Embedded Microcontroller using GPS as a Security Resource for Disabled People

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***Abstract*— This work presents an alternative tool to give support to disabled people for several situations. Based on an embedded microcontroller and using a common GPS antenna, this system allows people to be located at any place by his/her nurse or any people which be responsible of him/her. The system is hidden on the wheelchair in a strategic position. Saving in micro SD card all routes that has traveled, the system sends a message with current location on several operation modes. Coordinates can be sent each second if an alarm button has been activated. If user suffers an epilepsy episode, an alarm tone starts and a message is sent to his/her caretaker. If user got lost, coordinates are sent to his/her caretaker and a message is sent with a legend to ask for support and be located. This system allows disabled people to be more independent and be supervised in long distances, being sure that can receive support if something goes wrong.**

Keywords—Microcontroller; GPS; ARDUINO; epilepsy; wheelchair.

I. INTRODUCTION

Understanding the needs of disabled people, several systems have been designed to give them support, systems that contribute in some way to adapt and give facilities to this people. During last years, government and some institutions have been working hard to design every time, technologies with adaptive characteristics. It has been shown that disabled people work as hard as possible to come true their goals, even, more than people who have any kind of disability. With technologies that give them some kind of support, they are able to live in a better way, being more independent than disabled people which don't use technologies. This work represents an alternative use of microcontrollers and GPS antenna to give support to disabled people. This work pretends to motivate this people to live in a better way with no dependence on being always with someone else. This system has been thought to supervise several situations that disabled people could experiment, some of these situations can be supervised in long distances, others are critical situations that all people could experiment as abduction or an epilepsy episode, and this system try to prevent or solve in a good way.

As a clear example, there are several systems in the global market to give support to disabled people. One of those examples could be the system called HeadMouse, this system is a computer program that allows people to use the computer without the need for hand use (especially designed for people with physical disabilities in the hands or arms), as it controls the mouse by light and soft nods. For operation is required to install a quality webcam to the computer, no additional hardware required. As another example, is the system called abcSound, this one basically is a word processor (such as Word) with the variant that is speaking, so it is ideal for students with visual disabilities. The advantages are that people play the written text by voice synthesizer: by letter, line, or full text. The user can thus detect possible spelling mistakes you have and the correction of their expressions. It has different applications, but the most useful and advisable to use as the word processor only. Another alternative, although the software has not been created for it, is to read stories or lessons to children. Industry has applied one important sector to improve technologies and give this people an alternative to live more comfortable and feel free to trying as much fields as they want [1].

The idea of design this project, began with a research about technologies that can help disabled people, in specific people that need to use a wheelchair, and making a research about the prices of this kind of technologies. In the global market exist a large field of applications, some of them with a high cost and some other with a reasonable cost to acquire them, and of course, a really important interest to improve these technologies to give support to disabled people. Based on a combination of several projects that have been designed during last years, this project will improve some systems, and will reduce costs besides being a commercial system really easy to acquire.

Nowadays exist, in the global market, several systems to improve efficiency in traveling a wheelchair, systems that use pattern recognition, GPS/RFID, autonomous traveling capability, GPS to control wheelchairs, and some other systems to improve powered wheelchair for battery duration for long periods. This project will use a GPS system, an embedded systems with all instrumentation and control, and a SMS/GSM module, all in conjunction will build a complete system that allows disabled people to travel around alone with no necessary assistance or attendance, this project will allow to be almost independent and feel free to make things as a most of the people that doesn't use a wheelchair. One of the principal objectives of this project is to help Alzheimer's people, that need a wheelchair but they forget where they are? And who are they? With this system, people will feel free to travel around,

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and people in charge will feel comfortable to leave them alone, being sure that with GPS coordinates will find them at any place.

This work focuses on design a system to give disabled people the opportunity to travel and walk alone, with no directly a supervisor. Based on an embedded microcontroller and using a common GPS antenna, the system is hidden on the wheelchair in a strategic position. The main function is to alarm people who are in charge of them, about several situations, in this way; they will be supervised but not directly. People, who are in charge of disabled people, will receive a specific message depending on what situation is happening with the user. User will be able to select different buttons marked by issue. The system allows people in charge identify specific coordinates, places and times everywhere where disabled people are traveling, and with that main function, to be in contact with each other with greater security. People in charge will be able to meet with disabled people at any place, even if they lost visual contact with him/her.

II. METHODOLOGY

The system is based on ARDUINO UNO board, using a commercial GPS antenna SKYLAB model SKM53, a micro SD card module will be used to save the database, the information of coordinates and messages will be sent by a SMS/GSM module. The characteristics of ARDUINO UNO board are shown on table I [2].

TABLE I.

Microcontroller	**ATmega328**
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz

The system will start to function with a power button, and being hidden the complete system on the wheelchair. It counts with a rechargeable Li-Ion battery [3]. The system starts locating by GPS, and once it started to save coordinates, it will show a green LED to indicate that GPS is working. The wheelchair will counts with at least three different buttons which will be installed on strategic positions, depending on needs of user. Those buttons will indicate the scale of emergency or attendance. Primary button will send a message of high emergency. This emergency button will appear in the system as a red button, to indicate that is needed a high level of attendance. And will start sending coordinates each second, to indicate all positions and don't lose the position of the user, allowing people on charge to locate him/her immediately. A second button will indicate that user needs attendance. This second button will be an amber button, and it will indicate that the necessity of the attendance is medium level. And a different message will be sent to people in charge. Coordinates will be sent each 10 seconds, and a message each minute. The third button will be activate an alarm to indicate just attendance, a minor level alarm, This low level alarm will be indicated by a green button ,perhaps user just need to go to the restroom, or just to move to another place being helped. Then the message will indicate just attendance, and coordinates will be sent each 30 seconds.

The legend for each message will be customized by people in charge depending on user's needs. Perhaps some users need just two buttons; the system will be customized according to user's needs.

The complete system function is to be started by a power on button, this allow system to starting connecting with satellites. Once the system is connected with GPS, a green LED will turn on; it indicates that the system is working. A blue LED will start flashing, which indicates that the GPS is sending/receiving coordinates, and the user could be sure, even people in charge that user could travel such as independent people.

For people who suffer Alzheimer's, the system contains a module via SMS, where people in charge could send a message to ask for user's coordinates and the system will return coordinates. In this way, if user forgot to ask for attendance and his/her position, people in charge will be able to find him/her easily. This is one important contribution, due to the risk that this kind of people is facing day by day, due to disabilities.

III. RESULTS

Table II will show the format of how ARDUINO UNO obtains coordinates through GPS antenna. The format has been adapted for this application. For this system is just necessary to obtain latitude and longitude, as well as date and time. Fig. 1 and Fig. 2 show a reconstruction of a trajectory for different points, using just as an example for the correct reconstruction.

With this data, and supported by Google maps or Google Earth, the system will be able to make a reconstruction of the complete trajectory based on the coordinates and times that system is sending to the microSD card. At this point exist two variants to analyze data. The first one and the most important is to analyze data directly by people in charge, on his tablet, cell phone, personal computer and so on. This is helpful to find wheelchair's user at the moment or if need some kind of support, which is the main idea of the system. The other variant to analyze data, is with the microSD card that is receiving directly coordinates, saving these data on an excel file, and analyzing with commercial tools, as Google maps, Google Earth and so on. This second variant could help to analyze if the system needs to be improve about accuracy, or data sequencing with some kind of delay, or faster than the original timing.

Table II, shows in a simple format, how data will be sending/receiving to the microSD card. What the system will need to find user, are just latitude and longitude. But the system will save date and time, as well as Latitude and Longitude, and of course if some message will display asking for some kind of support.

TABLE II.

Date/Time	Latitude	Longitude
05/28/2013 14:26:37	20.57909	-101.21572
05/28/2013 14:26:38	20.57908	-101.21571
05/28/2013 14:26:39	20.57907	-101.21573
05/28/2013 14:26:40	20.57907	-101.21575
05/28/2013 14:26:41	20.57906	-101.21577
05/28/2013 14:26:43	20.57904	-101.21587
05/28/2013 14:26:44	20.57903	-101.2159
05/28/2013 14:26:45	20.57903	-101.21593
05/28/2013 14:26:46	20.57904	-101.21596
05/28/2013 14:26:47	20.57906	-101.21598
05/28/2013 14:26:48	20.57909	-101.216
05/28/2013 14:26:49	20.57912	-101.21603
05/28/2013 14:26:50	20.57916	-101.21608
05/28/2013 14:26:51	20.5792	-101.21615
05/28/2013 14:26:52	20.57924	-101.2162
05/28/2013 14:26:53	20.57927	-101.21624

Figure 1 shows a reconstruction of a trajectory using timing of one sample each two seconds. As well as speed average of 60 km/h in a vehicle. This figure shows high accuracy due to speed and sampling.

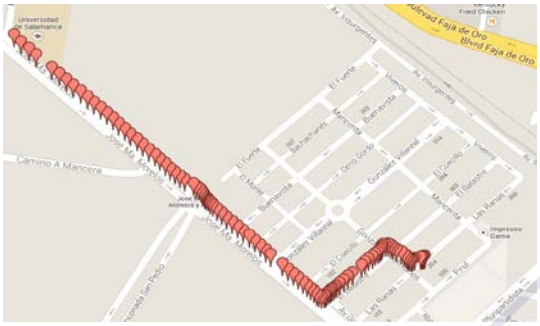

Fig. 1 Reconstruction of a route in different points walking.

Figure 2 shows a reconstruction of a trajectory using timing of one sample per second. As well as speed average of 80 km/h in a vehicle. This figure shows high accuracy due to speed and sampling.

Fig. 2 Reconstruction of a route driving a car.

The system shows high accuracy, as well as high speed response. A wheelchair will travel with low speed as this system was proved, for that reason data are reliable and acceptable. This methodology was based on a project designed by Jeremy Blum and shown by him on his blog; he is a recent graduate of Cornell University's College of Engineering, with both a Master's and Bachelor's degree in Electrical and Computer Engineering (ECE) [4], as well as several articles on the Internet designed all around the world by several engineers [5] [6] [7].

Based on the Jeremy's system, to obtain latitude, longitude and date and time, this system has been modified to work on ARDUINO UNO board, and with another commercial GPS module. As well as working with a SMS/GSM module to be able to be in contact in real time from user to people in charge or vice versa. Taking some ideas on several systems and designs on the global market, the purpose of this application of technology was found to help disabled people, designing some system to give some kind of support and let these people feel free to live in a better way, with comfort, safety and being independent. With a similar way to work, this system starts turning on a power on button. And the system will be saving data from the GPS module to the microSD card module; at the same time the system will be sending/receiving information into a SMS/GSM module to be in contact each other, disabled people and people in charge. Some of the configurations about this system are shown next.

A part of the source code is shown on Fig. 3 and Fig. 4, where is indicated how initialize GPS module, how data will be saved on the micro SD module respectively.

```
File dataFile;
int CS = 4;

unsigned long fix_age;
SoftwareSerial GPS(2,3);
TinyGPS gps;

void gpsdump(TinyGPS &gps);

bool feedgps();

void getGPS();
long lat, lon;
float LAT, LON;
```

Fig. 3 GPS module initialization.

```
long lat, lon;
float LAT, LON;

void setup()
{
 GPS.begin(9600);
 Serial.begin(115200);

 pinMode(CS, OUTPUT);

  if (!SD.begin(CS)) {
    Serial.println("initialization failed!");
    return;
  }
  Serial.println("initialization done.");
  Serial.print("Latitude");
   dataFile.println("Latitude : ");
  Serial.print(" ");
  Serial.print(" :: Longitude");
   dataFile.println(" :: Longitude : ");
  Serial.print(" ");
  Serial.print("Date: ");
  Serial.print(" ----- Time: ");
  Serial.print("\n");

}
```

Fig. 4 Main function to save data in micro SD module.

Next step for this system is to design the SMS/GSM module and proof sending messages from the system to people on his/her mobile. Besides that module, the system will contain a function on the microcontroller to show people if the user is having a bad time, as could be asking for help to people by emitting an audio message to indicate that he/her need to be attended immediately. It could be a useful function that prevents some kind of incident while people on charge take time to meet with him/her. Nowadays the system contains GPS module, and micro SD saving information module, as well as the power stage, all of them showing a successful function.

IV. CONCLUSIONS

This system has shown good efficiency, fast response, and has worked with high accuracy using commercial modules. Until this stage of the project all issues have been working according to the established goals. For future works, will be working on the compatibility of the system with smartphones to create a free app using this system, and thus contribute the community with some design for disabled people. Even the system is under design; it has shown good results at this stage.

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