Implementation of a global trailer tracking system using a microcontroller

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Abstract. This paper underlines the importance of goods transport and mostly, the importance of knowing at all times where the trailers and trucks of a fleet are, in order to manage the fleet properly. The authors have proposed a prototype that connects to the 24 volt power supply of the truck and charges the lithium rechargeable batteries. After disconnecting the trailer, the tracking prototype can be located via SMS on any national or international route, depending on the GSM mounted in the device. The proposed prototype will be tested further and several directions of improvement have been proposed.

1. Introduction

Moving people or goods from one location to another defines the notion of transportation. Over the years, the economic wealth and military power of a people or a nation have been closely linked to streamlining the transportation process. Transport ensures access to natural resources and promotes trade. It can also ensure the movement of soldiers, equipment and supplies for military purposes.

A major influence on the place and the way people live was from the transport systems and the routes used. Sustainable transport is needed for the population to be able to live properly and expand on the territory of a country away from factories and farms.

The transportation system makes it possible to own some goods in a unit of time. Through this process, the marketing units can be supplied with the necessary raw materials and goods, adding value to them at the time of purchase by customers [1]. The transport process contains the side of human activities that changes the geographical position of goods and people using various special means to meet the material and spiritual needs of society [2].

In the transport activity the demand must be analyzed and known, for this the relations between the transport system and the activity system require permanent understanding and correlation. To this end, a function is defined that conditions this process, as follows [2]:

- ✓ Related to production and consumption - creates a link between the development of the economy and the development of the transport system;
- ✓ Related to the geographical location - highlights the role of transport depending on the geographical area (can be local, regional or interregional transport);
- ✓ Related to the activity of some enterprises - The connection between the actual transport and the related activities (handling and storage) is highlighted;

In transport, certain guidelines are used to organize and conduct the whole process in optimal conditions. Important factors to consider are [3,4]:

- ✓ Factors that depend on geographical location: transport in rural areas; transport in urban areas; transport in suburban areas (makes the connection between localities in the vicinity of a city; national transport (within a country); international transport; intercontinental transport (between two continents).
- ✓ Factors that define the purpose of transport: for the purpose of transporting persons; for the purpose of transporting goods.
- ✓ Factors that define the organizational structure, ie the totality of the means of transport used and the equipment owned by a functional system.

The most important requirements for optimal transport are:

- ✓ Imposing a high active safety which requires an adequate technical condition of the vehicles participating in the traffic in order to ensure the safety of the passengers and to avoid deterioration of the integrity of the transported goods. A special importance in maintaining a high level of safety also comes from the quality of the existing infrastructure and services that must ensure a good circulation and in unfavorable weather conditions. Last but not least, traffic control equipment (eg traffic lights) has a particularly important role to play in avoiding conflicts that can lead to accidents and damage;
- ✓ Continuity of the transport process which reflects a constant provision of services over a period of time;
- ✓ The linearity capacity that can be fulfilled if traffic studies are performed for the analysis of routes with congestion possibilities, the determination of peak days and hours;
- ✓ The duration of the transport, which must aim for the lowest possible value;
- ✓ Cost reduction can be considered a key element if it is done at the same time as meeting the other conditions;
- ✓ Increasing comfort - can be achieved at the same time as meeting the condition of linearity;
- ✓ Integrity of goods - a key condition in the field of transport, is to deliver the goods in optimal conditions to the recipient, in the same condition and quantity as on receipt;
- ✓ Limiting pollution - reducing as much as possible and in accordance with the law the sources of pollution, using means of transport that meet the conditions of pollution, avoiding the production of waste after transport. The transport process can be polluted by noise, air pollution, water pollution, etc.

2. Material and Method

One of the persistent problems in goods transports is properly locating the trailers, therefor a device was conceived in order to identify that the trailer is not moving and on the other hand, to see the current positioning.

Fleet telematics is a form of technology that transmits data from commercial trucks to another. Examples of fleet telematics currently in use include satellite cargo tracking, vehicle tracking, and electronic data recording devices. The concept of telematics appeared in the 1960s, before the advent of personal computers and the Internet. A closer look at the history of GPS monitoring systems and fleet telematics can show how beneficial they are for the fleet. If a telematics tracking system is implemented, specific notifications can be received whenever drivers meet certain parameters. These features prevent the accumulation of information that may be irrelevant. Such systems allow settings to be customized to display results of a high degree of importance, for example, when the vehicle is parked or if there is an engine problem. A telematics system combined with GPS allows the management of the vehicle fleet in order to increase profitability.

The proposed system consists of a GPS system (GPS NEO 6M), a microcontroller (Arduino Uno), a GSM system (Shield GSM SIM 800L) and auxiliary components like DC-DC LM2596 converter, two lithium cells 3.7 volts each, voltage booster XL6009, TP4056 Charging Board Module.

Because the built-in system requires different supply voltages for the GSM module (3.4V - 4.4V) and the Arduino microcontroller (5-12V), the lithium cells were used together with the voltage booster to be able to provide the necessary power and proper operation.

TP4056 Charging Board Module disconnects lithium cells from the charging source when they have a 100% capacity to prevent overheating or even explosion.

3. Results and Discussions

First, the power circuit was conceived (figure 1): the supply voltage from the trailer electrical installation will be connected to the input pins of the LM2596 voltage drop module; the TP4056 charging modules will be connected to the output pins of the LM2596 voltage dropper; each lithium cell will be connected separately to the B- / B + charging pins on the TP4056 charging modules; the XL60009 power supply will be connected to the output terminals of a TP4056 charging module.

Secondly, the GSM module was connected to the microcontroller (figure 2): the 5V pin on the GSM module is connected to the 5V pin on the Arduino microcontroller; the GND ground connection on the module is connected to the GND on the Arduino board; the RST pin of the module is connected to pin 2 on the Arduino; the RX pin on the module is connected to pin 11 on the Arduino; the TX pin of the module is connected to pin 10 on the Arduino; the Arduino board is connected to a PC via the USB connection.

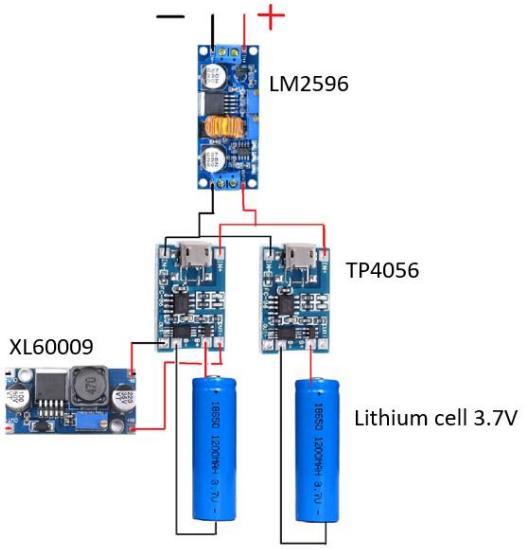

Figure 1. Electrical wiring for the power circuit

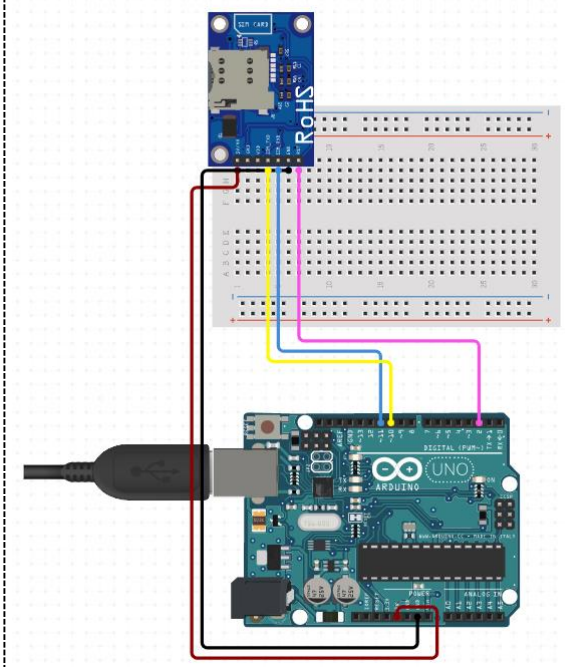

Figure 2. GSM connection to the microcontroller

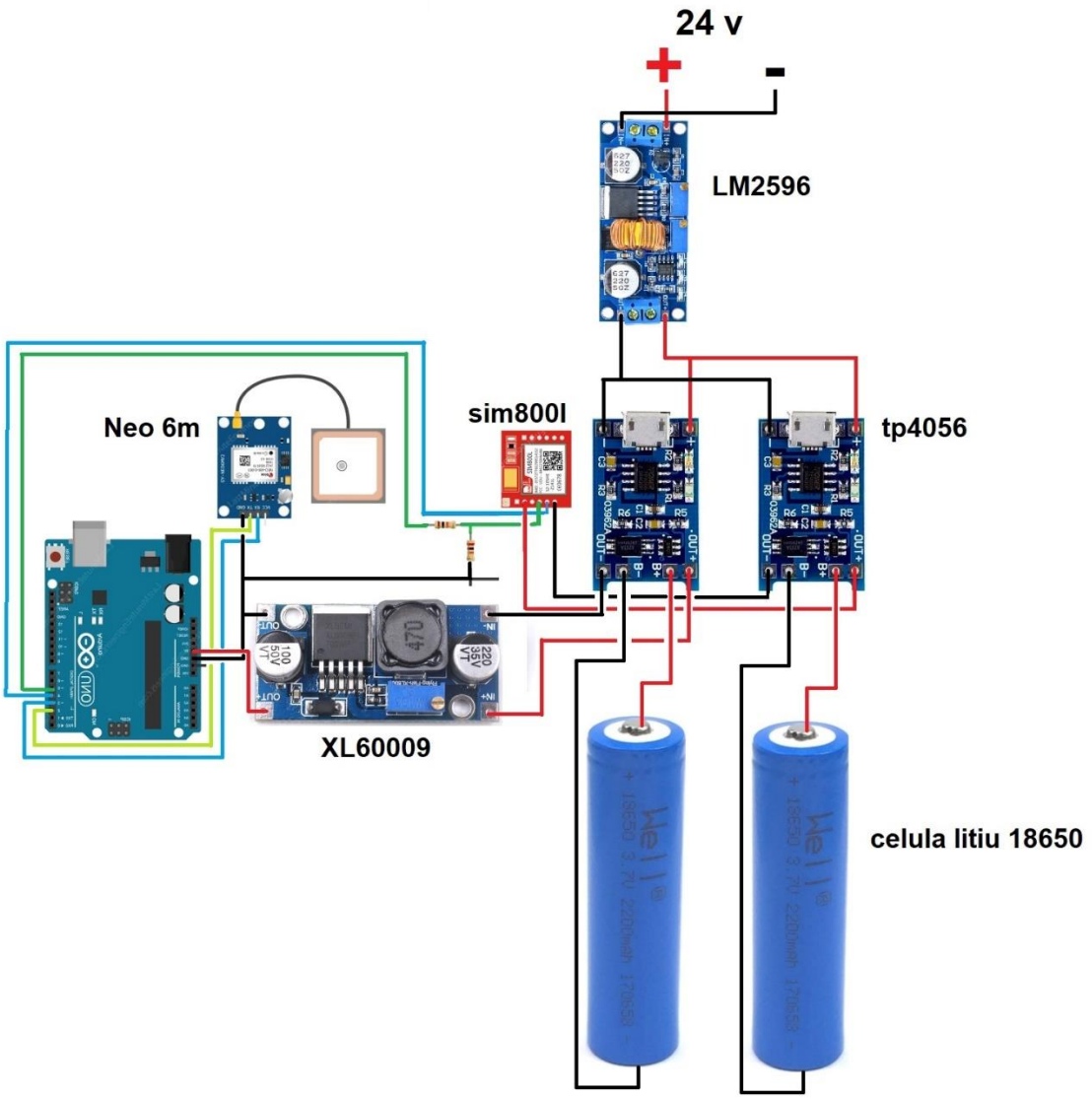

Figure 3. Final wiring for the prototype circuit

In order to reduce the consumption of energy from the batteries while the trailer is not connected to the truck, the program was made so that it transmits the velocity and the location only when certain messages are sent to the prototype.

Figure 4 presents a part of the code used for the attachment of the location to the message transmitted by the GSM, uploaded to the Arduino microcontroller, while figure 5 shows the actual communication between a phone that inquires the velocity and the location of the prototype, and therefor of the trailer that it is mounted on.

```
if (inputFromModem.indexOf("Locatie") > -1)
{
  gpsSerial.listen();
  int trimis = 0;
  while (trimis == 0 )
  {
    if (gpsSerial.available() > 0)
      if (gps.encode(gpsSerial.read()))
      {
        mySerial.print("https://maps.google.com/?q=");
        mySerial.print(gps.location.lat(), 6);
        mySerial.print(",");
        mySerial.print(gps.location.lng(), 6);
        updateSerial();
        mySerial.write(26);
        trimis = 1;
      }
  }


}
```

Figure 4. Program segment with the attachment of the location to the message transmitted by the GSM

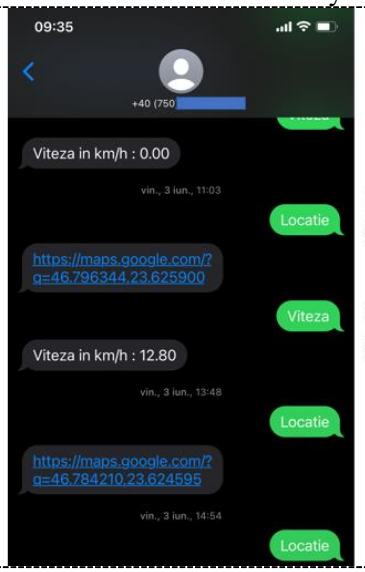

Figure 5. Print screen from the communication with the prototype, underlining the location and the velocity inquiry and response

4. Conclusions

The prototype is fully functional and will be tested on national and international transport of goods, mounted on trailers.

For future improvements, instead of inquiring only on a need to know basis, the system can have a secondary program, activated via SMS, that will transmit continuously the velocity and location of the trailer.

References

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[4] 2011 Ordonance no. 27/31 regarding road transport (Romania)