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THE LIQUID LEVEL DETECTION PROCESSING SYSTEM BASED ON LABVIEW

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ABSTRACT

Level as one of the important indicators in the industrial production, need accurate measurement and control at any time .We use the single chip microcomputer and LabVIEW design a level test processing system, according to the laboratory level test processing equipment. We deal with the field signal with the use of the SCM hardware circuit and can get the measurement and conversion, which includes display circuit, keyboard and reset circuit, alarm circuit, power rectifier circuit design, etc. In the upper computer system, we can realize level setting, monitoring, displaying and recording function with the help of the LabVIEW. Moreover, the results of the system test are good.

Keywords: *LabVIEW, MCU, RS–485, Level Detection, Data Acquisition*

1. INTRODUCTION

The problems in the process of production and people's daily life more and more are involved in level control and processing. For instance, in drink production, food processing, chemical production, and sewage purification and so on, can use storage liquid pool, and the liquid height control requirements of fluid in the pool need more precise. Too much water will lead to unnecessary waste, but too little can not reach the standard to meet the requirements .So in many cases, even small measuring relative error can cause great economic loss. Therefore, in order to ensure the production efficiency and product quality, it must have the right controller automatically to adjust the accumulation of fluid in the pool of liquid flow rate, liquid level keep in normal level[1,2].

The United States NI company has developed LabVIEW software. It is easy and flexible for users to complete their required system through the way of the graphical programming .At present , LabVIEW has popularity in industrial production, laboratory operations, academic research, and other fields , because it is easy to grasp, convenient to operate and so on .It is set up inside the large numbers, powerful function library, which can provide users with more program function .At the same time it can satisfy the function of data acquisition card and the agreement hardware of RS -485 and RS-232. Besides, with the use of LabVIEW , it can make programming process more convenient[3].

We can put all these practical problems from different background simplified to a problem of liquid level control and processing. In the industrial control process, liquid level is a very important parameter.

The laboratory level test processing equipment and level control equipment are controlled by traditional analog instrument .Only with the use of computer to level processing instead of the laboratory equipment, can we make a further explore of the research experiments .Virtual instrument VI plays a more and more important role in the worldwide especially in the industrial production level detection as a system combined with standard interface to the hardware module, computer platform and the development of testing software. Level as one of the important indicators in the industrial production, need accurate measurement and control at any time. The previously used method is artificial placement timing level monitoring and to control the switch valve according to the difference between the liquid level gauge measuring indicated value and the setting numerical value .But in this way ,it will produce the misreading and mistake, the lack of real time, be unable to well deal with the emergency situation .This paper will design a set of real-time, automatic level control monitoring system, and fully introduce the concept of virtual instrument .

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And make the design of the monitoring system with clear structure, simple concept.

In this paper the research we study is the intelligent real-time level detection processing system based on the LabVIEW control platform, and controlled by the MCU .The main research content two aspects: one is the hardware design, and this hardware design part of the liquid level data measurement included display circuit, keyboard and reset circuit, alarm circuit, power rectifier circuit design, etc. The other aspect is the LabVIEW platform for liquid level data real-time display, and processing operation, etc.

Section 2 presents the overall design of the system. In section 3, we introduce the hardware design. In section 4, we introduce detailed design steps of the liquid level system design based on LabVIEW. Section 5 gives a conclusion to the whole paper.

2. GENERAL DESIGN[4]

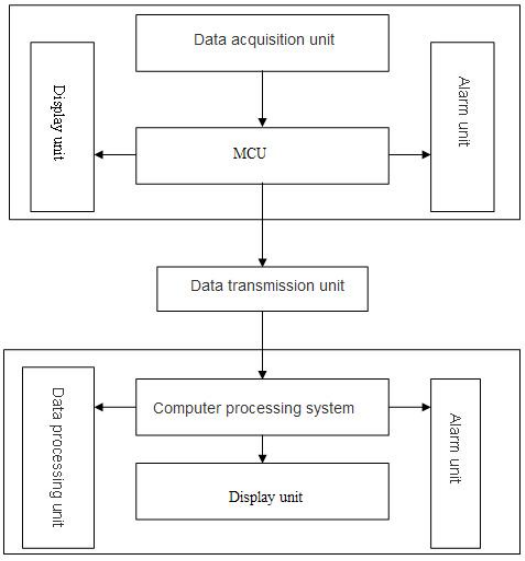

Figure 1: System Structure

In the hardware platform design, should meet the requirements as follow:

Take the accuracy of measurement into fully consider, select the hardware which can satisfy the accuracy of requirement.

Be strict with controlling the cost of hardware production, which can make sure the capital input of the system cost less than other products.

In the design process, we can use modular thought which includes three aspects: mechanical structur, upper computer and lower computer shown in figure 1

Along with the level changes, we transform the variation of the liquid level height into the input physical signal, then transform this signal into the encoder, and transform the physical signal into electrical signals. What's more, put these data digital processed in the lower computer into the actual liquid level height, and then realize the demonstration and warning with the help of upper computer.

3. THE HARDWARE CIRCUIT TRUCTURE DESIGN

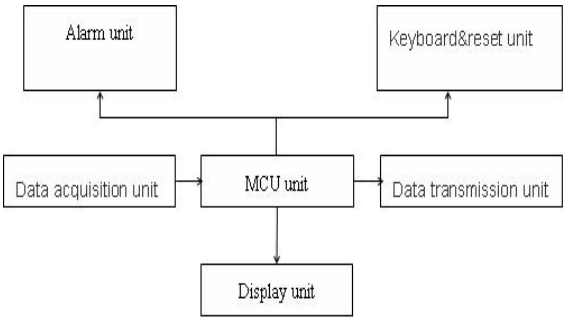

Figure 2: Hardware Structure

The system hardware can be divided into data acquisition unit, data transmission unit and single-chip microcomputer processing unit, keyboard reset unit, alarm unit and display unit.

In each design, micro controller is the core which ensures the system is running. We should make choices according to the actual situation and the specific requirements of subject, and this time we select STC89 single-chip microcomputer. It is a new type of 51 single-chip microcomputer has a very low power consumption, anti-interference ability and wide range of voltage. Do special treatment to reset circuit, power circuit and clock circuit in order to prevent the artificial influence. In the meantime, do some protection for each input and output port for power and ground pins. In the data acquisition unit, we select the absolute type encoder ROQ425Multi rotary encoder designed and produced by German Hyde han company in order to minimize signal acquisition form errors and satisfy the accuracy requirement. The action voltage of this converter is 5v, using gray code as its output code, using the pure binary and the biggest machine speed is 10000 revolutions per minute.

In the upper computer system, install the LabVIEW system, the liquid level of real-time

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monitoring, alarm and display can be shown based on the virtual instrument simulation, monitor, and display function.

3.1 The Data Acquisition Circuit Design

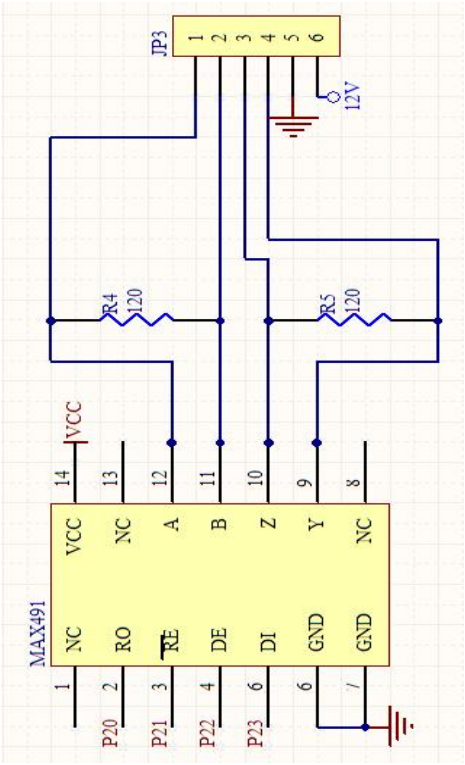

Figure 3: Data Acquisition Circuit

Due to the output signal of the encoder ROQ425 conform to the RS - 485 protocols, so it needs to be transformed into a signal as the input of single-chip microcomputer. There are many chips to complete this conversion, which can be generally divided into classes: full duplex and half duplex. From the encoder reading sequence diagram, we know that the output of the data makes a conversion in the clock signal falling edge and transmit in the clock signal rising edge .Therefore, we choose a full duplex conversion chip. We choose the MAX491 chip, which is a kind of low power transceiver used for RS - 485 and RS - 422 communications. And this chip contains a driver and a receiver; what's more, its transmission rate can be 2.5 Mbps .Data acquisition circuit diagram is shown in figure 3.

3.2 The Upper Computer and MCU communication circuit design

MAX485 is a kind of widely used interface type chip, more as a transceiver for RS - 422 and RS - 485's communication. Its structure is very simple; each component contains a driver and a receiver. MAX485 can do normal operation at a 2.5 Mbps

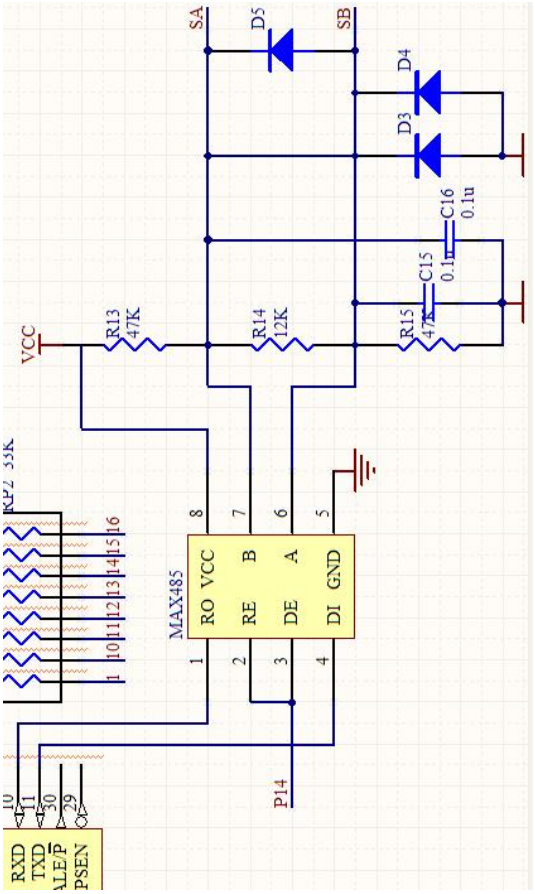

Figure 4: MAX485 Communication Circuit

transmission speed, and one of its advantages is that it does not restricted by the driver.

One of the functions of MAX485 is to change the TTL level into RS-485 levels. Its rated current is 300 μA, rated voltage is 5v. And using a half duplex as a communication way.

We just use only one pin of the single chip but control two pins of the MAX485. Decided by its work pattern, one input signal can not only receive but also send information. Due to the MAX485 half duplex work pattern that this situation can be realized. It has to receive and send differential signal end, respectively end A and end B. When send data is 1, the level of A to be higher than B side at this time. On the other hand, end A is lower than end B, when send result is 0.

In order to structure MAX485 linear topological network, the requirement is to set up two terminal matching resistance , whose resistance is equal to transmission characteristic impedance of the cable, here we choose the resistance of 120. In addition, in order to improve the reliability of the node, output module still need

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to be configured pull-up resistors and pull-down resistors. But in this subject, distance is short, baud rate is low, combined with the actual conditions of the limit in the design, so we can ignore these things' influence.

The communication circuit designed with MAX485 chip is shown in figure 4. Put the input /output of the enable end respectively on both ends connected to the single-chip microcomputer serial input/output, which can make the P14 has an effective control to MAX485's enable end. In order to improve the reliability of the MAX485 and prevent chip in the idle state missing network fail-save protection, it needs to be configured pull-up resistors and pull-down resistors. What's more, put MAX485's A and B respectively on both ends connected to R13 and the R8.

3.3 The Keyboard and Reset Circuit Design

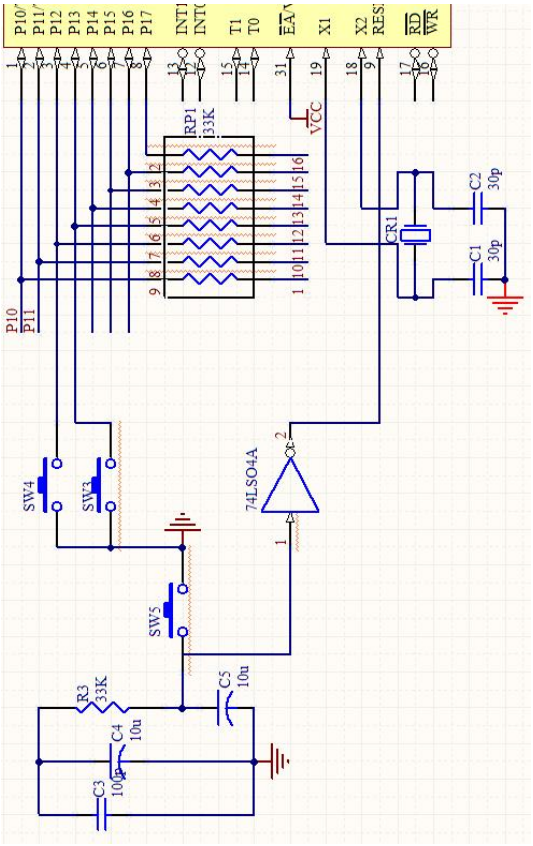

Figure 5: The Keyboard and Reset Circuit

Keyboard circuit as a manual operation method of single chip microcomputer has a very important significance to the single-chip microcomputer's command control and data input. Because it can be used as one-to-one independent key making a direct control to the single-chip microcomputer .In the process of interaction with the single chip microcomputer, we take program scanning query as a way to check the level. When you press the button, the corresponding I/O port present a low level state, on the contrary, it presents a high level of the state. We design the keyboard circuit based on this kind of independent type keyboard interface form, which is shown in figure 5.In the figure, P12 and P13 have an effect to choose a mode of high and low limit of the level, and confirm the button pressed .Then get into the measurement program after initialization. P10 and P11 play a role in adjusting display as to realize the liquid level limit setting .Due to the mechanical switch will have a delay in the switch, we should take some other measures to reduce the impact caused by delay.

In designing reset circuit settings, we use not only the key reset, but also the electric reset. Press the key 5, input of 74LD04 is low level, reset pin appears as high level, after this it completes the reset. Similarly, at the moment of electricity, C5 is no charge and appears as low level, and then makes SCM reset pin appears as high level, then become low down after period of time, after this it completes the reset.

3.4 The Power Circuit

Each chip has the use range of voltage; high voltage will make components by the influence of different level, make the result out of accurate if not serious, and damage components if serious, so power rectifier circuit is very necessary. Usually the original voltage is 220v AC; through the coil's voltage are 7v and 15v. And the voltage is transferred to regulated block by the rectifier and capacitor's filter, thus obtains the undecided voltage.

Here we use triode to design the external control circuit; it can protect SCM from external high voltage damage and interference. At the same time we use two current limiting resistors to protect the triode and the I/O port. . The triode cannot break over when I/O port is the low electric, and the output is low level; On the other hand, the output is high level.

In addition, we select MAX7219 chip to control, so as to realize the encoder numerical display. The chip can drive eight bit seven segment LED lamp seven segment LED lamp seven segment LED lamp or 64 separate LED lamps, is a relatively universal serial display chip.

In the 7219 register, XAH is a brightness register; its role is to adjust the brightness of the light-emitting diode. X9H is called decoding mode

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register, used to set the way of decoding ,it is BCD decoding when set 1, it is not BCD decoding when set 0. Display register is used to switch modes, one kind is test mode, and the other is the normal mode. XB is a limit scanning register; it is used to display the number of data. Light the decimal point, when D7 is 1.

4. LIQUID LEVEL SYSTEM DESIGN BASED ON LABVIEW[5-7]

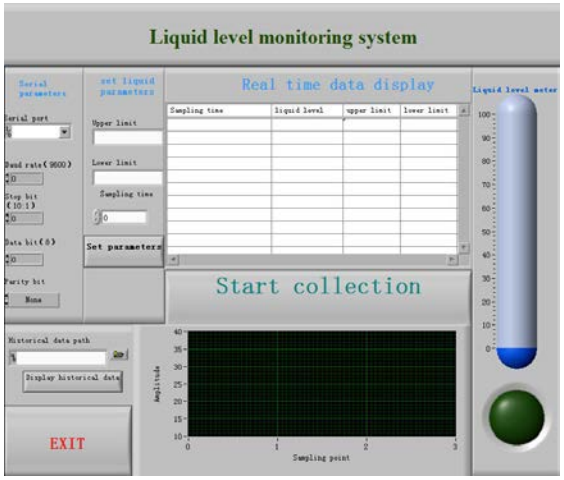

Figure 6: System Front Panel

In data acquisition and processing system, it is too large and too complex for some system. It is fortunate that, LabVIEW graphics/connection design function enables users to divide the complex system into several subsystems, with the idea of modularization to complete design task .The main functions of the program of the system is the standard of module partition, and these functions includes data acquisition, data real-time display, data storage, historical data reading, system alarm etc. Physical structure is shown in figure 6.

4. 1 the Program of Data Acquisition and Display

Before data acquisition, we need to set parameters, including the choice of serial port, baud rate, data bits, parity check, stop bits settings, and at the same time also need to set the lower limit and upper limit of the liquid level .It needs to give an alarm and lit the lamp when the acquisition data is greater than the upper limit or less than the lower limit. Take the real-time data display template for an example to explain the system design steps, which is shown as follows.

Control option board->new -> list, forms, tree -> form;

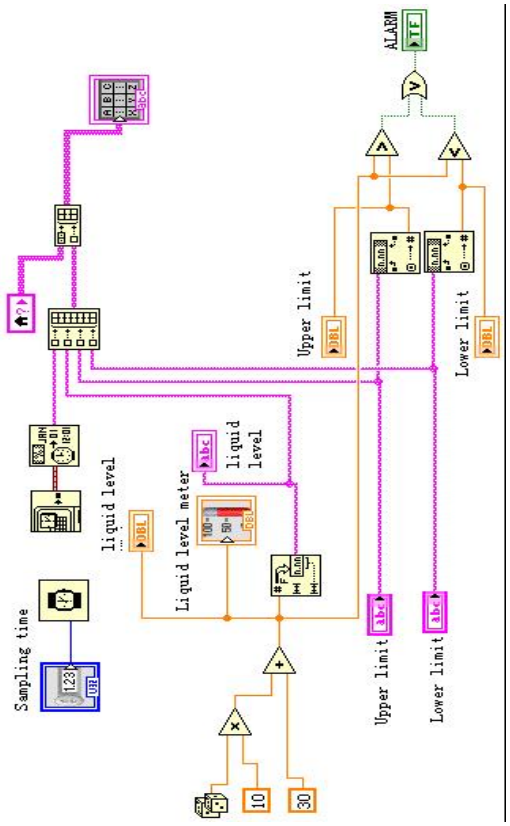

Figure 7: Program of Data Acquisition and Display

Start collecting (button) -> Control option board -> Boolean -> Enter button;

Upper limit-> Control option board -> choose new -> numerical value-> numerical display control;

Lower -> Control option board-> choose new -> numerical value ->numerical display control;

Alarm lamp -> Control option board -> choose new ->Boolean -> the round indicator;

Function option board -> programming -> timing -> get date/time (seconds);

Function option board -> programming -> timing -> formatting date/time string;

Function option board -> programming -> timing -> wait (ms);

Function option board -> programming -> string -> string/numerical value conversion -> numerical values to decimal string conversion;

Function choose plate -> programming -> array -> create array;

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4.2 The Program of Data Save

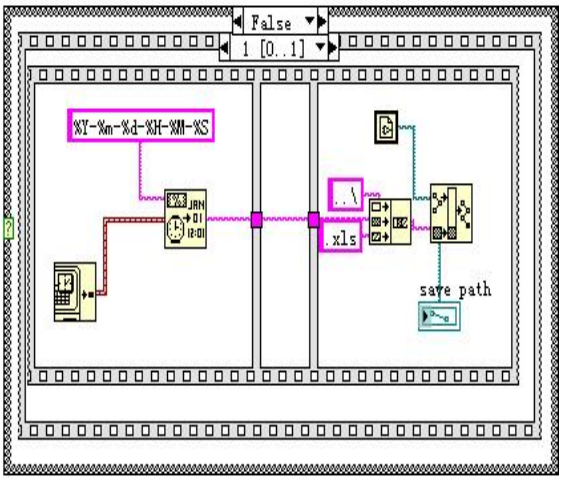

Figure 8: Create Excel Form Named After Time

The data storage is to save acquisition data named after time in excel, so every time running, it can produce different excel table because time is different, and it will not lose data, concrete program is shown in figure 9.For historical data query, because acquisition data has be stored in the excel, the historical data just need read program to be read when calculating, and each data is unique in time.

4.3 Debugging Results

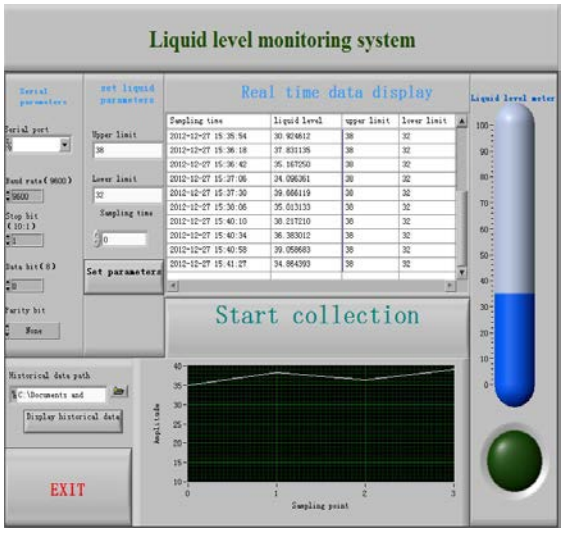

Figure 9: Liquid Level Monitoring System

Make up a control system of single loop water level according to the requirements .Check before operation, to make sure the correct attachment and the equipment protection measures equipped .Set the parameters of initialization procedure, press the automatic button , and the system into a closed loop, observe real-time curve directly , waiting for the water balance in the meantime .We can choose control object, enter the lower and upper limit value in the monitoring interface when the system is running . The real-time control curve and real-time data are displayed in the interface .Debugging results are shown in figure 9. And in figure 9, it expresses acquisition waveform dynamic curve very clearly. Most importantly, the system realizes the control function well.

The prominent characteristics of the design are to save acquisition data. .It is convenient for users to access the historical data later, and it can realize the data remote accessed .So it has practical significance .We can read out the record data ,just running the history data read program ,which is very convenient .

5. CONCLUSION WORDS

In the industrial control process, liquid level is a very important parameter especially in dynamic state. It can have a very good production effect with appropriate methods to test and control the liquid level .We use the single chip microcomputer and LabVIEW design a level test processing system, according to the laboratory level test processing equipment. And we use LabVIEW system to realize the level setting, monitoring, displaying and recording, which achieves a good effect in the upper computer system. At present , LabVIEW is easy to grasp, convenient to operate and so on .Besides ,with the use of LabVIEW ,it makes programming process more convenient .All kinds of virtual instrument and measuring and controlling system realized by the use of LabVIEW will have a bright future .

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