these data to the central computer located in afar place from all paratroops. The central computer monitoring the paratrooper team's positions in the map continuously while they are moving. The design helps in minimizing the information gathering time, reduce the information transfer time between paratroops and increases safety in the land. In addition to that the new device is less weight and circuit complexity. The study recommends further more analysis and design features added in addition to improve the security using encryption techniques to this positioning and tracking system using Nano circuitry so that the whole device to be in a size of hand watch or less.**

Keywords*— paratrooper; GPS; LCD; X-bee; GUI; Actual Map

I. INTRODUCTION

Wireless communication is the transfer of information between two or more points that are not connected by an electrical conductor. Today wireless communication become the master use in most applications to make two or more devices communicate, for example in team tracking devices, the devices need to communicate remotely with each other. Team tracking here means knowing the position of every group member who are in a far place from each other. The tracking today is going to the direction of military and security service especially for the paratroops team, those who travel in different place in the world and need tracking system to help them, the tracking system using GPS technology. GPS is a very simple and efficient way for navigation, positioning and tracking. This system is designed to provide information about location based services. The presented GPS based hand held terminal is designed using hardware components like microcontroller and GPS receiver. This handy device can be carry anywhere there is no need to connect it to Personal Computer (PC) all the time for tracking. The main feature of this navigation system is its ease of use along with the compact size and visual display of results using PC and LCD display. The GPS protocol GPGGA its format captured by the GPS receiver for providing exact location as in [1].

II. RELATED WORK

Many researchers have recognized the use of GPS for navigation and tracking applications. Some studies present how to design a vehicle tracking system which combines the installation of an electronic device in a vehicle with designed android application to track the vehicle's location. The purpose of the device is to gathering the data from field and deliverer's it to server from where it fetched by Android application and the vehicle real time position can be viewed on Google maps in Android application using internet as in [2].

Other research used the position detection and tracking by locating friends and family member's positions by using GPS and web technology. This system includes a mobile client, a repository, a web client and a map service. The mobile client is used to find position and send a Popup SMS to user when his/her friends or family members come around the user's area of direction, this position information can be sent to the server and the same information can be managed and viewed using the web client by other user as in [3].

On other hand using GPS with a Field Programmable Gate Array (FPGA) for location based services along with the emergency services for car black box. The sequence of the procedure is first, GPS receiver navigates position information. Then the LCD showing the position. After that, temperature sensor senses temperature. And moisture sensor senses humidity. After execution of desired software, the final result seen on online form as in [4].

Major of the previous studies in spite of their different purpose and used of GPS for monitoring, but these systems designed is not a collaborative system consist of several

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monitoring point (one in the main paratrooper and the other in the central unit) leads to increase safety if some paratroops lost.

III. Methodology

Team tracking design consists of three parts: central computer (central unit), paratrooper and main paratrooper unit. These three units are collaborative with each other, the main paratrooper is one paratrooper that communicates with the central unit and other paratroops as shown in Fig. 1.

A. Main Paratrooper

The function of the main paratrooper is to receive the coordinates of the reference point (the reference point is the position of place that all paratrooper will gather on it after reaching the land) through the X-bee from the central, and then the main paratrooper will send this point to other paratroops through the X-bee. Also this unit receives all coordinates from other paratroops, above of that it receives its current position of the paratrooper from the GPS device that attached with this device and display it on the LCD.

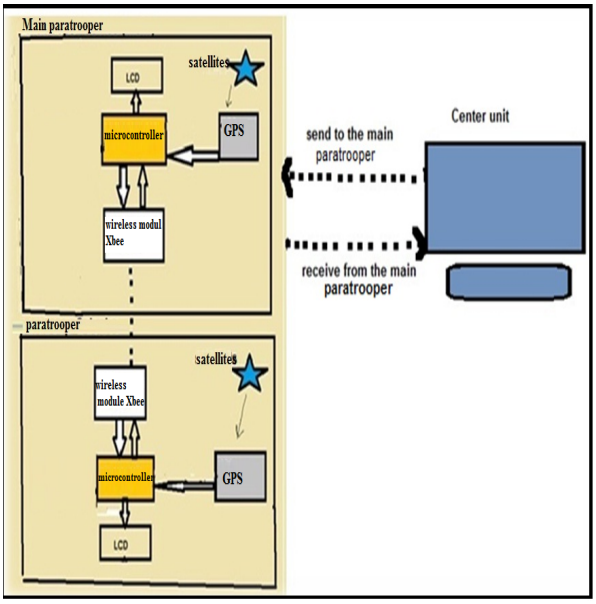

Fig. 1. System block diagram.

B. Paratroops

Every paratrooper must have a unique identification number identify him in paratroops team, this number is embedded in the mobile device that consist of a GPS, microcontroller and X-bee, in order to send his position to the main paratrooper continuously.

C. Central unit

This unit consist of commander of the team which monitor all paratroops via PC Graphical User Interface (GUI). The function of this unit first, he sends the reference point that all paratroops will gather on it when they reach the land second, monitor paratroops from far distance for more safety, as example if some paratroops get lost the commander of this unit will know his position. The reference point sends by the following procedure. Firstly, he sends the reference point to the main paratrooper. Secondly the main paratrooper sends this reference point to other paratroops on the same area.

The maximum distance considered in this study is 100 meters between paratroopers and 100 meters between main paratrooper and the central unit but in real life can be far distance, depending on the wireless distance used in the hardware design. Thirdly the central unit receive the positions of all paratroops from the main paratrooper while they are moving and displays their position on the map using desktop interface application. Fig. 2 represents the communication between the central unit and the main paratrooper.

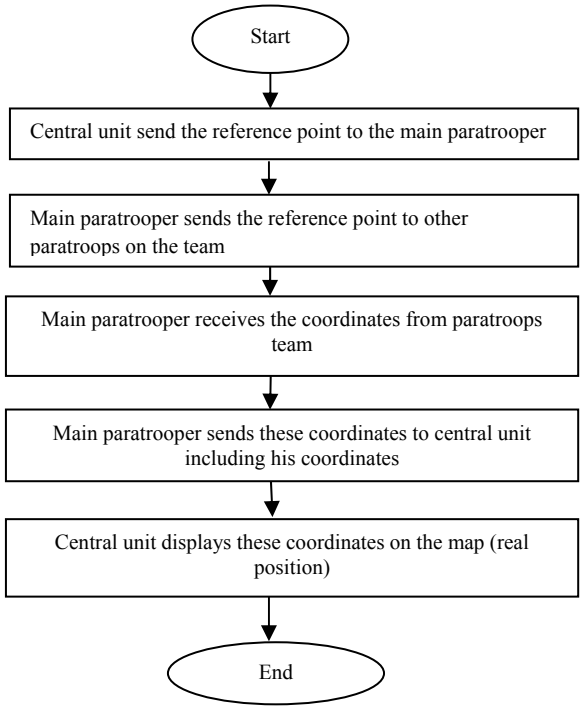

Fig. 2. Communication between the central unit and the main paratrooper.

Fig. 3 is the map used to represent the real positions of the paratroops. Table 1 describes the map items.

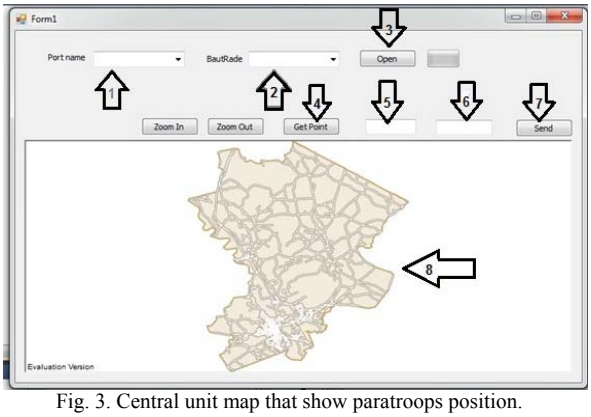

Fig. 3. Central unit map that show paratroops position.

TABLE I. DESCRIPTIONS OF PARATROOPS MAP ITEMS

Item	Description
1	Select the port number.
2	Select the Baud Rate that needed for transmission.
3	Open the ports.
4	This button when press, displays latitude and longitude of the selected reference point.
5	The Latitude of the selected reference point.
6	The Longitude of the selected reference point.
7	Sending the selected point to the main paratrooper
8	Map shows the position of all paratroops.

IV. SYSTEM DESIGN COMPONENT

There are two steps to implement the proposed system hardware design process and software designs process:

A. Hardware design process

To connect the paratroops team with each other there are multiple hardware component used for the main paratrooper and other paratroops: GPS, Microcontroller, LCD, and X-bee wireless. As shown in Fig. 4. And Table 2 describes the items of the hardware interface circuit of Fig. 4.

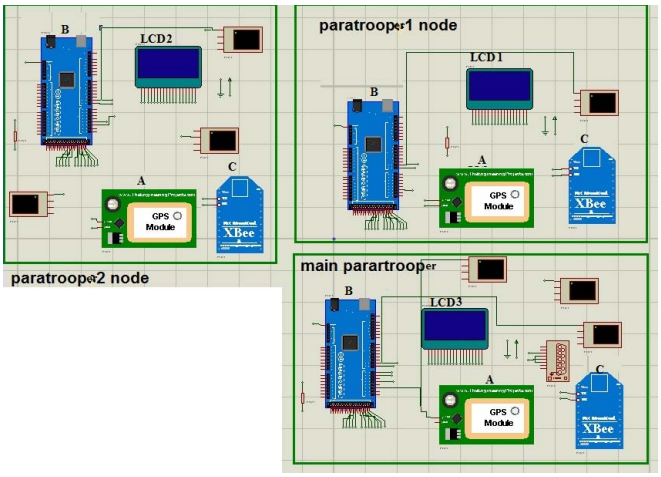

Fig. 4. Hardware interface circuit.

TABLE II. DESCRIPTION OF HARDWARE INTERFACE CIRCUIT

Item	Description
LCD1 & LCD2	Displays the communication data (his position and reference point) between main paratrooper and paratroops node 1 &2 simultaneously.
LCD3	Displays the communication data (his position, all position of paratroops and reference point) between main paratrooper and paratroops node 1 &2 simultaneously.
A	GPS that Determine the coordinate (position) for paratroops.
B	Arduino microcontroller that consist the code.
C	X-bee of main paratrooper and paratroops node communicate. X-bee S1 is used here with range 100 meter, so the simulation distance here is 100 meter between paratroops.

B. Software Design process

The software programs used to build and to simulate the hardware circuit for all paratrooper are Proteus and Arduino software. On other hand the software programs used to build the center unit is visual basic for GUI interface with a libraries called Actual Map downloaded and installed from the Internet and embedded in the visual basic language by importing the libraries in the program, as shown in Fig. 3.

V. SIMULATION RESULTS

When the system is simulated the system menu is displayed. The selected Baud Rate is 9600. Firstly, the commander selects the reference point for the paratroops and send it to the main paratrooper as shows in Fig. 5 and Fig. 6, Table 3 describes the menu items.

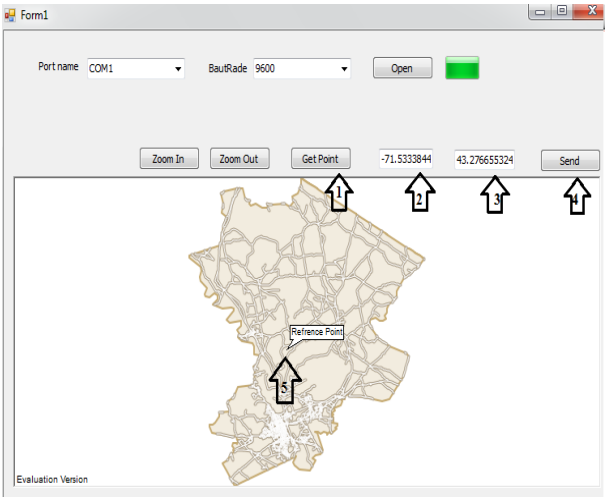

Fig. 5. Reference point for paratroops.

TABLE III. DESCRIPTION OF FIG.5 ITEMS

Item	Description
1	This button when press on it get the latitude and longitude of the selected point.
2	The Latitude of the selected reference point.
3	The Longitude of the selected point of the selected reference point.
4	This button sends the selected point to the main unit.
5	The reference point.

In Fig. 6 the Graphical LCD (GLCD) doesn't display the reference point because the errors in libraries of the origin Arduino software that deals with GLCD, instead of that it used Hyper Terminal program to display the reference point that commander sent it to all paratroops.

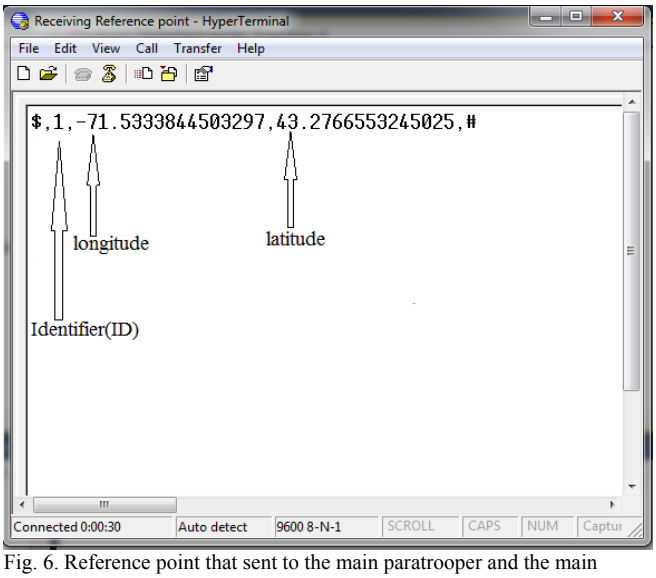

Fig. 6. Reference point that sent to the main paratrooper and the main paratrooper sent it to all paratroopers.

Secondly, paratrooper of node 1 and paratrooper node 2 send their positions to the main paratrooper. As shown in Fig. 7, 8, 9. And Table 4 describes the main paratrooper item after all positions received from other paratroops.

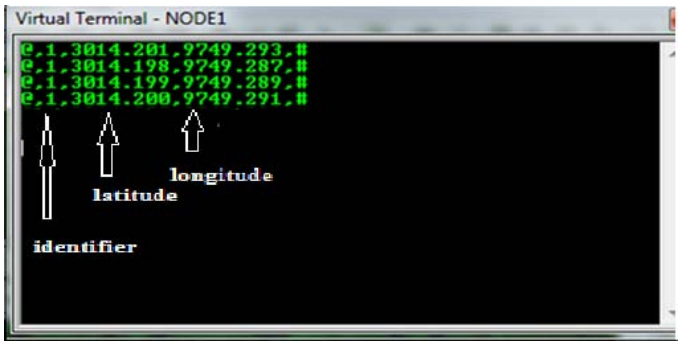

Fig. 7. Paratrooper node 1 on the LCD.

Fig. 8 display the position of the second paratrooper of node 2.

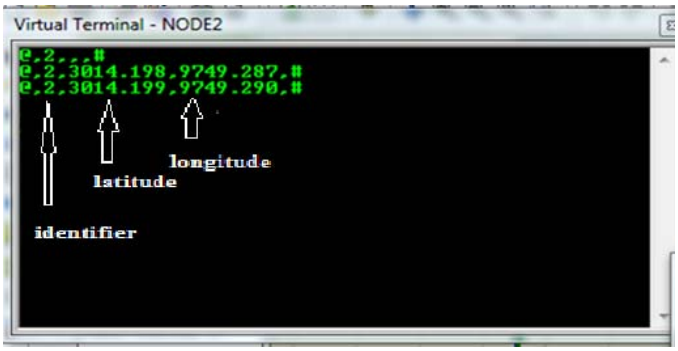

Fig. 8. Paratrooper node 2 on the LCD.

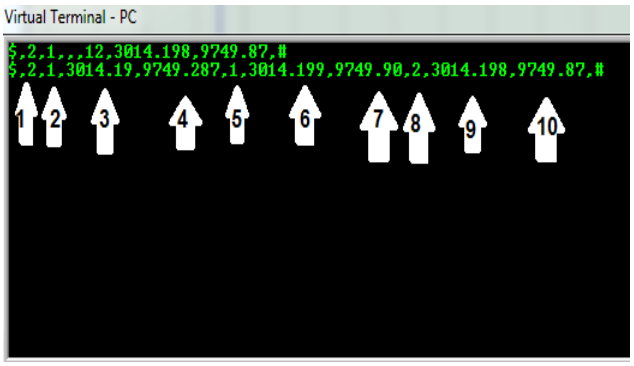

Fig. 9. Main paratrooper after all position received from other paratroops.

TABLE IV. DESCRIPTION OF THE MAIN PARATROOPER

Number	Description
1	Number of paratroops with the main
2	Identifier of main paratrooper node
3	The Latitude of main paratrooper
4	The Longitude of main paratrooper
5	Identifier of paratrooper1
6	The Latitude of paratrooper1
7	The Longitude of this paratrooper1
8	Identifier of paratrooper 2
9	The Latitude of paratrooper2
10	The Longitude of this paratrooper2

Fig. 10 demonstrate how the LCD will be look like in the main paratrooper device. The red point (1 & 2) represent the position of paratrooper node 1 and position of paratrooper node 2, the black point (m) represents the position of the main paratrooper and the blue point (R) is the reference point that all paratrooper will gathering on it.

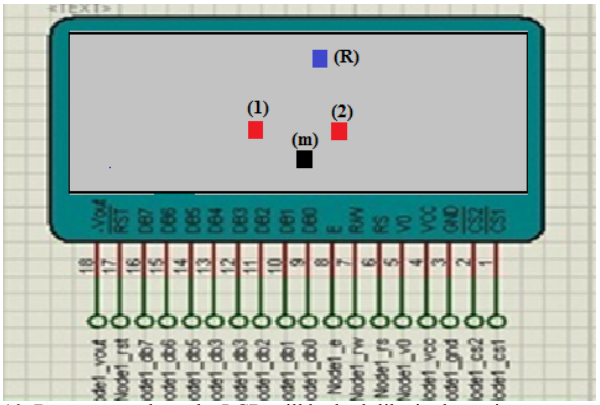

Fig. 10. Demonstrate how the LCD will be look like in the main paratrooper.

Fig. 11 and Fig. 12 demonstrate how the LCD will be look like in the paratrooper node 1 and paratrooper node 2 device respectively.

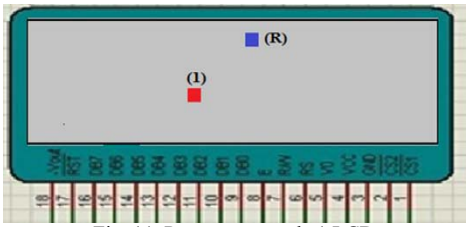

Fig. 11. Paratrooper node 1 LCD

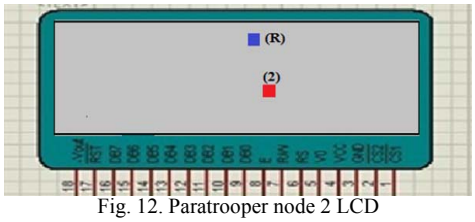

Fig. 12. Paratrooper node 2 LCD

Lastly the central unit display these positions on the map, as shown in Fig. 13.

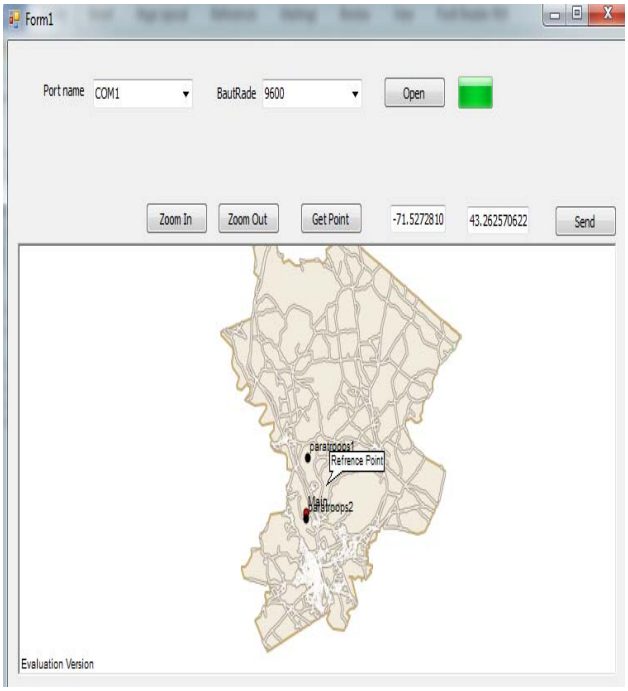

Fig. 13. Position of each paratrooper in the map.

Fig. 14 illustrates the main paratrooper, other paratroops and the reference point with more details after zoom in the map.

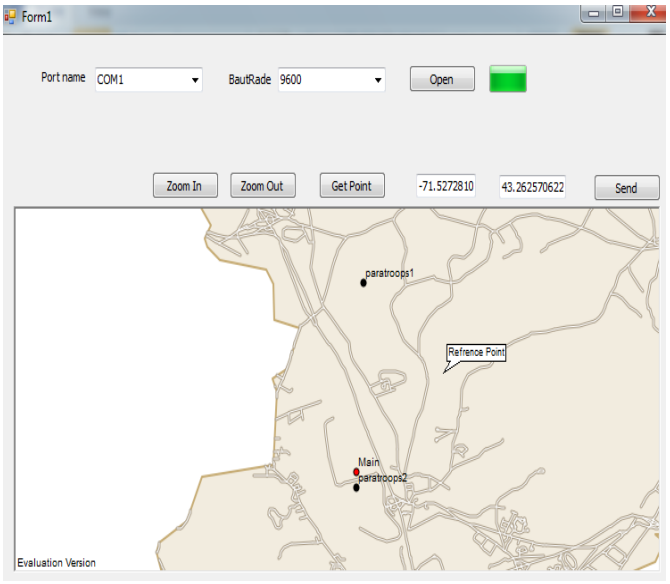

Fig. 14. Positions of all paratroops after "Zoom In".

VI. Conclusions

The positioning and tracking system designed in this paper reduce the information transfer time between the paratroops team. The system also improves the security in the war land because it sends text data instead of voice conversation. In addition to that the system designed has small size and less complex circuit. Finally, several monitoring points (one in the main paratrooper and the other in the central unit) leads to increase safety if some paratroops lost.

VII. Recommendation

The central unit map is in a very narrow range it recommends to be in a wide range like Google map. Moreover, recommends using encryptions and decryption techniques in communications between the units (paratroops and main paratrooper). Also the GLCD do not display the final position result in the simulation when it used with Arduino mega2560 because there are some problems in the libraries file, so it recommends suitable and advance one in hardware design. Finally, the distance between the paratroops them self and main paratrooper with the central unit depend on the wireless technology used so wide range of wireless is recommended.

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