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REAL-TIME TRAFFIC MANAGEMENT FOR EMERGENCY SERVICES

A. BRATU[1] M. CREŢU[1]

Abstract: *The efficiency and robustness increased after using embedded technology for monitoring and control applications. Due to traffic load, emergency vehicles such ambulances, police cars and fire trucks can get stuck or they are delayed in reaching their destination. The paper describes an intelligent and complex application that helps to clear traffic and to improve security while having fast response of the emergency services. By making use of embedded and internet we can develop an application to clear the traffic while coming in the path.*

Key words: *traffic, control application, embedded technology.*

1. Introduction

The fast response of the emergency services such as ambulances or fire fighters cars has become a challenging situation nowadays. Because of many reasons like lack of infrastructure, increasing number of cars or even chaotic driving the time until the ambulance reaches to the patient place is reduced a lot. Sometimes the ambulance gets stuck in traffic and those minutes can cost humans life. The present project is proposing an improvement of emergency services with final effect in saving humans life. The ambulance path it will be cleared in advance by using high technology. Presently the clearance of the heavy traffic is done using the siren of the ambulance or police cars.

There is a system called as “Intelligent traffic light controller”. Where traffic light intelligently decides based on the total traffic on all adjacent roads. This system can minimize long waiting time and gives the priority to ambulance, fire brigade, or V.I.P vehicles. The system can be used only in intersections which have installed the traffic lights. In this paper we propose a “traffic controller” that announces the drivers of all vehicles about nearby ambulances and prepares them for sidestep. Our system can work without traffic lights [4].

Basically, the main idea of the project is that the PC control sends an information signal to the driver, after the operator from call centre send a work order using the interface software. The data sent will contain the path, destination and the time to reach the final point. Then, from the PC control, a signal clearance will be send to the electronic boards on the way and traffic light control. One of the goals is to reset the timer to green signal whenever ambulance has in path which got the traffic load and making the opposite signal board to red signal. All the processes are controlled by the FPGA and software installed on the PC. Real Time Data acquisition from the sensors mounted on the roads

[1] Student at “Integrated Electronic and Communication Systems”, *Transilvania* University of Braşov.

will provide information which will help calculation algorithm for choosing the fastest and safest way to destination. This new technology combines the technology of embedded system and Internet of Things which can get the maximum benefits and saves many lives. Hardware implementation requires FPGA board, electronic display boards, GPS, GSM platform hubs and software includes algorithm for calculation route, for Internet of Things cloud servers and accessing points.

2. Design and Implementation

From design point of view the application is composed of two main parts: the embedded hardware components connected to the FPGA board and the software component (LabView) as illustrated in Figure 1. All hardware peripherals are sending or receiving signals through the FPGA, the brain of the application. The LabView represents the interface with the operator. The software from Smart Device represents the interface with the driver from ambulance.

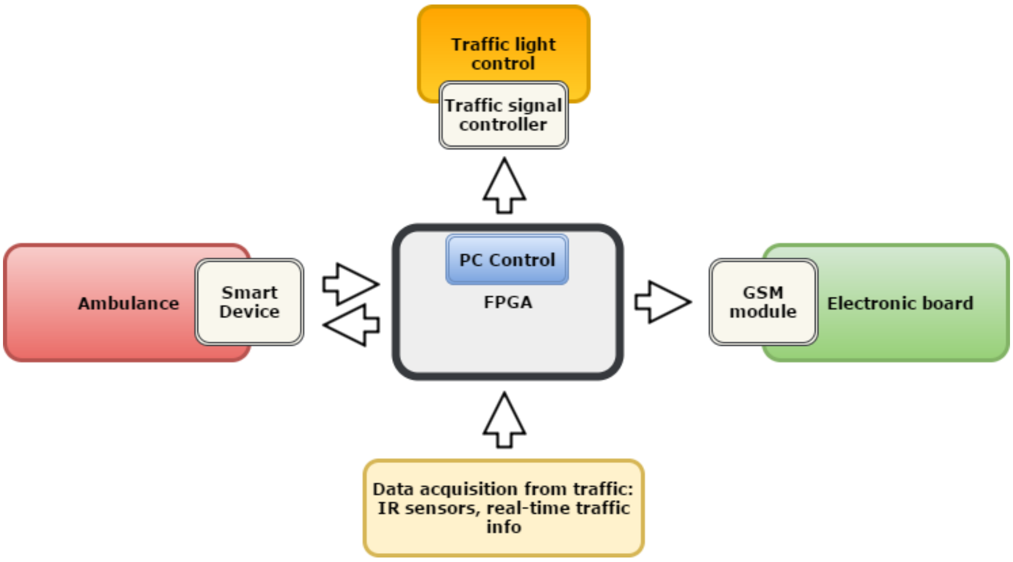

Fig. 1. *Application Design*

2.1. Hardware Application

Field programmable Gate Array (FPGA)

The core of the hardware application will be the FPGA board. Based on our requirements the most suitable is Atlys Spartan-6 Development Board. The Atlys circuit board is a complete, ready-to-use digital circuit development platform based on a Xilinx Spartan 6 LX45 FPGA. The on-board collection of high-end peripherals, including Gbit Ethernet, HDMI Video, 128Mbyte DDR2 memory array, audio and USB ports make the Atlys board an ideal host for complete digital systems built around embedded processors like Xilinx's MicroBlaze. Atlys is fully compatible with all Xilinx CAD tools, including ChipScope, EDK, and the free WebPack, so designs can be completed with no extra costs [11].

The Atlys board can be communicated with and programmed by the Digilent Adept software. In addition, the board can be programmed by Xilinx's iMPACT using the Digilent Plug-in for Xilinx Tools. The communication between FPGA and PC we have chosen to be over Ethernet because of its high-speed link for transferring data (Figure 2).

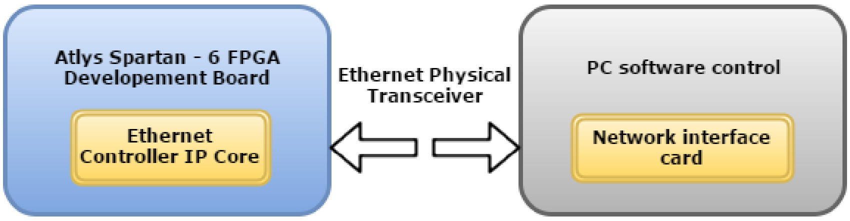

Fig. 2. *Communication FPGA-PC - general overview*

Real-time traffic information is one of the crucial components that affect traveler's decisions. By provision of effective traffic information, it is not only to assist travelers in making better route choice decisions but also increase the reliability in road networks. Particularly, in the event of traffic incidents, travelers can avoid traffic congestion, through consulting means of traffic advisory devices such as variable message signs, cellular phones or the internet, in accessing relevant traffic incident and route guidance information. It was found that the provision of real-time traffic information significantly affects the route switching behavior of drivers on expressways [3]. There are several technologies for real-time travel time data collection, such as automatic vehicle identification (AVI), automatic vehicle location, electronic license plate matching, video imaging and cellular phone tracking [8].

Wireless Sensor Networks (WSNs) allow for embedded sensors to be interconnected for observing and controlling consumer and industrial actions [7], [2]. The use of Vehicular Sensor Networks (VSNs) or infrastructure WSNs have been proved to be promising solutions for monitoring and management of traffic. WSNs are flexible in terms of and energy efficiency and data collection type, e.g., video [6]. If a vehicle contains a WSN node, then localization algorithms can be used to determine its location. The General Packet Radio Service (GPRS) technology canal so is used for the dynamic control of traffic signals [1].

Distance Based Emergency Vehicle Dispatching Algorithm

In order to achieve optimal traffic light control to provide clearance for any emergency vehicle and to shorten its travel time, we propose a distance-based emergency vehicle dispatching algorithm. We assumed only one emergency vehicle per direction. The proposed algorithm is represented in Figure 3. The EVs in the flowchart represent the emergency vehicles.

The proposed algorithms has mainly six steps:

1. The sensor senses the presence of emergency vehicles. The emergency vehicles are ambulances, fire trucks and police cars.
2. Calculate the distance between the emergency vehicle and the intersection.
3. The controller checks that the arriving emergency vehicles are at the same distance or not. If they are at the same distance, the controller randomly chooses the direction to set the green light. Else, he chooses the direction set in ascending order with the distance.

4. Determine the green light duration based on the measured distance values and send these values to the traffic lights.

5. Verify the passage of the emergency vehicle and measure the speed of the emergency vehicle and count the vehicles moving along with the emergency vehicle towards next intersection. The system sends the measured data to the next intersection.

6. The controller checks for the presence of the emergency vehicle. If no vehicle, then it resumes normal operation. Else, it continues repeats from step 2 to step 6.

We focused on visual sensing methods for determining green light sequences and green light duration. Distance measurement techniques help us to find the nearest emergency vehicle to the intersection and determine the green light sequence. Up to now, we have discussed in detail visual sensing methods to collect the emergency vehicle information. It is also important to talk about how fast the measured information is delivered to the TMC. For that we have investigated the Medium Access Control (MAC) layer in sensor networks to prioritize the emergency vehicle data and to reduce the transmission delay for emergency messages [5].

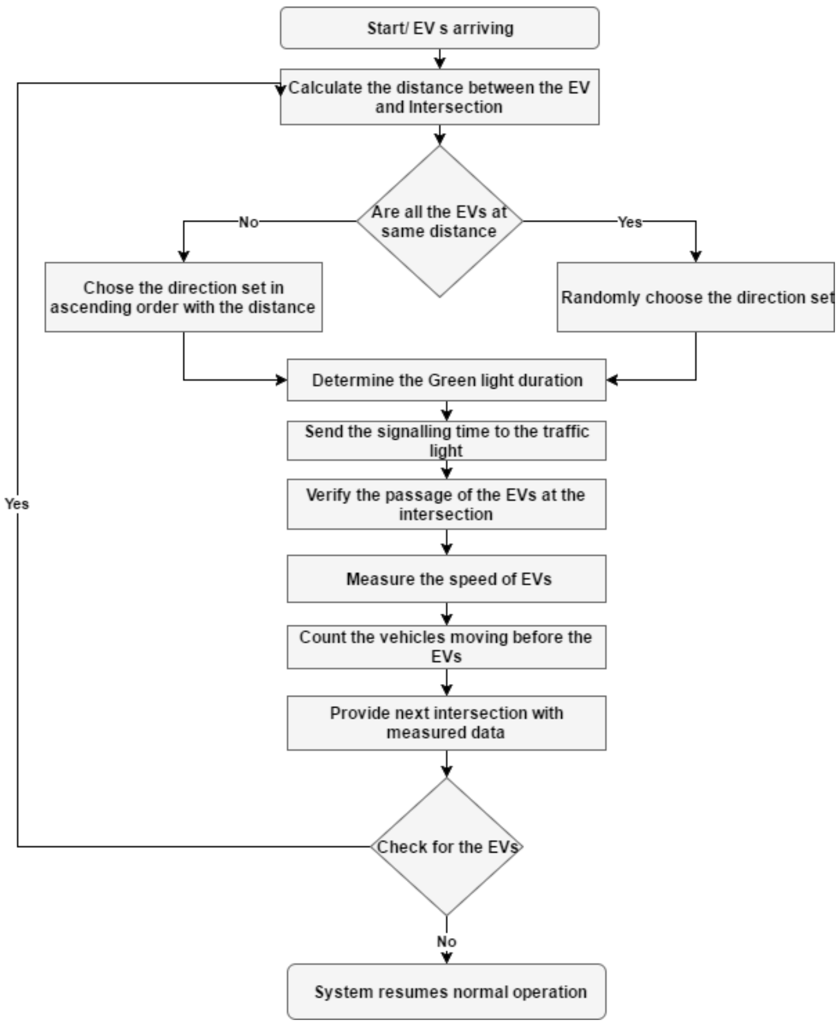

Fig. 3. *Distance-based emergency vehicle dispatching algorithm*

Wireless Electronic Board Using GSM

We know the importance of notice boards in public places like railway stations, bus stations and airports. In our application the message on the electronic display is considered to be one of the outputs from FPGA Board. After gathering and processing all the information from traffic on the electronic board will be displayed the warning message for clearing the path and elapsed time until the ambulance is in the area.

For interfacing GSM Module with FPGA board we make use of soft processors cores to send the messages straight from FPGA. The program is coded in C, cross compiled on PC and loaded to FPGA. GSM modem which is arranged at the display unit receives the message. Now the controller reads the message from the GSM modem and displays it on LCD.

The GSM module requires decoding command responses.

When user sends the message from the PC Control, GSM modem sends the bellow command serially to indicate that new message is received:

+CMTI: “SM”,3

In the above command number 3 indicates the location of the new message. Now you need to read this unread message to display on LCD. The command to read the message from GSM modem is:

at+cmgr=3

Here the number 3 indicates the location of the message to be read. After giving this command GSM module send the below command serially:

+CMGR: “REC UNREAD”,”MD-WAYSMS”„”13/05/20,15:31:48+34″

The circuit consists of 8051 controller, GSM module, Level converter and 16*2 LCD. LCD is connected to P1.0 and it is used to display message. GSM module is connected to controller through the max232 IC. Here it is used for level conversion. LCD is used in 4 bit mode. Means only 4 data lines are required to display the data. The controller logic levels and GSM module logic levels are different. Hence we use max 232 level converter as a mediator between Controller and GSM to transfer the data. In order to communicate with GSM we need to send some AT commands using serial communication (UART protocol). The GSM sim 300 module is used. This module requires 9600 baud rate. The following steps are performed successively after communication is established:

1. Initialize the LCD and UART protocol
2. Check for the command **+CMTI: “SM”,3 (Location number)** to know whether the new message is received or not
3. If you receive the command then store message location number.
4. Now read that particular location and extract the body of the message
5. Display the message on LCD [10].

GSM module

The GSM is a cellular network which means that cell phones connect to it by searching for the cells in the vicinity. The coverage area varies according to cells the mobile phones uses. The horizontal radius of the cell varies depending upon the height of the antenna and, gain of antenna and preoperational conditions from few hundred meters to several kilometers. 35 kilometers is the longest recorded distance for which the GSM supports. The network operates in number of different frequencies varying from few 900 MHz to 1800 MHz which is typically known as 2G. The transmission power is limited to a maximum of 2 W in GSM 850/900 and 1 W in GSM 1800/1900 [9].

3. Application Software

The software applications designed to run on a PC with a Windows operating system are:

- LabView application which implements the logic of FPGA and the user interface;
- C program that is the "core" of the LabView application.

The software application designed to run on Smart Devices with an Android operating system:

- Java application for Android that is running on the Smart Devices from the ambulance cars.

• LabView application

This application enforces the FPGA logic and calls the C code using Code Interface Node. The control application receives the data from the sensors through the acquisition board, the data is processed (C program) and displayed on the interface. The operator sends the commands using the interface. The data is sent through the digital output to the ambulance car.

• C program

This application is the "brain" of the LabView application. It gets the input values from the FPGA sensors as input parameters and calculates the optimal road.

Input values of the program:

- Coordinates of all ambulance cars
- Coordinate of the patient
- Traffic congestion for all possible roads

Returned values:

- The numbers of the first five ambulance car
- The optimal roads between each ambulance car and the patient
- The time to travel for each segment of the road

• Android application

One Smart Device is located in each ambulance car. The Smart Device has this application installed. The application is able to accept a request from FPGA that contains the optimal road with time for each segment of the road. The application communicates with the FPGA using Wireless.

The figure (Figure 4) below shows how a request from a patient is treated from the point of view of the software.

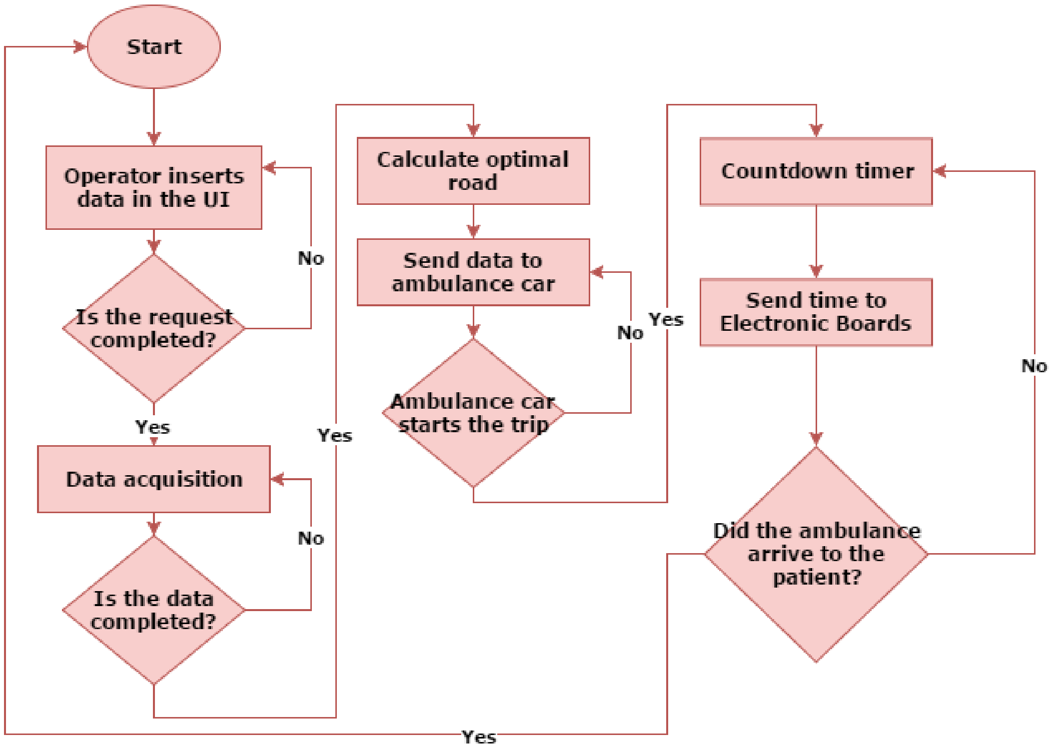

Fig. 4. *Flowchart of Software application*

4. Conclusions

The implementation requires hardware and software integration of the different components which basically needs adaptation in order to communicate and send/receive signals. With the help of the algorithms used, the response of the application for our purposes is achieved with high standards. Decision regarding which route to follow belongs exclusively to the system and the human intervention is very low. Real-time data acquisition from traffic offers a better overview of what is happening in the way of emergency vehicles and this helps to avoid accidents or congestion. The technologies of Internet of Things and embedded systems make possible that a complete automation in monitoring system from data detect to data transmission, and to intelligent decision-making.

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