Design and Implementation of Can Bus for Distributed Injection Molding Machine based on Arm Controller

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ABSTRACT
In this paper, the distributed intelligent control of plastic injection molding machine based on ARM controller through CAN field bus technology is proposed. The basic components of hardware and Software design are also discussed. The intelligent control system enables the procedure self-learning, fault diagnosing and process parameters such as temperature, injection pressure, flow, limit position etc., in the molding process. The ARM controller as a slave computer for this control system not only provides on-site monitoring but also can provide distributed remote control services for the host computer. The closed-loop control system, composed of the ARM controller and sensors, realizes the prompt adjustment of the processing parameters in the plastic injection molding machine

Keywords
ARM controller, CAN bus, injection molding machine, distributed control system, artificial intelligent control.

1. INTRODUCTION
At present, the control mode of injection molding machines is mainly stand-alone control, which cannot provide the network control function for injection molding machines. The maintenance and the management for the machines are also limited to on-site management level. This kind of operation and management mode is not only unable to meet the requirements of automation and scale production, but also it is harm to the operator's health because they are longtime working in the environments that is full of machine noise and plastic smell. In order to solve the problems mentioned above, the best way is to develop a kind of flexible, effective and practical control system of injection molding machine and establish the automation production line. In regard to this, a new distributed intelligent control system based on ARM and CAN field bus was presented in this paper. This control system can realize the distributed intelligent control and the on-site monitoring of the injection molding machine. Besides, the hardware composition and software design scheme of this control system are also discussed in this paper.

2. RELATED WORKS
In general the literature survey provides that the injection molding machines are stand-alone control. The maintenance and the management for the machines are also limited to on-site management level. To avoid this problem , a new distributed injection molding machine based on ARM and CAN bus technology are utilized .

Zhilei Cui 2011 [1] gives the details about the networking of distributed injection molding machine based on CAN bus.In this it has ARM controller in each machine communicates with the server PC through CAN bus. This system is based on ARM processor which has high performance, and this networking of system provides more advantages i.e., reducing human operators , productivity and accuracy of the product increases. It has improved real-time monitoring and optimize the performance of the system. From this paper the basic idea idea of the project based on ARM and CAN bus is taken.

Tan Siyun 2010 [2] Provides With the development of electronic technology, the plastic injection molding machine controller which applied a single CPU core in the low-end plastic injection molding machines cannot meet the need. A high level of integrated fully automatic plastic injection molding machine controller which based on multi-CPU. Multi-CPU is used for hardware design. In this paper it has multi CPU to control the injection molding machine which has some complexities in hardware and software implementations.

Xia Dong 2008 [3] This paper presents a design method and its implementation of an automatic weighing system based on CAN field bus in process control of industry. First, the general situation of field bus and advantages of CAN bus are introduced. Then the mechanical configuration of a glass weighing system is designed and the interface circuits of its control system based on CAN bus network is implemented. Eventually we introduce the software design of the control system and apply it into the real system. The running result of the industrial system based on the automatic CAN bus control proves the efficiency and reliability of the system design.

Ahmed S.F 2007 [4] In this paper we discuss electro-hydraulic controlling systems of injection molding machine by using a simple Micro controller based embedded system that provides an effective and easy way to control the sequence of the hydraulic actuators movement and the states of hydraulic system. The project of a specific controller for Injection Molding Machine application join the study of automation design and the control processing of Hydraulic systems with the electronic design based on micro controllers to implement the resources of the controller.

3. SYSTEM ARCHITECTURE DESIGN
The ARM-based distributed intelligent control system mainly consists of the host computer, CAN field bus, ARM controller as the slave computer and other accessories, as shown in Fig.1 The control center of the system, host computer, together with CAN field bus, connects all ARM controllers scattered in different working locations, realizing the distributed intelligent control for the injection molding machines. The main functions of the host computer include the initialization of the network, the communication management between the ARM controllers, file transfer, the status monitoring of the machines, product information

statistics, the remote maintenance of the systems and the software upgrades. The ARM controller, as the middle bridge, can provide the remote control for the host computer and can carry on the local control for the machine, such as the setting and modifying the processing parameters, detecting, displaying and controlling the status parameters such as the injection pressure, the flow, the temperature and so on.

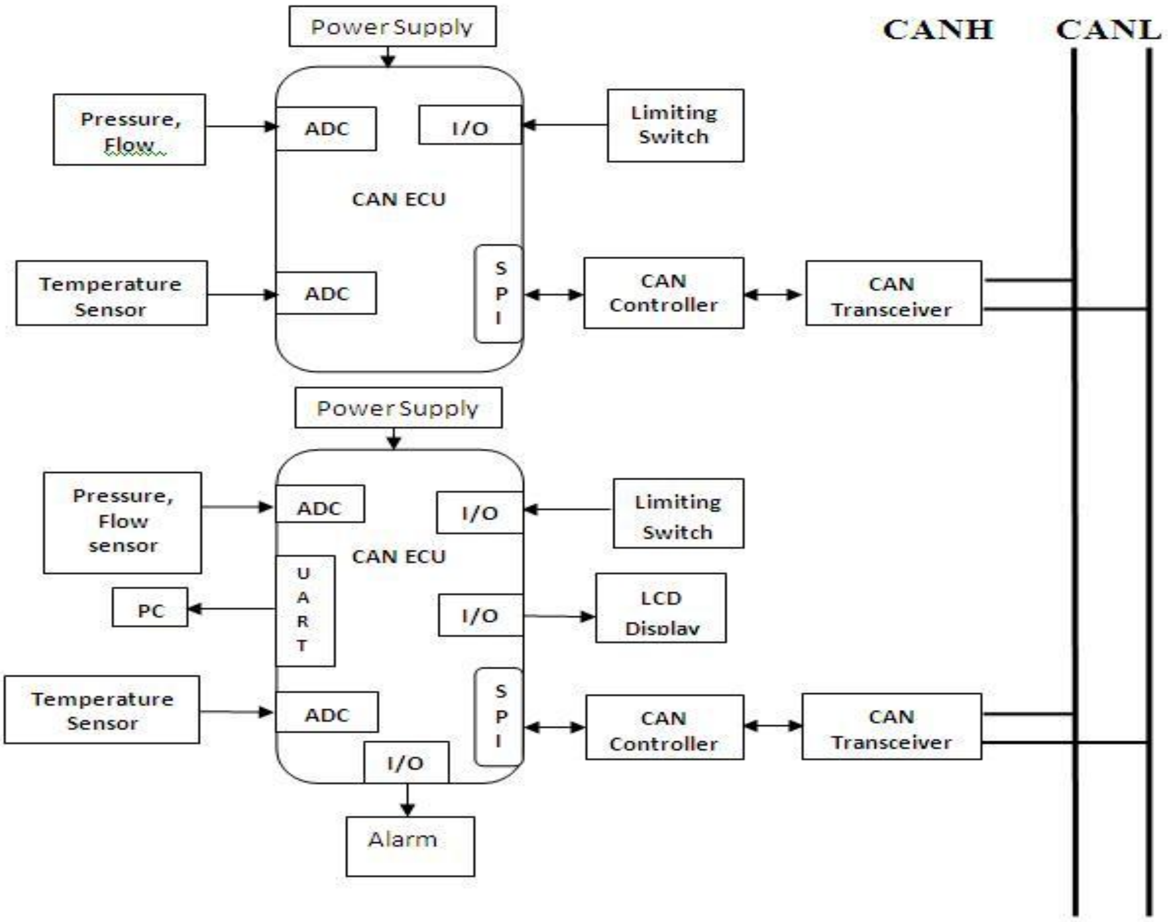

Fig 1: System Architecture Design

4. ARM CONTROLLER

The LPC2129 ARM controller are based on a 16/32 bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, together with 128/256 kilobytes (kB) of embedded high speed flash memory. The LPC2129 ARM controller includes CAN module, serial communication interfaces, UARTs, SPIs, ADC module and other accessories as shown in Fig 1. For critical code size applications, the alternative 16-bit Thumb Mode reduces code by more than 30 % with minimal performance penalty. With their compact 64 pin package, low power consumption, various 32-bit timers, 4-channel 10-bit ADC, 2 advanced CAN channels, PWM channels and 46 GPIO lines with up to 9 external interrupt pins these microcontrollers are particularly suitable for automotive and industrial control applications as well as medical systems and fault-tolerant maintenance buses. With a wide range of additional serial communications interfaces, they are also suited for communication gateways and protocol converters as well as many other general-purpose applications. The ARM controller is attached to every injection molding machine which are located in different locations .It has inbuilt two CAN channels through which the processing parameters are broadcasted to the nodes which are located in various locations.

4.1 Features

- 16/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 16 kB on-chip Static RAM.
- Two interconnected CAN interfaces with advanced acceptance filters.
- Four channel 10-bit A/D converter with conversion time as low as 2.44 ms.

5. CAN COMMUNICATION MODULE

The CAN ECU unit consists of Microcontroller, CAN controller and CAN transceiver as shown in Fig 2.

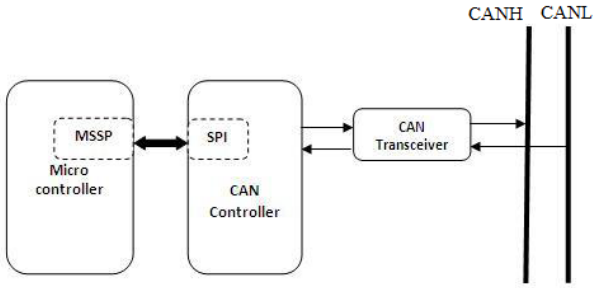

Fig 2 : CAN ECU unit

The CAN bus which consists of a differential two wire bus such as CANH and CANL as shown in Fig 2. CAN communication is based on Message based communication protocol not on address based communication. The CAN bus broadcasts the data on the network. It automatically disconnects the node which is faulty and no data is broadcasted in that particular node and it is intimated to the host computer which monitors and controlling all the nodes in the network. Automatic retransmitting of data on the network is also an another advantage.

5.1 Broadcast communication mechanism

The CAN bus broadcasts the message on the network as shown in Fig 3.

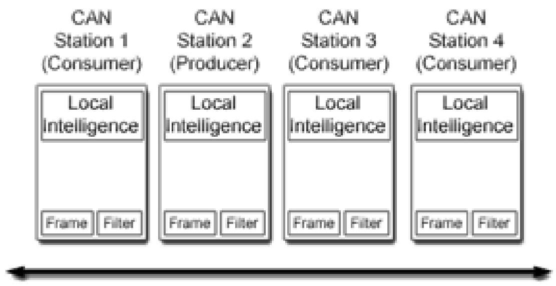

Fig 3: Broadcast Communication Mechanism

6. SENSORS

The sensors which provides the values of Temperature, pressure, flow etc., we use different sensors in this paper is also discussed. The sensor output is given to the ADC in the ARM controller which converts analog value into digital value.

6.1 Temperature Sensor

To measure the temperature the sensor which we selected is LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°Cat room temperature and ±3⁄4°C over a full −55 to +150°C temperature range . LM35 has 3 pins such as Vs, Vout, GND as shown in Fig 4.

Fig 4 : Connection diagram of LM35

6.2. Pressure Sensor

The NPC-1220 series of Solid state pressure sensors are designed to provide a cost effective solution for applications that require calibrated performance over a wide temperature range packaged in a dual-in-line configuration, the NPC 1220 series is intended for printed circuit board mounting. Optional pressure port and lead configurations give superior flexibility in low profile applications where pressure connection orientation is critical.

6.3. Flow sensor

The sensor which we selected is an mechanical sensor as shown in Fig 5.

Fig 5 : Flow sensor

This sensor will operate with the mechanically flow of liquid through the sensor. It has an operating life as 500,000 liters and a maximum pressure ranges 6.0 bar (85 psi).

7. SOFTWARE DESIGN

The software design of the system can be divided into two parts. One part runs on the host computer, whose functions include the initialization of the network, communication management, file transfer, the working status display and record, the on-line modification of the processing parameters of the products, the statistics of the produced products, the remote maintenance of the system and the software update. The other part runs on the ARM controller, which is responsible for the on-site data acquisition, data processing, the implementation of the processing commands, the setting and modification of the processing parameters, and the communication with the host computer, and the communication with the host computer. After the products are finished, the system can do statistics on the yield rate and on the time consumption of the products. According to the results of the statistics, the system can analyze the current process parameters comprehensively, such as flow, injection carriage pressure, injection time, clamping time etc. By comparing them with the related parameters existed in the process knowledge base, these processing parameters can be further optimized and can be stored to the process knowledge base to replace the old ones to do the up gradation. In this way, the knowledge base will be continuously updated. When the machines can't work normally, for example, blanking unsuccessfully, insufficient injection pressure, no material or wrong heater, etc., the system will give fault alarm. As for the treatment of the faults, the operator can either choose automatic or manual reparation. If automatic reparation is unsuccessful, computer will give the suggestion report for by manual reparation. When manual reparation is successful, the system will automatically save the procedure of the manual reparation into the knowledge base in time for later use, such as the methods of solving the troubles, the time consuming and the effect etc. After the machines stop working, the system will give advices report on the maintenance and reparation of the machines.

8. CONCLUSION

In this ARM based distributed intelligent control system of the plastic injection molding machine, the onsite monitoring of the system provides the reduction of manpower and yield rate of the products is also increased, and the accuracy of the product is also higher. The experimental results shows that the critical in setting, processing of the molding machine parameters is reduced. The plastic injection molding machines are networked using ARM controller via CAN bus technology. For the future Instead of CAN bus we can use FLEX RAY bus protocol for higher baud rate compared to CAN bus.

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