September 18-21, Predeal, ROMÂNIA

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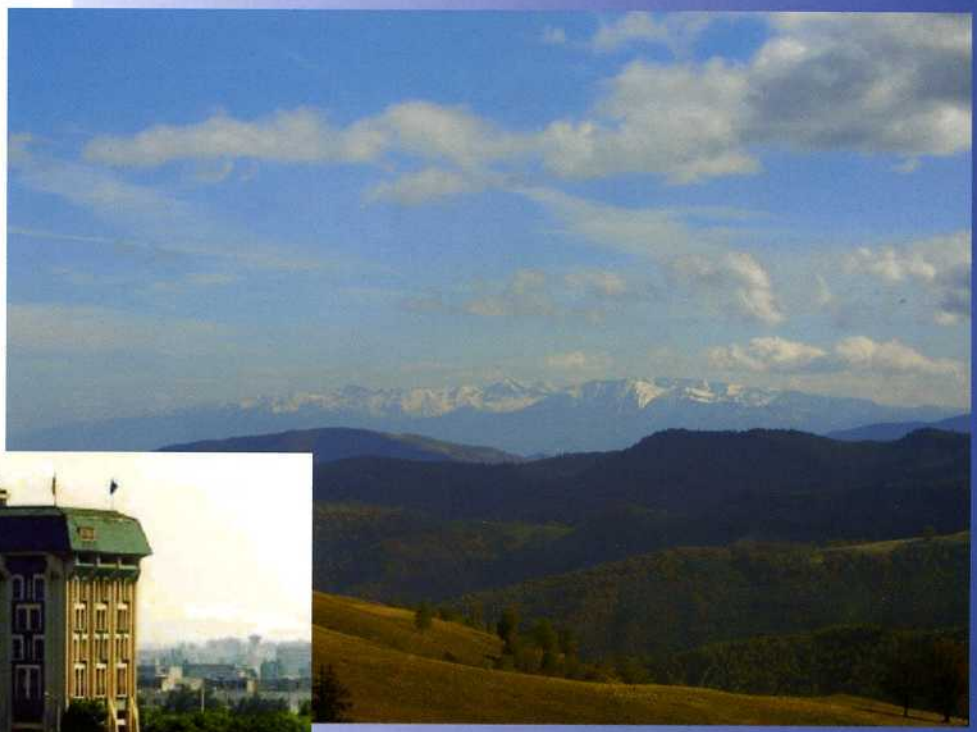
Conference proceedings



International Symposium for Design and Technology of Electronic Packaging

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implemented in compliance with the BS EN 60601-2-25/1995 medical standard of patient's protection and a dynamic software (scheduling) solution was also described in order to reduce the power consumption.

The successfully distribution of the medical information via a Bluetooth channel with low power consumption increases the self confidence of the patient. A wire communication solution increases the sampling rate and reduces the power consumption and this is adequate for wearable devices.

The whole context of this article is a part of the national project BIOMED-TEL currently under development at the "Transilvania" University of Brasov - Department of Electronics and Computers [8].

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Smart Development Platform For Embedded Systems

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Abstract

Nowadays, a platform for testing development systems became more and more important being assessed by the technological evolution and the wide range of the applications. This is the reason that has determined us to design a multi purpose development platform for genral use in embedded systems suitable for real time signal acquisition, real time signal processing and also, for data storage, data analysis and data transmission.
Even if the platform approach offers a large number of benefits it was designed with low non recurring engineering costs and low manufacturing costs and thus, the platform is suitable for testing and for implementing as well.
The development platform has already proved to be very useful in ***medical, energy, automotive and e-learning applications*** *but the biggest advantage is that it offers the possibility for* ***wireless transmission/receiving data to/from many acquisition systems****, to store data, to concentrate and to locally process an interpret them.*
Embedded system applications require architectures based on microcontrollers combined with I/O components in order to achieve computation and communication performances.
The possibility to execute distributed tasks and to correlate the results increases the range of applications for the development platform.

1. Introduction

Nowadays, embedded system's field became a necessity.

We focused our research on developing a Smart Platform with low cost and low power consumption able to be used in a variety of applications like data acquisition and data mining, health care field, automotive, energy applications, learning and e-learning.

This platform is based on AVR8 family, a new generation of 8-bits microcontrollers that includes on the same chip a very powerful interrupt control system.

These controllers have in the same time a low power consumption that recommends this family for portable and/or energy intensive applications. For this reason we have adopted these controllers to implement our Smart Platform (SP).

In this paper are presented several applications in the filed of portable medical devices, energy power management and automotive.

2. Technological Research and Architecture

Before implementing the Smart Platform studies about the components behavior were made. A prototype platform was implemented and each module was tested by designing the component's drivers.

We have analyzed a lot of microcontroller's families and we have taken into account the following elements: (i) processability of the CPU represented by ISA, internal architecture and clock performance; (ii) the possibilities to communicate: so-called communication interfaces (serial and parallel ports), converters analog to digital (A/D) and digital to analog (D/A), including the interrupt system.

For these reasons we have chosen AVR8-bits family that also has very low consumption accepting to be supplied between 2.7 to 5V and presents a sophisticated power management on chip (6 different modes) and also a good ratio performance/price. Thus, the system is suitable for portable applications.

The architecture of the prototype is presented in **Fig. 1**.

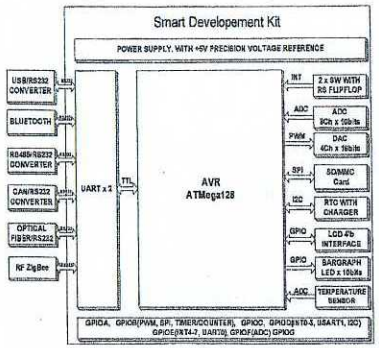

Fig. 1 Platform's architecture

Corresponding at each interface we have designed different modular drivers for wire/wireless and optical links (USB/RS232 Converter, Bluetooth, RS485/RS232 Converter, Fiber Optics, RF ZigBee).

Because the microcontroller has A/D Converter we have previewed the board with separately supply for analogical components of the platform.

Because it is a general purpose platform an important problem was how to choose the right components and how to make good power management hardware and software as well.

3. Implementation

The implemented Smart Platform is presented in **Fig. 2.**

We have previewed by design, as a lego, connectors that make directly accessible all the ports of the microcontroller and also allow the user to choose the desired interface for each port and thus increasing the versatility of the platform.

After the tests were made, by the help of the Orcad Tool, the final Printed Circuit Board (PCB) that respects the IPC (International Printed Circuits) standards was implemented.

In order to achieve throughputs approaching 1 MIPS per MHz we have used ATMega128, a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture, that executes powerful instructions in a single clock cycle thus allowing the system designer to optimize power consumption versus processing speed. [1]

One of the biggest problems was to separate the analog and digital components. Thus, we have designed two separated ground planes for the above mentioned signals (analog and digital). The analog ground plane connects all the passive components presented in **Fig. 2** and the digital one it is dedicated to the microcontroller. The analog and digital ground planes were connected on the microcontroller's analogical ground PIN in order to eliminate the digital noises generated by the commutation of the processor. Because the ADC (Analog to Digital Converter) PORT is very susceptible to noises the datasheet specification were respected and the system was implemented in order to have the length of the nets as short as possible.

Experimental results have proved that the features of the ATMega128 have satisfied all the needs for our applications related to the medical ambulatory

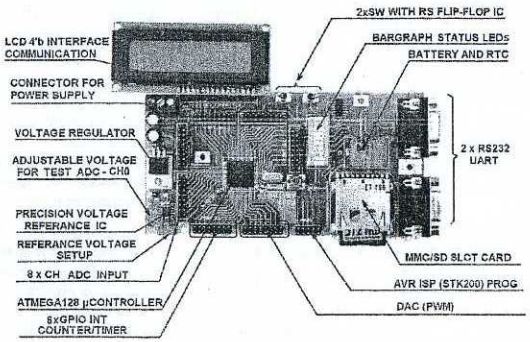

Fig. 2 Implemented development system

monitoring, automotive, energy management and educational remote laboratory because the maximum acquisition time used in our applications is 6.5ms.

In order to make possible the acquisition, processing and storage we have implemented onto the microcontroller a firmware developed in ICCAVR. We also have used WinAVR and GCCAVR tools for developing firmware and for simulation we have used AVRStudio.

The acquired data are sent using the USART interface and after processing data can be pointed out onto a graphical display.

Because some acquired data have to be permanently recorded a mass storage card which communicates with the microcontroller through SPI was implemented. This card expands the applications' area to offline processing applications.

A real time counter (RTC) was implemented in order to correlate the time with the records stored on the MMC SD Card.

An important aspect is the supplying system. To improve the energy management all the components have separately ways for supplying and thus if the supplying battery riches a threshold voltage value all the peripheral components are disabled and the Smart Platform automatically saves the context and enters in Power Down Mode.

4. Applications and Experimental Results

The Smart Platform has a wide range of applications.

For example the platform was successfully used in medical signal acquisition and preprocessing and in power elelectonics too, as a start up system for a locomotive and for an on-board debug for vehicle in accordance with OBDII (On-Board Diagnostic System) and KWP 2000 standard defined by ISO14230-1,2,3,4.

The Smart Platform was designed to be supplied from chemical and also from non-chemical power supplies. Thus the Platform is suitable for wearable applications that need low power consumption, research, educational applications and for industrial electrical power applications too.

4.1. Health care field

Being implemented for research activities the Smart Platform was used as a testing module for the prototypes. For example, medical signals were acquired and converted by the help of this Platform.

A Bluetooth solution was implemented with LMX9838 and the digitized medical data were sent to a Laptop/PDA (Personal Digital Assistant) - that supplementary processed and pointed the data out onto a graphical display as it is shown in **Fig. 3.** [2]

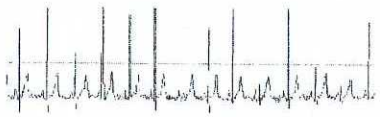

Fig. 3 ECG acquired signal and transmited through Bluetooth to a Laptop

4.2. Energy applications

The Smart Platform was also used as a start up system for a locomotive. The functionality of the start up system implemented onto the Smart Platform has been tested for 5 months.

Onto the Platform it is implemented a firmware that controls the transfer of the stored energy onto the supercapacitor and battery to the engine.

To be able to establish the optimal ratio between using the energy stored on the battery and the energy stored on the supercapacitor the follow parameters were considered and software determined:

- ratio between maximum current from the supercapacitor and maximum current from the battery
- ratio between the initial voltage value and the minim voltage from the battery at the start up moment
- the stored energy level on the supercapacitor

An experimental result of this application it is presented in Fig. 4. [3]

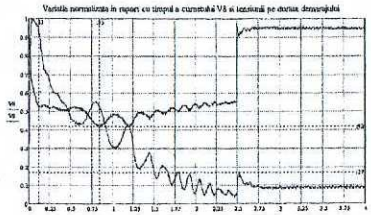

Fig. 4 Intensity and voltage variation in time

Another important application is storing the acquired data. Thus, a software solution was implemented and the stored parameters from the MMC Card helped at making historical evolution diagrams for the locomotive.

4.3. Automotive

The Smart Platform can have implemented a firmware in order to optimize the control strategies of "energy sources" in correlation with electrical machine and board computer.

By the help of this Platform studies about fuel consumption, average speed, engine RPM (rotation

per minute), temperature, oxygen sensor voltage, air flow rate and maintenance can be made.

A general result of these offline studies it is represented by a historical table of the monitorized parameters and a graphic.

The vehicle's data logger is presented in Fig. 5.

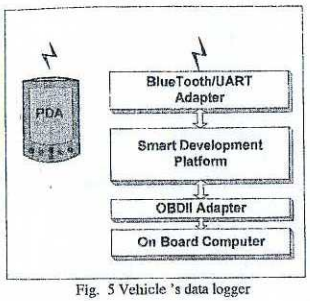

Fig. 5 Vehicle 's data logger

We have detailed a part of the automotive application Fig. 6.

4.4. Learning and e-learning

Because the hardware and firmware were designed in order to fulfill the didactical needs, the Smart Platform is a versatile system that can be used for workshops in the field of electronics. Thus, the system reaches the requirements of a learning object that can be used as a didactical material for possible applications.

To be suitable for the field of electronics learning we have previewed the system with the capacity of storing the acquired data onto the local card. The acquired signals, once they are digitized they can be wirelessly sent to other proccessing modules or they can be sent via SMS to a phone/PDA. Also, graphics can be made and pointed out onto the local display attached to the Smart Platform.

The AVR family architecture is one of the preferred architectures being suitable for educational and experimental purposes because of its wide range of supported applications.

We have used ATMega128 that has FLASH, EEPROM and SRAM memories, auxiliary units such as counters, timers, memory, pulse-width modulation units, RTC clocks, A/D converters etc and these modules are mandatory in the improvement of the student's skills. [3]

All the facilities of the Platform can be used in remote laboratory too and thus the importance of the platform is increased.

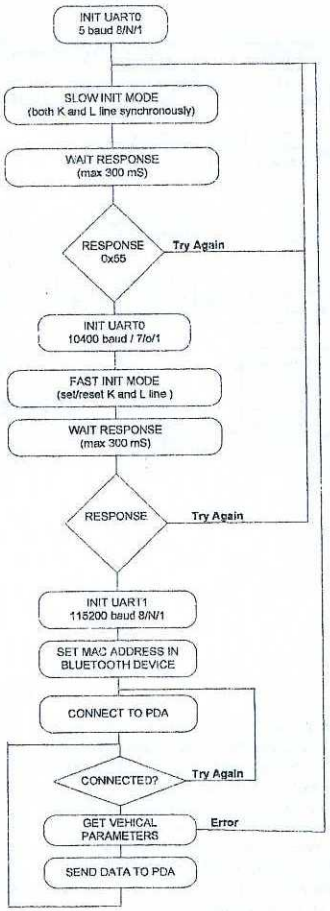

Fig. 6 Flow diagram of vehicle's data logger

The system can generate a sequence for a mirror system in order to excite it and after that to collect its outputs sequences (hardware test bench).

5. Conclusions

In this paper, a new general purpose Development Platform for embeded systems was described.

The platform was designed to have low power consumption and thus to be suitable for a wide area of applications.

Being designed with low non recurring costs the platform has proved to be suitable for applications such as electronics, computer engineering, chemistry, physics, probability and statistics, medicine, automatics, automotive, robotics etc. [4]

Because e-learning environment education needs to be integrated partly or completely into education we have adapted this Smart Platform to be used in remote laboratory.

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