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Multi Sensor Data Processing Using Single Chip Microprocessor

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Abstract:

The paper deals with one possible solution of event rules programming in the field of data processing from different sensors. Block diagram of used event rules programming is introduced. The commercial door motion control system based on data processing from several sensors was developed. Signals from encoder, inductive proximity sensor, passive infrared motion sensor module, fire sensor and DC power system failure sensor are processed. The system control element is simple ADuC812 microcontroller. Particular electric diagram of eight-channel parallel input is described.

Keywords:

Event rules programming, sensors, microprocessor ADuC8xx, motion control, PISO register

1. Introduction

The big development of microprocessors in recent years allowed their use in applications where relay systems were previously used. The great advantage of these single-chip microprocessors is the adaptability of the operating program and hence the diversity of the required operations. The largest and most important use of these microprocessors is in control systems reacting to external events like movement, heat, fire, light etc. It is possible to use microprocessors practically anywhere if the designed system is equipped with proper sensors for these events.

The principle of the microprocessor control, reacting to any external event, is to solve a main problem - processing a large amount of input data. This input data represent serial-parallel information about the system environment in which the control process runs. Parallel information is usually given by several signals from

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different sensors. Serial information is the system's current continuous time. The parallel processing of input signals from the sensors is shown in Fig. 1.

Generally, input signals (IN) of different properties enter into the input processing circuits. Input processing circuits have to adjust the data so that the output signals from these circuits can be used in microprocessor. For example, eight binary signals with different amplitude are processed in a case of commercial door motion control (described below in chapter 4). Output signals for the microprocessor are the two main signals. The first one informs about the event and is known as EXT_INT, hence the connection to the input of microprocessor external interrupt (see Fig. 3). The second signal is a serial signal that contains all suitably modified input signals (IN_01 to IN_08) for later clear identification.

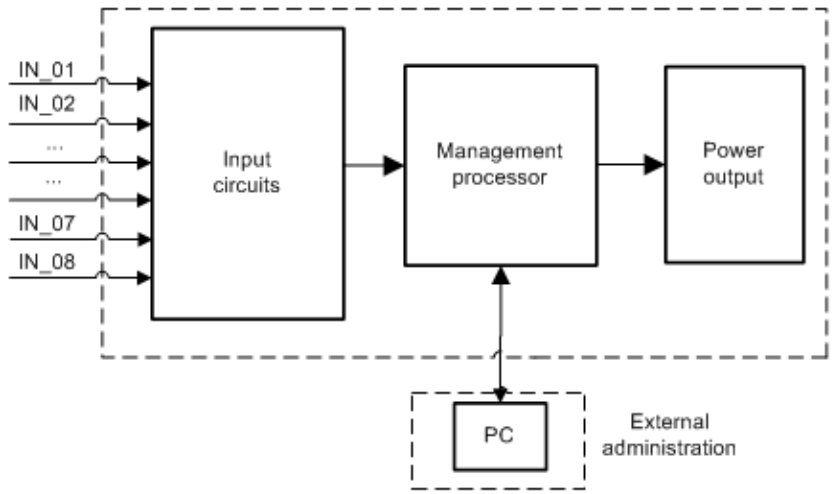

Fig. 1 Block diagram of designed event rules programming

The processed signals are analyzed in the microprocessor and then the processor runs the output operation using general power output module. Present microprocessors are also typically equipped with a serial input for their administration, i.e. it is possible to program the processor without disassembling it (In Circuit Programming), to change a content of memory data, or to debug the program runs, etc.

2. Event Rules Driven Programming

The program flow based on event rules programming can be divided into several phases:

- setting initial conditions of the program functions;
- initialization of needed interrupts (the highest priority is any event on the input IN_01 to IN_08);
- running the main body of the program – directing the flow of the program by the occurrence of the events;
- processing each single event;
- processing multiple events (priority evaluation);

Principle of the event rules programming is shown in Fig. 2. The program is running in waiting loop after initial conditions are set. External service interrupt (INT) calls interrupt service routine if any event occurs. Then the program solves particular event according to the priority evaluation (represented by the register value "H").

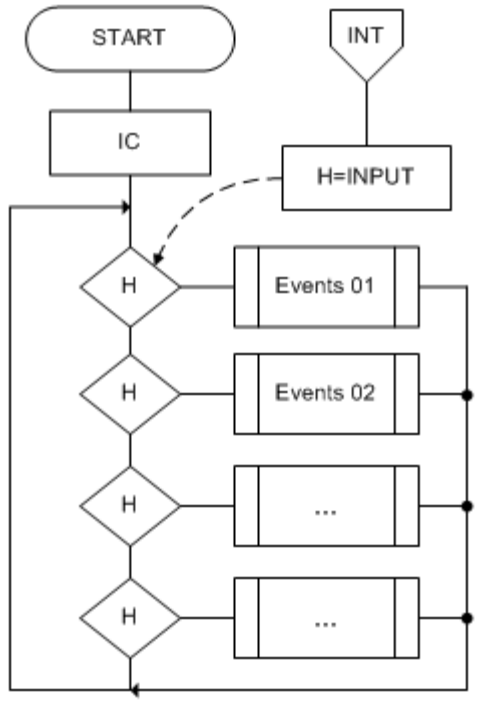

Fig. 2 Principle of used event rules programming

3. Inputs Adjustment

The number of control inputs is relatively large in many applications. On the other hand, the number of ports of microprocessors is small as it is necessary to use many of them for other functions. Therefore, it is quite useful to use circuit that can convert a large number of incoming information (logic level changes) into one input of microprocessor. One of the most suitable circuits is HC/HCT 597 8-bit Serial/Parallel Input and Serial Output (PISO) Shift Register with Input Latch. This device consists of an 8-bit input latch which feeds parallel data to an 8-bit shift register. Data can also be loaded serially. Another advantage is the possibility of daisy chaining. This is a serial connection enabling to get a single serial output from the $N \times 8$ parallel inputs. It is also possible to record all inputs at the same time due to the LATCH input.

Wiring diagram for recording of eight parallel inputs IN_01 to IN_08 is shown in Fig. 3. The inputs are clearly described in Tab.1. One added signal, created by all input combination, is used to cause an external interrupt (External interrupt request) in the control processor. RC circuits in each input initiate the action of the EXT_INT output signal only if the falling edge of one of the inputs IN_01 to IN_08 is detected.

Diagram complexity (including diode couples BAS70-04 over voltage protection) is changed for HC/HCT30 circuit response only if falling edge of input signals is detected.

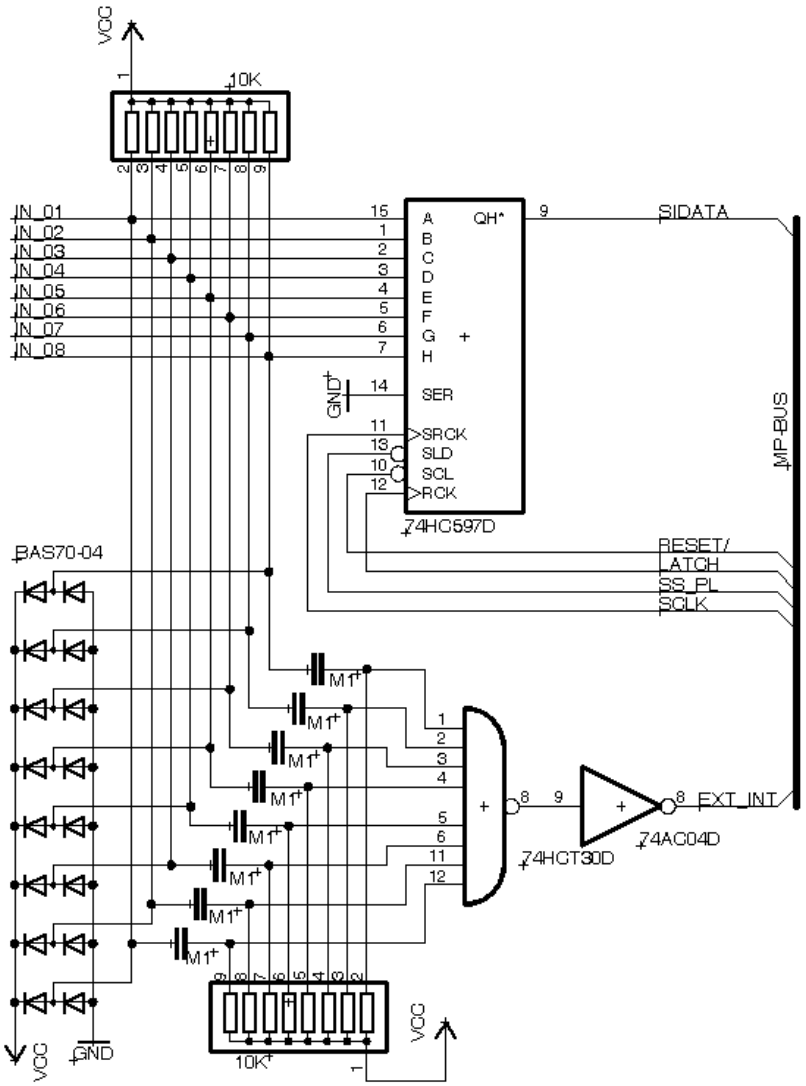

Fig. 3 HC/HCT 597 eight parallel inputs wiring diagram

PISO circuit operation is shown in the time diagram in Fig. 4. Interrupt of the processor is activated by the falling edge of INT input and the program fully operates PISO circuit. At the same time LATCH signal initiates synchronous recording of all parallel inputs. The following signal SS_PL ensures the transcription of data into the serial shift register inside the PISO circuit and then the processor "reads" the captured data from SIDATA using time from the SCLK signal.

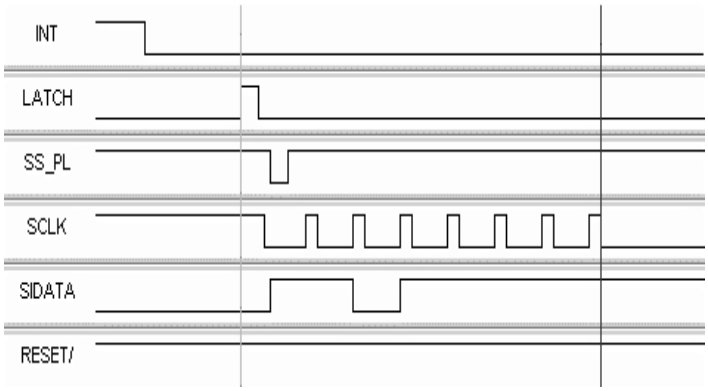

Fig. 4 PISO circuit operation time diagram

It is possible to increase the number of parallel inputs using another PISO circuits. The output (pin 9) of the first PISO circuit is connected to the SER input (pin 14) of the next PISO circuit. Circuits for combination of input signals are similar – HC/HCT30 circuit for all input signals summation and two input gates for merging output signals. Program will then read 2×8-bit data which is repeated routine of the reading eight parallel data.

Tab. 1 Inputs description (to the wiring diagram in Fig. 3)

Symbol	Meaning of the input
IN_01 : IN_08	PISO parallel inputs
SIDATA	microprocessor serial data input
RESET/	resetting shift register to a low level but no change in the input latch.
SCLK	serial data clock for shifting data into the shift register and to microprocessor
LATCH	latch clock for loading parallel data into the input latch
SS_PL	shift register mode control – serial shift or parallel load
EXT_INT	microprocessor external interrupt

4. Commercial Door Motion Control

The whole commercial door system is represented by ten independently opened sliding doors and basic requirements for this particular application were given by the customer. The basic function of the primary system [1] is to open single sliding door based on the detection of a human body motion (or any other motion) in the area in front of the door and to close it after pre-defined time if no motion in the door area was detected. There is an advanced function of a primary system interlock being

activated when dangerous situation occurs and the doors are opened in sequences with possible time control.

Another door control is possible via manual control when the detection system is intentionally switched off. The reliability of the system is enhanced by power supply backup. The 18-volt DC power system with backup battery is fed from the 230-volt AC power supply. The battery is able to open all doors in case of external power supply failure.

The drive control element is ADuC812 microcontroller [2], which not only controls Valeo 0273 GML type DC motor but also processes information from several sensors. The PWM driver [3] is based on BTS780GP power module and the DC motor armature is directly fed from the power MOSFETs of the PWM driver. The Valeo 0273 GML type DC motor rotation motion is converted into sliding door motion via toothed belt.

Motor rotational speed is measured by PM-R24 encoder [4] and the velocity feedback is connected to ADuC812 microcontroller where program for the door motion velocity stabilization is running. The door position is indicated by signals from four GL-N12 series inductive proximity sensors [5] that cause Interrupt Request of the running program. Firstly we used only two GL-N12 sensors as position switches but later we had to use two more sensors due to the weight and momentum of the sliding door (about 80 kilograms). A position switch installed at certain distance before the door end position gives signal to the control program to slow down the door motion so that the door stops smoothly and gently just by the end position sensor.

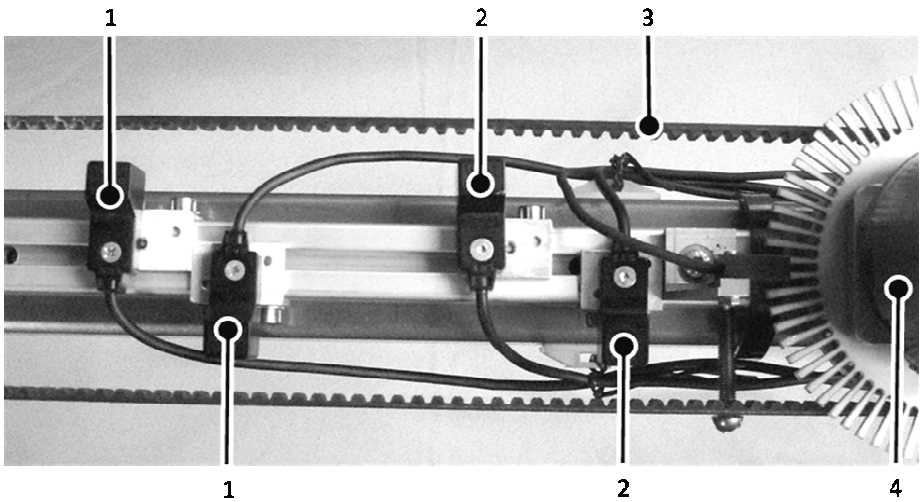

Fig. 5 Mechanical design of primary system – slow down (1) and stop (2) inductive proximity sensors, toothed belt (3) and Valeo drive (4)

The obstacle motion in the door area is detected by four MS-112 passive infrared motion sensor modules. Fire alarm system is not integral part of the commercial door motion system. Signal from fire sensor opens the doors one after another or in a particular time sequence.

The initial conditions such as door motion velocity and PWM signal frequency of the full bridge power transistors are entered from user PC via USB interface. It is also

possible to use USB interface to load the program into control processor and to get information from it during the program compilation.

5. Conclusion

The processing of input signals and motion control is widely known and used but to carry out particular tasks from theoretical knowledge can sometimes cause practical problems. All functions of HC/HCTT 597 circuit can be performed by one simple program. In addition, most microcontrollers have more parallel ports. However, the authors of this article used ADuC812 single chip four parallel port microprocessor that only has 8kB of internal memory. The memory is primarily used for controlling door motion including the special start and slow down sequences.

To summarize the article, the authors have wanted to show one possible successful solution of multi sensor data processing using a single chip microprocessor ADuC812. The functionality and running of this commercial door motion system was verified during several hours of testing. The whole commercial door motion control system is to be put into service in a very near future.

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