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# A NEW INTERACTIVE SYSTEM FOR REAL-TIME SOUND PROCESSING AND SPATIALIZATION

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## ABSTRACT

We developed a new electronic system for real-time sound synthesis, processing and spatialization. It is called SAIPH and it is made by two different subsystems: Betel Orionis [3-5], for the sound synthesis, and Rigel, for the sound processing and spatialization. The first one is based on the dedicated DSP Orion [1], while the second one is based on two fixed point DSPs of the 56300 family by Motorola: the 56301 DSP and the 56302 DSP. SAIPH is intended for live performances in concert halls and it is interfaced with personal computer and MIDI controls that allow the composer or performer to interact with it.

## 1 INTRODUCTION

The project goal [2] is to meet the expressive demands of the musicians; these demands have been subject to a radical change in the course of this century. The research for new sonorities and new dynamic possibilities together with the vast progress within the field of electronics and computer science have contributed towards the birth and development of computer music. Today, within the field of contemporary art music, electronic synthesis and sound processing systems are very regularly applied. A system has been designed which allows synthesis, processing and spatialization of sound in real-time (it is intended to be used live in a concert hall): this system is SAIPH.

SAIPH is designed as a modular system: it is made of modules dedicated to perform specific musical signal processing. A SAIPH system block scheme is illustrated in Figure 1.

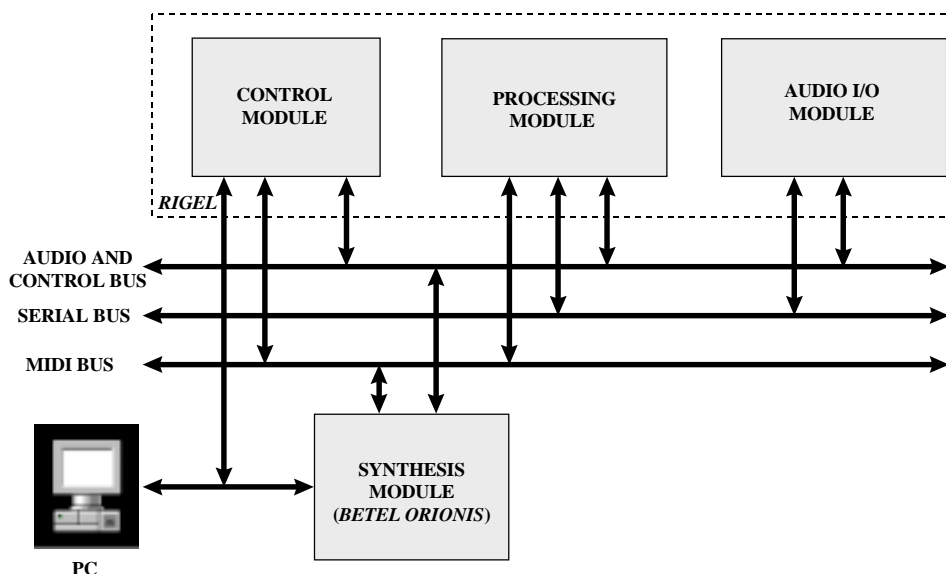


Figure 1. SAIPH block scheme

The Rigel system, presented in this paper, is the module of the SAIPH system allotted for sound processing and spatialization and for physical modeling synthesis.

## **2 THE 56300 DSPs FAMILY**

In this section a brief description of the features of the DSPs used in the control module and in the processing module will be given.

The 56300 family [6] is the fastest family of fixed point DSPs by Motorola. The DSPs of this family manage 24 bits wide word and can run up to 100 MHz. They have a lot of ports that allow to connect them with a large number of peripheral devices; these ports include:

- 1) the Host Interface (HI), that allows the DSP to be connected to a host processor
- 2) two Enhanced Serial Synchronous Interface (ESSI), that can manage up to four input/output audio channels
- 3) the Serial Communication Interface (SCI), that can be connected to a host processor serial port or a MIDI device
- 4) the External Memory Expansion Port (Port A), that allows the DSP to be interfaced to an external dynamic memory module of up to 16 Mwords of 24 bits wide.

## **3 THE RIGEL SYSTEM**

Rigel is a multiprocessor system able to realize all the principal algorithms for sound processing and spatialisation on up to 32 output audio channel.

The system is logically divided in three modules:

- 1) the control module, which realize the interface between a personal computer or a MIDI console and the system; this module also control the data exchange through the system buses.
- 2) the processing module, which manages the audio I/O module
- 3) the audio I/O module, whit up to 32 audio channels for sound spatialization.

These modules are connected by three system buses:

- the audio bus, for the audio samples exchange
- the control bus, for the control data transfer
- the serial bus, to exchange data with the audio I/O module.

There is another bus, the MIDI bus, which allows the user to interact whit the system through a MIDI console.

The Rigel system can be connected to Betel Orionis system via the audio bus so they can work together realizing the SAIPH system.

Rigel can be controlled in two different ways: by a personal computer or by a MIDI device. In the first case, the user drives by the PC the system which is connected to the ISA bus, in the second case is possible to interact with the system by a MIDI console connected to the system MIDI interface, driving at the same time a large set of parameters by MIDI potentiometers or buttons.

## **4 HARDWARE DESCRIPTION**

The Rigel system is constituted of boards connected through a main board. On the main board are placed the system buses and one control board, up to 8 processing boards and an audio digital interface board can be plugged in.

Each processing module can work alone on a audio signal or more modules can collaborate together to realise the processing of the same audio signal. The processing boards exchange data through the audio bus under the supervision of the control module (see Figure 2).

In the following sections a brief description of the system modules will be given, referring to the principal components utilized in their realization.

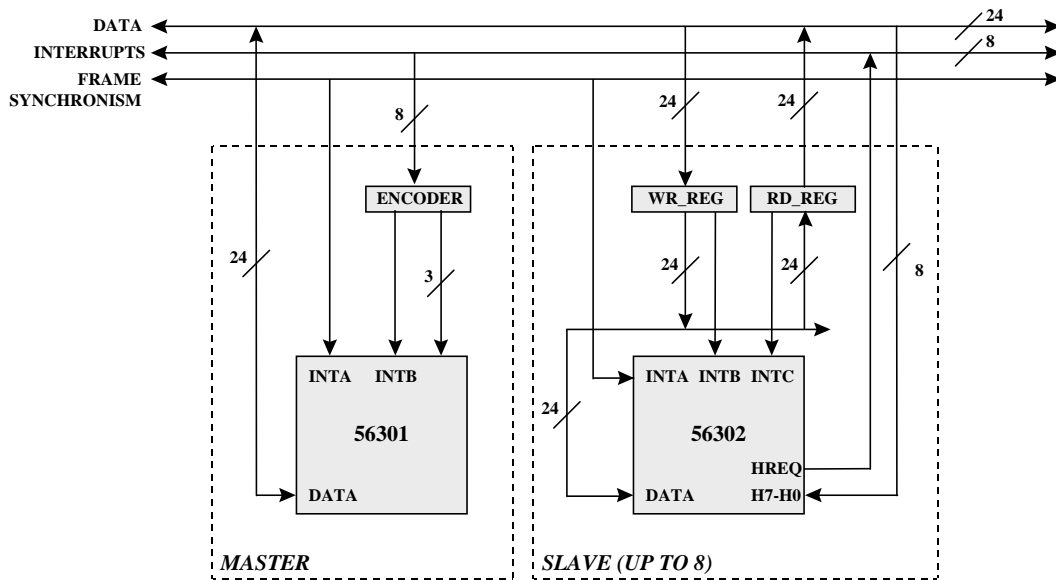


Figure 2. Audio and control connection block diagram

#### 4.1 The control module

The control module is based on the 56301 DSP by Motorola [7].

By the PC ISA bus the user can control in real-time the whole system. The 56301 host interface is directly connected to the ISA bus and this DSP, which is the master DSP of the system, controls through the control bus the other modules.

The microprograms for the DSP of the system can be loaded through the personal computer by the ISA interface or by the RS-232 serial interface connected to the serial communication interface of the 56301 DSP.

The control module is also equipped with a flash memory device of 1Mbyte of capacity. This memory can be utilized to store the microprograms for all the DSP of the system; if there is not a PC the microprograms can be loaded from the flash. In this case the real-time control of the system can be made by a MIDI console. The MIDI interface is also placed in the control module and the MIDI command reach all the others modules by the MIDI bus.

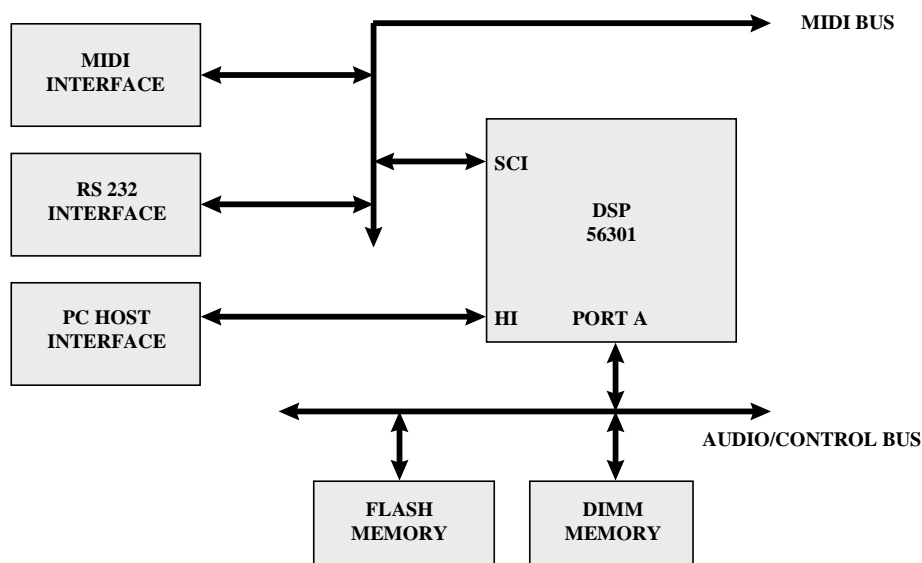


Figure 3. Control module block scheme

A DRAM module of 16 Mword of 24 bits wide is connected to the DSP external memory interface. In this memory can be stored data regarding the DSP processing or audio samples.

The control module block scheme is shown in Figure 3.

#### 4.2 The processing and audio I/O modules

The processing module is based on the 56302 DSP by Motorola [8]. This DSP has a large amount of internal memory in which very complex processing algorithms can run. The memory interface of the 56302 is connected to a dynamic memory module DIMM of 16 Mword of 24 bits wide in which can be stored samples for realizing the processing algorithms.

In the Rigel system we can have up to 8 processing module. To allow the data exchange between the processing modules of the system, in this board two registers were placed: in the first one the 56302 DSPs can write the data to be send to another module, in the second one it can read the data sent by another processing module. The data exchange is synchronized by the 56301 DSP placed on the control module.

The audio I/O module is in the same board that the processing module. In each of these boards two stereo CS4222 CODECs by Crystal were placed. These CODECs are connected to the two ESS1 ports of the 56302 DSP; in this way the board can manage 4 input/output audio channels. Therefore the whole system can have up to 32 input/output audio channels which allow the user to perform the sound spatialization.

The processing and spatialization module block scheme is shown in Figure 4.

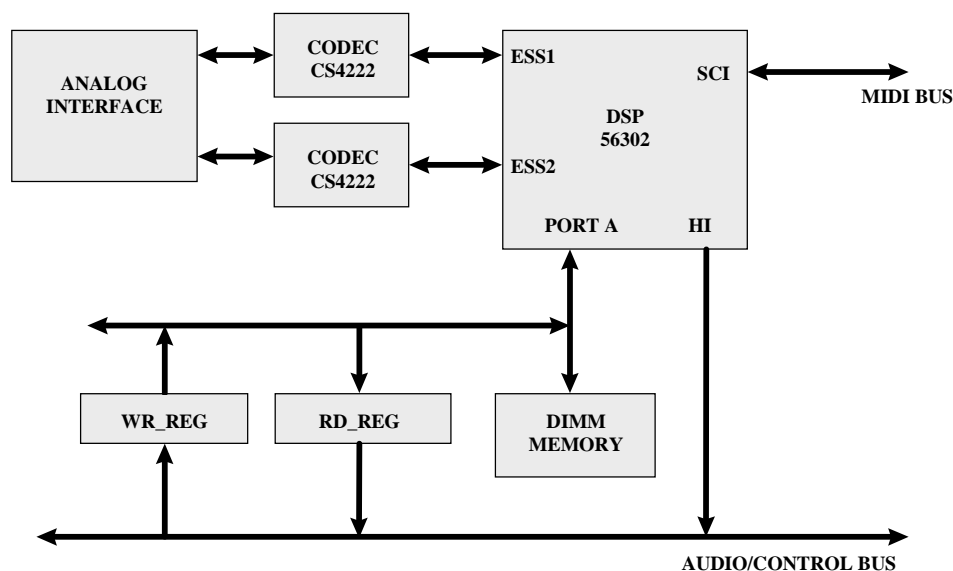


Figure 4. Processing and spatialization module block scheme

#### 5 SUMMARY

In this paper has been described the Rigel system, a new electronic system for real-time sound processing. It is based on two fixed point DSPs of the 56300 family by Motorola and it was designed as a multiprocessor modular architecture system. Rigel has a capacity of up to 32 input/output audio channels for sound spatialization and a high processing power that allows complex real-time processing algorithms.

This system is intended for live musical performances in concert halls and it can be driven by personal computer or MIDI controls.

#### REFERENCES

- [1] G. Nottoli, "ORION: a single chip digital sound processor/synthesizer", *Proc. of IX Colloquium on Musical Informatics*, 1991, Genova, Italy.

- [2] M. Salerno, F. Sargeni, G. Nottoli, G. Costantini, "Tecnologia e musica all'Università "Tor Vergata" di Roma", *Proc. of La terra fertile*, Ottobre 1996, L'Aquila, Italy.
- [3] G. Nottoli, G. Costantini, "Betel Orionis: a real time, multiprocessing sound synthesis system", *Proc. of Journées d'Informatique Musicale*, May 1998, Agelonde, France.
- [4] G. Nottoli, M. Salerno, G. Costantini, "Betel Orionis: un sistema multiprocessore orientato alla sintesi del segnale musicale in tempo reale", *Proc. of La terra fertile*, September 4-6, 1998, L'Aquila, Italy.
- [5] Giorgio Nottoli, Mario Salerno, Giovanni Costantini, "A new interactive performance system for real-time sound synthesis", *Proc. of International Computer Music Conference*, October 1-6, 1998, Ann Arbor, Michigan (USA).
- [6] Motorola, DSP 56300, Family Manual, 1995.
- [7] Motorola, DSP 56301, User's Manual, 1995.
- [8] Motorola, DSP 56302, User's Manual, 1996.

