REMOTE DETECTION AND TRACKING OF ALCOHOL CONCENTRATION FOR CAR DRIVERS

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***Abstract**: As driving under the influence of alcohol is the main cause of fatal vehicle accidents, a reliable method for alcohol testing and data recording, without the possibility to fraud the system is mandatory. Thus, besides the alcohol level measurement, a communication method for remote recording of the test results should be provisioned. This paper describes a microcontroller based implementation with real-time transmission of data, retrieved, modeled and displayed in a chart format, and furthermore securely stored in a record database. In our demonstrator, the code for the microcontroller ATmega328p that controls the data acquisition and transmission is written in C++, while the application created in C# controls all the sensor received information for calibration, verification and metrology testing. The system implementation uses low cost components with high performance.*

***Keywords**: Real-time communications, ATmega328p, breathalyzer, remote measurement, SQL*

1. INTRODUCTION

Alcohol consumption under no control and monitoring increases the number of car accidents and the traffic accidents victims. Methods to test and record the alcohol level - BAC (blood alcohol concentration) in the body can reduce the risks of traffic accidents. From statistical point of view only a few drivers have BACs higher than 0.15. Yet a much, much higher proportion have fatal crashes. The average BAC among fatally injured drinking drivers is about twice the legal limit [1]. BAC monitoring can be used also in different working environments for employee testing as the senses of perception and the possibilities to have coordinated moves are affected by alcohol.

In 1927 the breath analyzer took shape, represented by a football bladder, followed by the ethanol percentage analyses for the air in the football bladder that concluded that a man was “50 per cent drunk”, as it was presented as court evidence in a trial. The portable device for breath analyze was introduced by Parry Jones in 1972, as a consequence of the decision of the British government, introduced in 1957 the Road Safety Act, which defined the maximum level of alcohol that a person should have in his body while driving an auto vehicle. The company that Parry Jones began the examination of possibilities to develop a fuel cell alcohol sensor based of a more reliable screening instrument which help the police to test drivers much easier and it removes the test of urine and blood. [2]

Though monitored by police officers via breath analyses, the measurement must be tracked and stored, thus possible fraud or test changes are eliminated, and measurements can be considered as reliable evidence in a court of law.

What makes the difference between our demonstration for a breathalyzer and the other implementations [3][4] is that we have developed a method for the police to have a good trace of the people that will be tested in traffic.

Thus, we have included a method for the wireless transmission of measured information. Furthermore, a graphical display of results and integration with a SQL database, possibly extended Secure Storage in the Cloud, is part of the implementation. The Atmel AVR microcontroller performance makes the difference in case of the wireless transmission because the analog-to-digital conversion (ADC) speed is much faster and thus it brings efficiency for producing a real-time diagram. The microcontroller AVR it is used mostly for multi-processing on a common bus.

By adding the wireless to our implementation (though also mobile network like 3G-LTE could be an option [5]), data is transmitted in real time, captured and processed much faster, the measurement can be time-stamped, thus becoming evidence, data cannot be erased or modified. This kind of integrated communication uses a low-cost technology that can be implemented in any type of device and it provides flexibility and opens the borders in any area of interest.

2. SYSTEM COMPONENTS AND IMPLEMENTATION SCENARIO

The scenario that we have implemented is considering a portable alcohol tester that is connected via the wireless interface the police car, where data is automatically tracked and stored in a database, and furthermore it could be shared to a to a cloud database and a secure storage element. The system architecture is depicted in figure 1. The alcohol sensor takes 10 bits of data and transmits them to the police car through a wireless connection.

For an increased usability, the breathalyzer has a LED-based local indication of the measured alcohol level. When the sensor indicates a low alcohol, vapors level the green LED will light, when is medium the orange one will light, and the red LED is used for high sense of alcohol vapors. In the same time, the captured data are read by an application in C# that filters according to the calculation of BAC and help building a graphic. The application has a build-in database where data is recorded, searched or displayed.

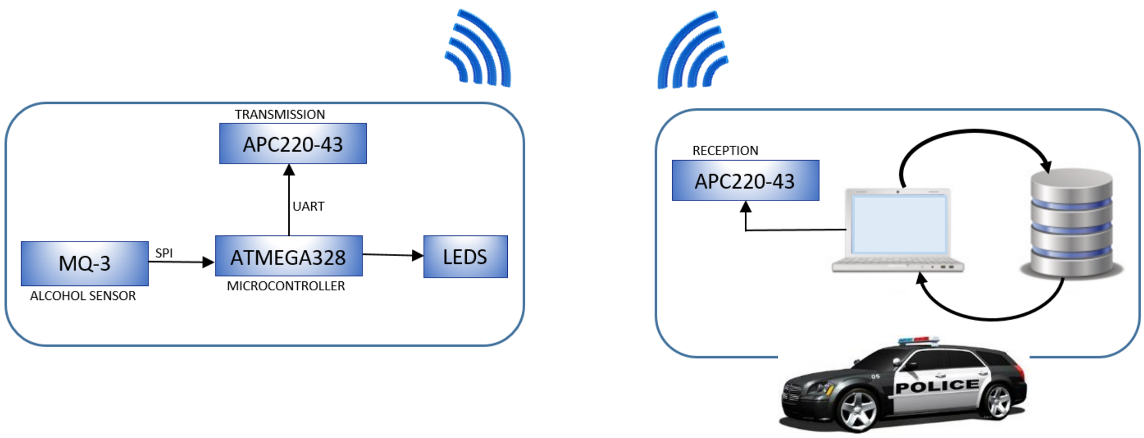

FIG. 1. Scenario for remote alcohol concentration testing for car drivers

3. HARDWARE IMPLEMENTATION

ATmega328P is a high-performance microchip pico-Power 8-bit AVR RISC-based microcontroller that combines a 32KB ISP flash memory with read-write capabilities,1024 EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-orientated 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.80-5.5 volts. By executing powerful instructions in a single clock cycle, the device achieves throughput approaching 1 MIPS per MHz, balancing power consumption and processing speed. [6]

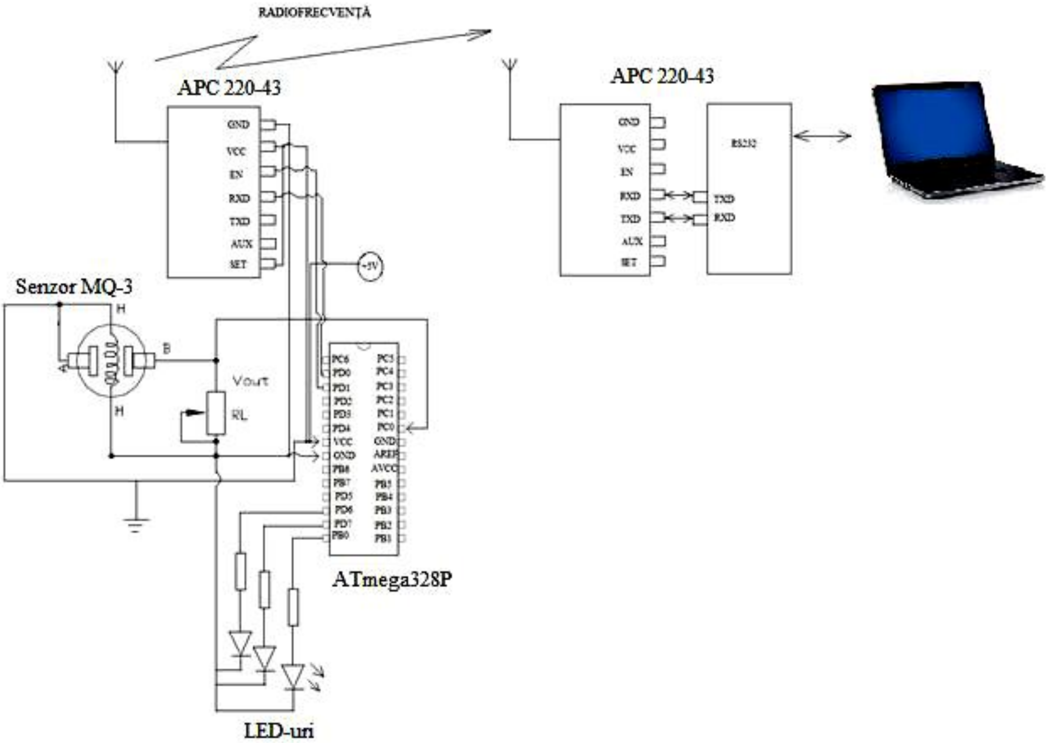

FIG. 2. The system block diagram

The sensor MQ-3 has a relatively simple 6-pin configuration, but there are used only 4 of them. Two are for the heat system, they are called H, and the other two are for voltage and ground. Inside the sensor exists a tiny tube that represents the heating system consisting of aluminum oxide and tin dioxide. Part of this tube is coil in which it is practically produced the heat. The sensor provides an analog resistive output based on the alcohol concentration and the drive circuit is represented by one resistor.

APC 220-43 is a highly integrated semi-duplex low power transceiver module, with high speed MCU. This equipment is using high efficiency forward error correction; it transmits transparent data with large data buffer zone and it provides more than 100 channels. Via the COM serial port or directly in software a user can set up the UART parameters. This wireless module can communicate with the other devices at about 1km distance with 2400 bps, the output power is 20 mW, the frequency 418MHz to 455MHz, uses for GFSK modulation, the interface is UART/TTL.[7] So for our implementation scenario, the transmission distance from the portable alcohol sensor to the police car should be sufficient.

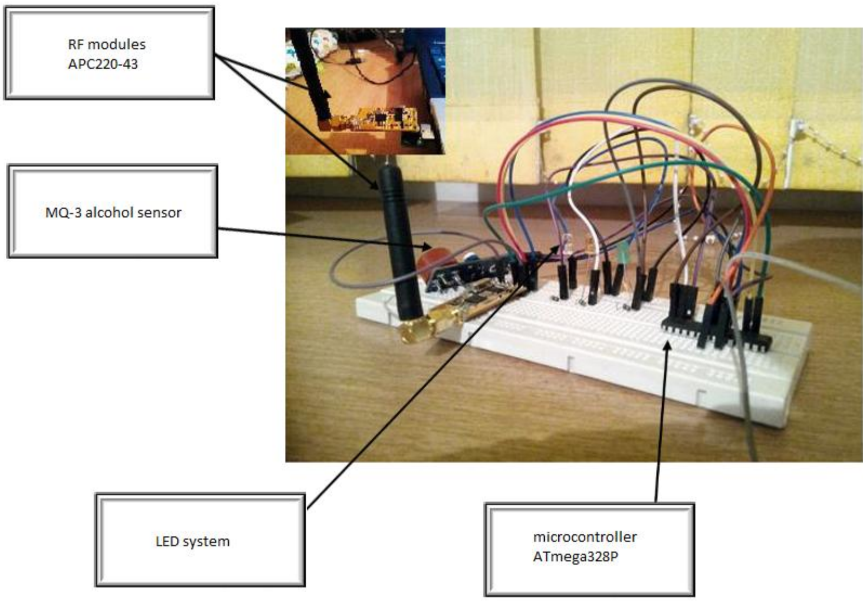

FIG. 3. The hardware components of the system

4. SOFTWARE IMPLEMENTATION

The tools used for the software implementation are AVR Studio 6.0 for implementing the C++ code on the microcontroller that it can perform the required tasks related to the project requirements, and Visual Studio Express to create an environment for the user, for this the code used is C#.

The code sequence that connects COM1 serial port is the following:

```
private void Make_Serial(string port, int boudrate, Parity parity, int
data_bit, StopBits stop_bit)
{
Serial_Port = new SerialPort(port, boudrate, parity, data_bit,
stop_bit);
try
{
Serial_Port.Open();
Serial_Port.DataReceived += new
SerialDataReceivedEventHandler(Serial_catch_data);
}
catch (Exception e)
{
MessageBox.Show(e.ToString(), "This is a error", MessageBoxButtons.OK,
MessageBoxIcon.Warning);
}
```

We have considered a real-time data acquisition form the sensor, so more values are recorded from the sample driver. Subsequent samples could help reduce one-time measurement errors and the need for retests. The user interface designed in C# presents in a graphical format these subsequent values.

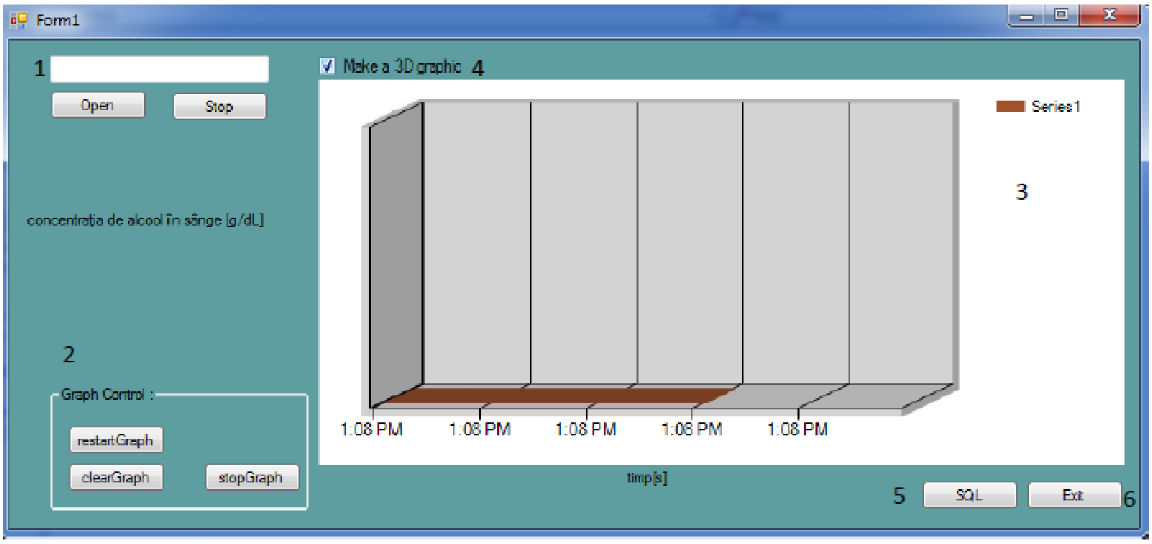

FIG. 3. The graphic displaying subsequent alcohol level sample reads.

The system has an SQL Server 2008 and all data displayed in the C# graphical interface is synchronized with the SQL Server. As visible in figure 4, from C# we have included some functions to search or display records from the SQL database.

To manage the massive information, the database is synchronized to an enterprise data warehouse, via the extraction, transformation and loading (ETL) tool from Informatica PowerCenter [8]. Thus, by using integration connectors data can be retrieved and manipulated, as Informatica PowerCenter can support an entire data integration lifecycle.

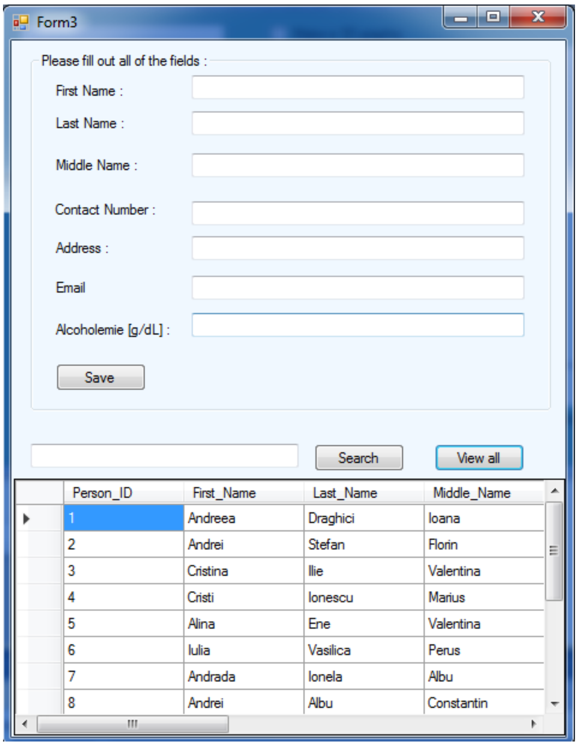

FIG. 4. The database interface and methods to search for previous records

5. CONCLUSIONS AND FUTURE WORK

The project aims to develop a new type of alcohol-test, more efficient and portable, including a method to prevent the fraud of the police check measurement and a method that helps storing the data and linking the data acquisition records to profile of the tested driver.

Another advantage of the structure and the malleability of the alcohol tester is the extension of the applicability domain, not only in police institutes, but also to other institutions or as a self-check for the driver itself, some automated systems coupling the breathalyzers to the car electronic, making it impossible for the driver to start the engine in case his alcohol vapor level is not proper. Using a microcontroller minimizes the dimension and reduces the cost of the system compared to using single board computers (SBC) like Arduino, Raspberry Pi, that are more expensive implementations.

The project may change in the future through a more comprehensive approach by introducing a LCD that will be able to see the values transmitted by the sensor in real-time. The radio frequency module used can be replaced by a mobile 3G/LTE one, thus extending the data acquisition area.

Other enhancement for the current system would be having an encrypted wireless transmission so that the information can't be retrieved by an unwanted person or have any kind of interferences that could corrupt the measured data. We chose the AES key-length 128 bit [9] to encrypt and decrypt the data using the Crypto-avr-lib, a set of implementations of different cryptographic primitives [10]. Due to the special limitations of microcontrollers (very little space, RAM and flash are ranging from a few bytes to a few KiB) reference implementations of encryption algorithms are not usable with their latest improvements, but Crypto-avr-lib offers adapted methods for microcontrollers. As AES is a symmetric-key algorithm, the same cryptographic keys for both encryption of plaintext and decryption of cyphertext will be used for protecting the data communication. This encryption of the communication should be doubled by the database encryption and a Cloud distributed database back-up, so that data is securely replicated and stored in different locations.

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