Design of a New Water Level Meter

Jian Huang

Xijing University, Xi'an 710123, China

565200245@qq.com

Keywords: Water level measurement; Capacitance sensing; High precision

Abstract: In engineering and experiment, it is often necessary to accurately measure water level, which can be used for flood control and has a significant impact on people's lives. At present, the commonly used methods are image acquisition and recognition, but they are vulnerable to interference, and the accuracy rate is low. In order to reduce interference and improve accuracy, a new technology based on capacitance sensing is adopted. When the water level changes, the parasitic capacitance will change. This change can be detected by a high-precision sensor and converted to the water level value.

1. Introduction

In daily life, water level detection has important social value and significance, and can be used for weather forecast and flood control. Therefore, there are many methods to detect water level, buoyancy or image acquisition technology can be used to detect water level. But both methods are susceptible to interference.

To avoid these shortcomings, a new method of water level detection is proposed in this paper. A new type of digital capacitive sensor FDC2214 is used to detect water level changes, based on non-contact capacitive sensing technology. FDC2214 has four channels, each of which can sense small changes in capacitance and convert them to up to 28-Bit binary output. Firstly, when a single-sided copper clad sheet is inserted into water, the parasitic capacitance will be generated by water medium on the copper clad sheet. When the water level changes, the parasitic capacitance will change. FDC2214 perceives this change and converts it to 28-Bit binary output, which can be processed by high-performance microprocessors.

2. Hardware Design

The schematic diagram of water level detection is shown in Fig. 1. In order to improve the speed of data acquisition, an external 40 MHz active crystal oscillator [9] is needed. In order to enhance the reliability and practicability of the system, it is necessary to test the environment. Channel 0 of FDC2214 detects the capacitance value of the current air environment, and channel 2 detects the capacitance value of the measured liquid environment, and immerses it completely in the liquid when measuring. The above two measurements are taken as reference values. Channel 1 connects a one-sided copper clad sheet and inserts it into the liquid. Part of it is exposed in the air. When the water level changes, the parasitic capacitance capacity of the copper clad sheet will change. FDC2214 is sensitive to this change and converts it into up to 28-Bit binary digits, which are transmitted to the high-performance microprocessor STM32F103ZET6 through the IIC interface to detect and process the data. The calculation of water level is carried out by formula (1).

$$L = h \times \frac{C_L - C_L(0)}{C_{RL} - C_{RE}} \tag{1}$$

  DOI: 10.25236/icemc.2019.021

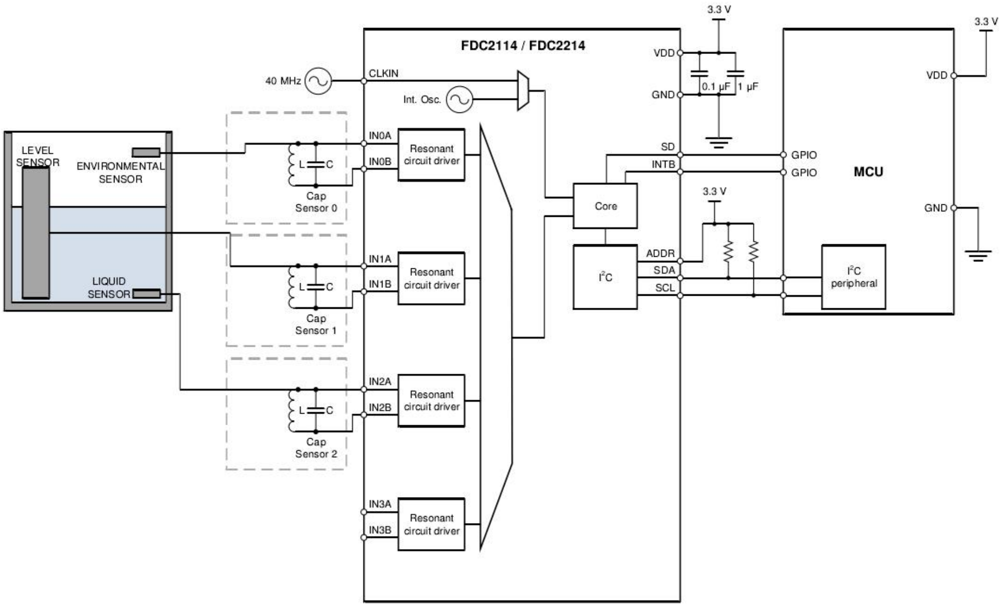

Fig. 1 water lever check diagram

3. Software

In this design, KEIL 5 is programmed in C language. Using IIC interface to sample the data。Giving some codes below:

```
    void IIC_Init(void)
    {
        GPIO_InitTypeDef GPIO_InitStructure;
        RCC->APB2ENR|=1<<0;
        AFIO->MAPR|=4<<24;
        GPIO_PinRemapConfig(GPIO_Remap_SWJ_JTAGDisable,ENABLE);
        RCC->APB2ENR|=1<<3;

        RCC_APB2PeriphClockCmd(RCC_APB2Periph_GPIOB|RCC_APB2Periph_GPIOA,EN
ABLE)   RCC_APB2PeriphClockCmd(RCC_APB2Periph_AFIO, ENABLE);

        RCC_APB2PeriphClockCmd(RCC_APB2Periph_GPIOA
|RCC_APB2Periph_GPIOB ,ENABLE);

        GPIO_InitStructure.GPIO_Pin = GPIO_Pin_10| GPIO_Pin_11 ;

        GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
        GPIO_InitStructure.GPIO_Mode = GPIO_Mode_Out_PP;
        GPIO_Init(GPIOB, &GPIO_InitStructure);
        GPIOB->ODR|=3<<3;

       GPIO_InitStructure.GPIO_Pin = GPIO_Pin_0;
        GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
        GPIO_InitStructure.GPIO_Mode = GPIO_Mode_Out_PP;
        GPIO_Init(GPIOB, &GPIO_InitStructure);

        RCC_APB2PeriphClockCmd( RCC_APB2Periph_GPIOC,ENABLE);
        GPIO_InitStructure.GPIO_Pin = GPIO_Pin_5;
        GPIO_InitStructure.GPIO_Speed = GPIO_Speed_50MHz;
```

```
    GPIO_InitStructure.GPIO_Mode = GPIO_Mode_Out_PP;
    GPIO_Init(GPIOC, &GPIO_InitStructure);
    IIC_SCL=1;
    IIC_SDA=1;
}
void LDC1314_Init(void)
{
    uint16_t deviceID = 0;
    IIC_Init();
    LDC_ADDR = 0;
    LDC_SD = 0;
    delay_ms(500);
LCD_write_16bit(LDC13xx16xx_CMD_REF_COUNT_CH0,0X04D6);

    LCD_write_16bit(LDC13xx16xx_CMD_REF_COUNT_CH1,0X04D6);
    LCD_write_16bit(LDC13xx16xx_CMD_REF_COUNT_CH2,0X04D6);
    LCD_write_16bit(LDC13xx16xx_CMD_REF_COUNT_CH3,0X04D6);

    LCD_write_16bit(LDC13xx16xx_CMD_SETTLE_COUNT_CH0,0X000A);
    LCD_write_16bit(LDC13xx16xx_CMD_SETTLE_COUNT_CH1,0X000A);
    LCD_write_16bit(LDC13xx16xx_CMD_SETTLE_COUNT_CH2,0X000A);
    LCD_write_16bit(LDC13xx16xx_CMD_SETTLE_COUNT_CH3,0X000A);

    LCD_write_16bit(LDC13xx16xx_CMD_CLOCK_DIVIDERS_CH0,0X1002);
    LCD_write_16bit(LDC13xx16xx_CMD_CLOCK_DIVIDERS_CH1,0X1002);
    LCD_write_16bit(LDC13xx16xx_CMD_CLOCK_DIVIDERS_CH2,0X1002);
    LCD_write_16bit(LDC13xx16xx_CMD_CLOCK_DIVIDERS_CH3,0X1002);
    LCD_write_16bit(LDC13xx16xx_CMD_ERROR_CONFIG,0X0000);
    //LCD_write_16bit(LDC13xx16xx_CMD_MUX_CONFIG,0X0820C);
    LCD_write_16bit(LDC13xx16xx_CMD_MUX_CONFIG,0X0C20C);
    LCD_write_16bit(LDC13xx16xx_CMD_DRIVE_CURRENT_CH0,0x9000);
    LCD_write_16bit(LDC13xx16xx_CMD_DRIVE_CURRENT_CH1,0x9000);
    LCD_write_16bit(LDC13xx16xx_CMD_DRIVE_CURRENT_CH2,0x9000);
    LCD_write_16bit(LDC13xx16xx_CMD_DRIVE_CURRENT_CH3,0x9000);
    LCD_write_16bit(LDC13xx16xx_CMD_CONFIG,0x1401);
    delay_ms(100);
        deviceID = LCD_read_16bit(0x7f);    while(deviceID != 0x3055)
     {
        printf("\r\nFDC2214 ID:%d",deviceID);
       }
       printf("\r\nFDC2214 ID:%x",deviceID);
}
```

4. Summary

This paper expounds the principle and method of water level measurement by STM32, gives the hardware circuit design diagram, describes the basic principle of capacitance sensing in detail, and compiles a program in C language under KEIL, which can accurately measure water level information and meet the design requirements. It has certain practical value.

References

[1] Baojiang; Tao Qingchuan; Zhang Peng. Water level line detection algorithm based on image

processing [J]. Hydropower and Energy Science, 2015, 33 (4): 96-99.

[2] Zhang Zhen; Zhou Yang; Wang Huibin; Gao Hongmin; Liu Haiyun. Image water level measurement with standard two-color water gauge [J]. Journal of Instruments and Instruments, 2018, 39 (9): 236-245.

[3] The application of Feng Guang, Zhang Changsheng, Liu Ziyu, Li Chuan, Qian Bin, Zhang Hanping.IADF algorithm in water level image measurement of two-color water level gauge [J]. Sensors and microsystems, 2016, 35 (10): 148-151.

[4] Zheng Guilin; Dong Qipeng. Accuracy study of air-mediated self-correcting acoustic water level gauge [J]. Rural Water Resources and Hydropower in China, 2018, 7:52-55.

[5] Zhu Guangming; Wang Ruirong; Yu Xiaoqing. Design of Qiantang River Flow and Water Level Telemetry Terminal Based on STM32 [J]. Instrument Technology and Sensors, 2018:18 (22): 229-236.