浙江科技學院
ZHEJIANG UNIVERSITÄT FÜR WISSENSCHAFT UND TECHNIK

实习报告本

Class　　　: 2020

Student ID : 9200353007

Name　　　: Josephine Odutayo Eyituoyo Odusanya

Supervisor : 曹晓超

Supervisor Company : AEE, 浙江科技大学

Location　 : 杭州，　浙江，中国

实习日期自　　**2023** 年　**12** 月　**18** 日至　　**2024** 年　**01** 月　**23** 日

Development of GPS system based on 8052 Microcontroller

School of Automation and Electrical Engineering

Summary

During my internship, I was tasked with developing a GPS system using the 8051 microcontroller. The resulting report offers a detailed overview of the hardware and software design process, which involved leveraging various components, including a GPS receiving module and a 12864 liquid display module, to achieve real-time GPS display functionality. In addition to technical aspects, the report delves into the history of GPS, its future, and emerging research directions. It also explores industry and national standards of GPS within the field of robotics. The report further examines non-technical considerations essential to successful engineering project implementation in China, such as social, environmental, safety, and economic factors, and the responsibilities of foreign enterprises and engineers. The internship was completed at AEE, Zhejiang University of Science and Technology, a renowned provincial university with a global perspective. Overall, the report offers a comprehensive understanding of GPS system development, making it an invaluable resource for individuals interested in this field.
.

Keywords : GPS, 8051, AEE, robotics

Table of Contents

Chapter 1 Introduction 1
1.1 Purpose of the internship 1
1.2 Overview of the Internship Company 2
Chapter 2 Overview of Internship Content 8
2.1 Introduction to the GPS 8
2.1.1 Historical Roots 9
2.1.2 Applications Across Different Industries 10
2.1.3 The Future of GPS 11
2.2 Current Research Directions 13
Chapter 3 Internship Content 15
3.1 GPS Device Working Principle 16
3.2 Hardware Circuit Design based on microcontroller 16
3.2.1 Minimum system 17
3.2.2 Reset circuit 18
3.2.3 Crystal oscillator circuit 20
3.2.4 Details of GPS Receiving module and MCU-GPS connection 22
3.2 Introducing the CH340 module 24
3.3 Software Development Environment 25
3.3.1. Proteus 8 Professional to Simulate 25
3.3.2. Keil C15 28
3.3.3. Stc-isp-15xx-v6.92K 30
Chapter 4 Troubleshooting Hardware and Software 32
4.1 Hardware Debugging 32
4.2 Software Debugging 33
Chapter 5 Industry and International Standards 34
5.1 Industry Standards 34
5.2. International Standards 34
Chapter 6 Non-technical Considerations 36
6.1 Analysis of Restrictions and Responsibilities in the China 36
6.2 Responsibilities of Enterprises and Engineers 37
Chapter 7 Summary of Experience 39
Chapter 8 Appendices 40
8.1 Appendix A 40
8.2 Appendix B 44
Chapter 9 References 54
Chapter 10 Acknowledgement 57
Report Reviews 58

Chapter 1 Introduction

The internship introduces in detail a microcontroller, GPS receiving module, 1602 liquid display module and other devices. The intention was to achieve the implementation of GPS real-time display function. In this report, the project undertaken is elaborated in detail from the aspects of hardware design and software design, and combines the characteristics of the hardware to study how the MCS-51 series microcontroller realizes serial communication with the GPS receiving module.

1.1 Purpose of the internship

Image 1

During the month or so taken to achieve this project, several milestones were outlined:

a) Gain hands-on experience with GPS hardware and software design.

b) Realize human-machine interface.

c) Complete a hand held GPS positioning receiving device with LCD display.

Through research on the GPS receiving board and LED display module, a system for collecting and displaying GPS positioning information is created.

1.2 Overview of the Internship Company

Zhejiang University of Science and Technology was founded in 1980, initially known as Hangzhou Industrial School attached to Zhejiang University. Over 40 years' development, ZUST has grown into a first-class application-oriented provincial university with distinctive international and regional characteristics.

ZUST has been keeping on the way of international education so that it always takes international exchanges and cooperation as an important development strategy; thus, its distinctive feature is international education. In this regard, ZUST is the first batch of universities to pass the quality certification on overseas students' study in China by the Ministry of Education; it is also the construction unit of "Sino-German Forum" base, the member unit of the Federation of Colleges and Universities among China-Central and Eastern European Countries, the member unit of the Alliance of Business Colleges and Universities along the Silk Road. What's more, ZUST is the first batch of colleges and universities sponsored by the Silk Road Chinese Government Scholarship, the first batch colleges and universities funded by the China Scholarship Council for Young Key Teachers' Overseas Study program, the first batch colleges and universities to recruit overseas students to study in China subsidized by the Chinese Government Scholarship. On the whole, ZUST is the first batch of universities with international characteristics in Zhejiang province, its overall internationalization level ranks at the top of universities with the right to confer master's and doctoral degrees in Zhejiang Province; it also ranks at the top 50 China's public universities with international competitiveness.

ZUST has hitherto established exchange and cooperative relations with 141 universities in Germany, France, the United States, Australia, the United Kingdom, Japan, Belgium, Romania and other countries (outside China's mainland) on the basis of 179 various international cooperation and exchange projects. Especially, the Sino-German cooperation has become an important window for education, cultural, science and technology exchanges and cooperation between Zhejiang Province and Germany, even between China and Germany, for the Sino-German cooperation between ZUST and German universities has been long and fruitful, e.g., the former German Chancellor Angela Merkel spoke highly of the cooperation achievements between ZUST and German universities during G20 Hangzhou Summit, besides, the former German President Herzog and Woolf visited ZUST personally one after another.

ZUST is one of the universities with the most international majors in English in Zhejiang Province for it offers 12 international majors in English at undergraduate level, 12 international majors in English at master level, and 2 international majors in English have been selected as the key international major project of Department of Education of Zhejiang Province. In addition, ZUST has developed three Sino-foreign cooperative education programs at the undergraduate level and founded the first

Sino-foreign cooperative educational institute in Zhejiang Province--Chinese-German Institute for Applied Engineering (CDAI), and the first national industrial culture institute --Chinese-German Industrial Culture Institute. Besides, ZUST has the first Chinese -German Industry-Education Integration Major--the pilot program Vehicle Engineering Undergraduate Major; it has also successively established two overseas Confucius Institutes in Romania and Germany respectively, among which the Confucius Institute in Babes-Bolyai University of Cluj-Napoca in Romania was awarded as the "Advanced Confucius Institute" in the world.

ZUST hit another milestone in being approved to change its Chinese name from 学院 (xueyuan) to 大学 (daxue). The official name change ceremony was held on the 18th of January at the schools Crystal Theatre on its Xiaoheshan Campus.

The above is just meant to be a brief overview of ZUST and it’s impact here in China and collaborations abroad. The internship was specifically hosted under a particular department known as the School of Automation and Electrical Engineering

The Automation and Electrical Engineering (AEE) Department at Zhejiang University of Science and Technology (ZUST) is a vital component of the university's academic landscape, playing a pivotal role in the field of technology and engineering. This department is dedicated to providing students with a comprehensive education in automation, electrical engineering, and related disciplines. This is the department that hosts my major, Robotics Engineering and has graciously permitted me to undertake my internship.

Image 2

The AEE Department at ZUST offers a range of undergraduate and postgraduate programs designed to equip students with the knowledge and skills needed to excel in the dynamic and rapidly evolving fields of automation and electrical engineering. The curriculum is carefully crafted to cover fundamental principles, cutting-edge technologies, and practical applications, preparing students for careers in industries such as manufacturing, energy, telecommunications, and automation.

Faculty members in the AEE Department are professionals and researchers with expertise in areas such as control systems, power systems, robotics, and artificial intelligence. They actively contribute to both academic research and industry collaboration, ensuring that students benefit from the latest advancements in the field.

Students in the AEE Department have access to state-of-the-art laboratories, allowing them to gain hands-on experience and apply theoretical knowledge in practical settings. The department also encourages students to participate in research projects, internships, and industry partnerships, fostering a holistic learning experience that goes beyond the classroom.

In line with ZUST's commitment to internationalization, the AEE Department actively promotes exchange programs, collaborative research projects, and partnerships with institutions worldwide. The college continues to improve the level and breadth of scientific research and social services, focusing on research directions such as robotics, intelligent perception, automation, intelligent control, and motor drives. It undertakes general projects of the National Natural Science Foundation of China, key R&D projects of Zhejiang Province, and major horizontal corporate commissions. Technology development projects. In the past five years, the college has completed various scientific research funding of 40 million yuan, and undertaken 10 national-level scientific research projects and 20 provincial-level scientific research projects. Won 3 provincial and ministerial awards, published more than 100 SCI/EI papers; more than 100 authorized patents; 2 results transformation auctions worth more than 800,000 yuan. The college organized and participated in China Robot Competition, Electronic Design Competition, National Smart Car Competition, National Automation System Application Competition, National College Student Intelligent Building Practical Skills Competition, Challenge Cup and many other competitions, and won the first prize in the National College Student Smart Car Competition. Excellent achievements such as the first prize in the National College Student Electronic Design Competition and the first prize in the National Robot Competition. In the past three years, it has won 264 awards in national, provincial and ministerial level subject competitions, and more than 50 projects have been approved in the past four years in competitions such as National Innovation, New Miao, Challenge Cup, and Internet+.

During the "14th Five-Year Plan" period, the School of Automation and Electrical Engineering was vigorous and advancing hand in hand, making continuous efforts to build a high-level socialist Zhejiang University of Science and Technology with distinctive international characteristics.

With all these milestones, it makes this department a good avenue to confidently apply the knowledge gained throughout my degree in a practical project.

Chapter 2 Overview of Internship Content

In order to fulfill the requirements for the course Engineering Technology Practice, I have undertaken an internship with the School of Automation and Electrical Engineering of Zhejiang University of Science and Technology. This internship involved the research, design and prototyping of a Global Positioning System (GPS) using an 8051 microcontroller, 1602 LCD and GPS module VK2828U7G5LF.

2.1 Introduction to the GPS

"GPS, or the Global Positioning System, is a global navigation satellite system that provides location, velocity and time synchronization" (Geotab, 2020). The fundamental elements of GPS include determining absolute location, tracking relative movement, and transferring time. But how does a GPS even work? Well, it uses a mathematical technique known as trilateration. Trilateration measures distances to pinpoint their exact location on Earth (GISgeography, 2022). It is one of the global navigation satellite systems (GNSS) that provide geo-location and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. When a GPS navigator lacks enough satellite data, trilateration cannot be performed. Obstacles like tall buildings or mountains can also obstruct weak satellite signals, leading to inaccurate location calculations. The GPS device will notify the user if it is unable to provide accurate position information. Today, it is so widely available, having been implemented in different devices on the market such as smart phones, cars and laptops. But in order to fully understand GPS's, we have to go back in time and observe it's development throughout history.

2.1.1 Historical Roots

The GPS came about because the United States Department of Defense initiated the development of a system to enhance military navigation capabilities.The Navstar 1 satellite marked the beginning of the constellation's journey on February 22, 1978. As time progressed, multiple satellites were launched and played a pivotal role in delivering accurate positioning data. Initially, the U.S. government had sole access to the constellation until the 1980s. It was only in 1994 that the 24 active satellites under U.S. control became fully operational.

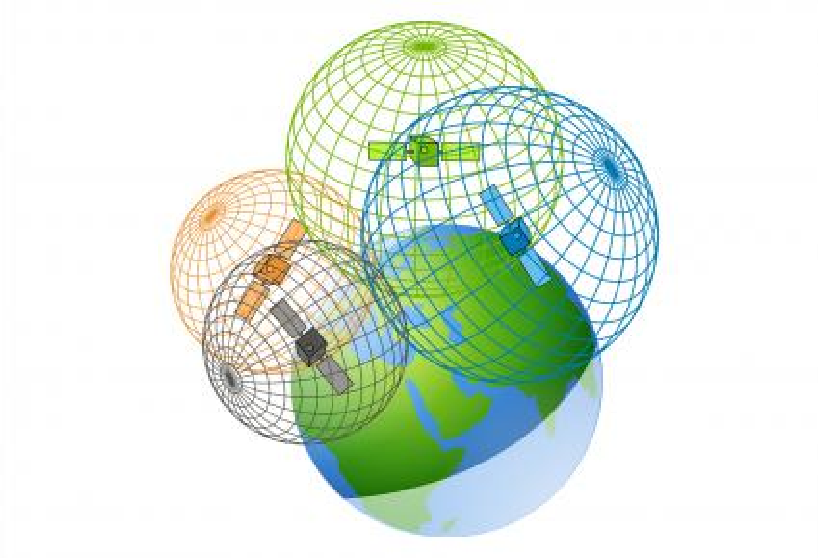


Image 3 Image source: GISGeography

2.1.2 Applications Across Different Industries

a) Navigation and Mapping

The advent of GPS technology has revolutionized the way people navigate, making it available to all. From the initial portable GPS gadgets to the sophisticated systems in contemporary cars and mobile devices, individuals can now enjoy unparalleled accuracy in their navigation. Mapping software utilizes GPS data to offer up-to-the-minute guidance, traffic notifications, and noteworthy locations, elevating the overall travel encounter.

b) Aviation and Maritime

GPS technology has become indispensable for pilots in the aviation industry, enabling accurate navigation and promoting safer air travel. Likewise, the maritime sector relies heavily on GPS for route planning, vessel tracking, and real-time monitoring. This has substantially enhanced the efficacy and safety of worldwide transportation by minimizing the likelihood of mishaps and streamlining routes.

c) Agriculture

Precision agriculture has emerged as a key beneficiary of GPS technology. Farmers use GPS-enabled tractors and equipment to optimize planting, irrigation, and harvesting processes. This results in increased crop yield, reduced resource usage, and overall sustainability in agriculture.

d) Emergency Services

Emergency response teams depend on GPS technology to obtain precise and rapid location information. This assists in prompt reaction to incidents, which can be crucial in saving lives. GPS technology is incorporated into emergency vehicles, enabling efficient routing and coordination during rescue operations.

e) Geo-caching and Recreation

PS technology has evolved beyond mere practical usage and has become a source of recreation for enthusiasts. Geo-caching is one such activity where GPS coordinates are utilized to hunt hidden treasures and containers, adding a tech-savvy twist to outdoor exploration. Moreover, fitness trackers and smart watches employ GPS for precise tracking of outdoor activities such as running and cycling.

2.1.3 The Future of GPS

We can not acknowledge the past and present capabilities of GPS's without considering what to expect in the future. The fifth industrial revolution has already introduced innovations in human-machine interactions and we can only expect it to improve.

Regarding the GPS however, here are some improvements to look out for:

a) Enhanced Accuracy and Reliability

Advancements in satellite technology and signal processing are paving the way for even more accurate and reliable GPS positioning. This is necessary for applications in autonomous vehicles, where precise location data is needed for safe movement.

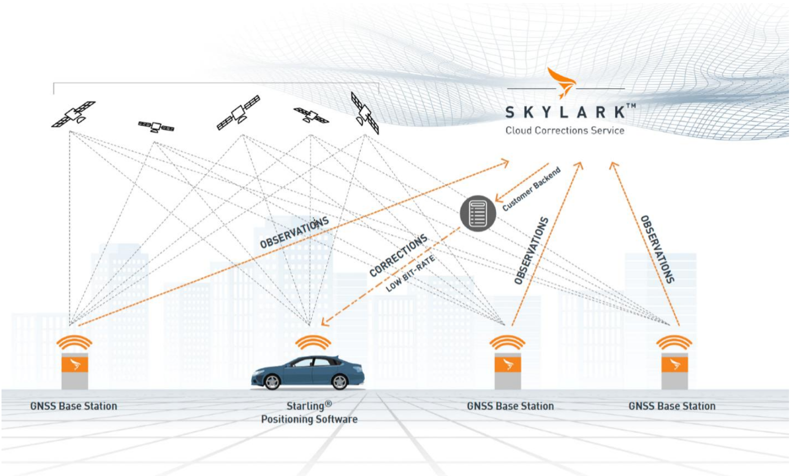


Image 4

b) Integration with Emerging Technologies

GPS technology is becoming increasingly important in the adoption of new technologies like augmented reality (AR) and virtual reality (VR). By using location-based AR apps, digital data can be displayed on the physical world, creating more engaging user experiences in a variety of fields.

Image 5

c) Space-based Applications

GPS is finding applications in space exploration. Satellites equipped with GPS receivers are being deployed to navigate and communicate with spacecraft, enhancing their autonomy and reducing reliance on ground-based systems.

Image 6

2.2 Current Research Directions

Present research has been focusing on addressing challenges and pushing the revolutionizing GPS technology.

1. Anti-Spoofing and Anti-Jamming

With the increasing reliance on GPS in critical infrastructure and military operations, researchers are developing techniques to counter spoofing and jamming attacks. These efforts aim to secure the integrity of GPS signals in the face of evolving threats.

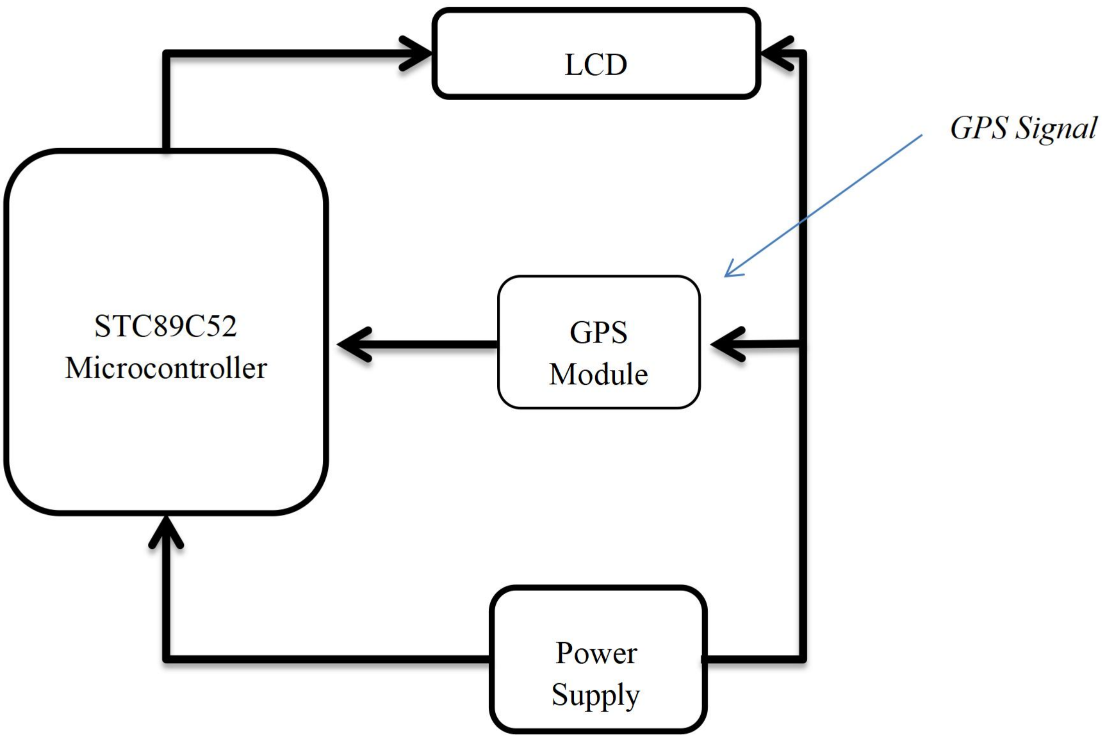
2. Quantum GPS

The exploration of quantum technologies is opening new frontiers for GPS. Quantum positioning systems, harnessing the principles of quantum mechanics, have the potential to provide ultra-precise location information, surpassing the capabilities of classical GPS.

Since its inception, GPS has reshaped the way we navigate and interact with the world. From its military origins to its ubiquitous presence in our daily lives, GPS continues to evolve, promising a future filled with enhanced capabilities and applications across diverse industries. It is a vital piece of technology and it is important to understand its capabilities.

Chapter 3 Internship Content

During this internship, my role went beyond the theoretical, delving into the heart of engineering practice. Collaborating with experienced professors, I immersed myself in the details of GPS communication protocols and use of the 8051 microcontroller. This hands-on experience promises a dynamic learning environment, allowing me to bridge the gap between theoretical knowledge and practical application. The structure of the device is detailed below in the block diagram.



Block Diagram

3.1 GPS Device Working Principle

The system is a portable device with small size and easy operation. The system firstly receives the satellite data from the GPS module. The module transmits the data information to the MCU through the serial communication interface. The single chip processor STC89C52 is used as the core processor to separate the NMEA0183 standard statement sent by the GPS module and extract the key positioning information. The LCD 1602 displays the positioning information.

3.2 Hardware Circuit Design based on microcontroller

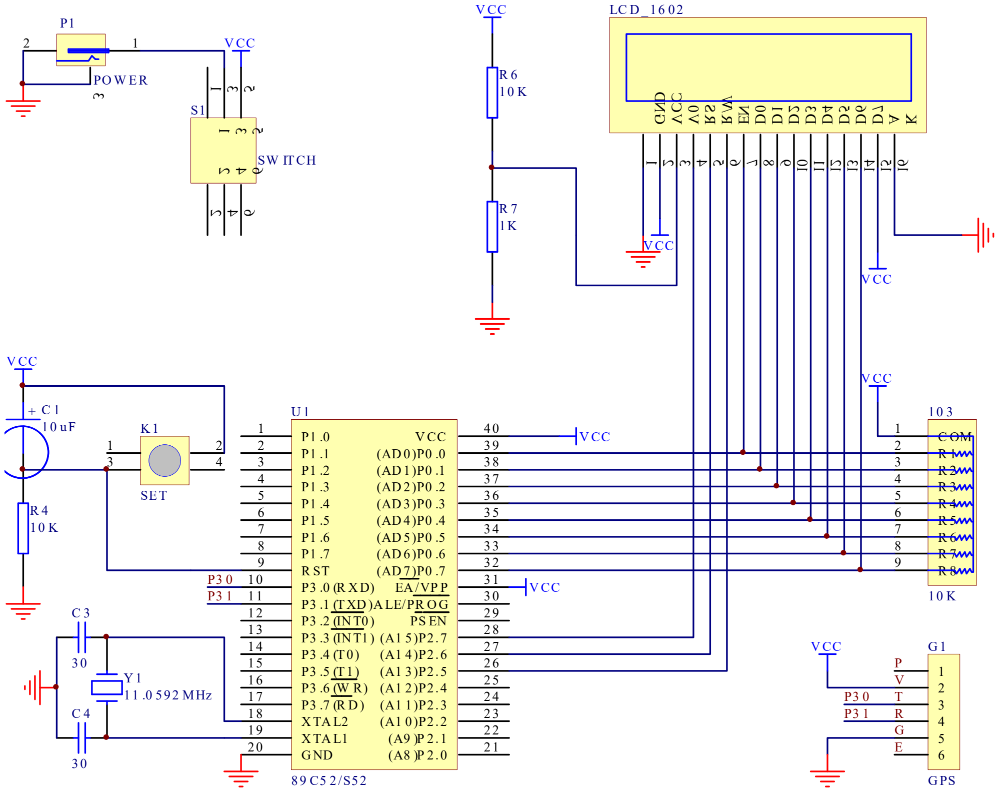


Figure 1 Hardware Connection of the whole system

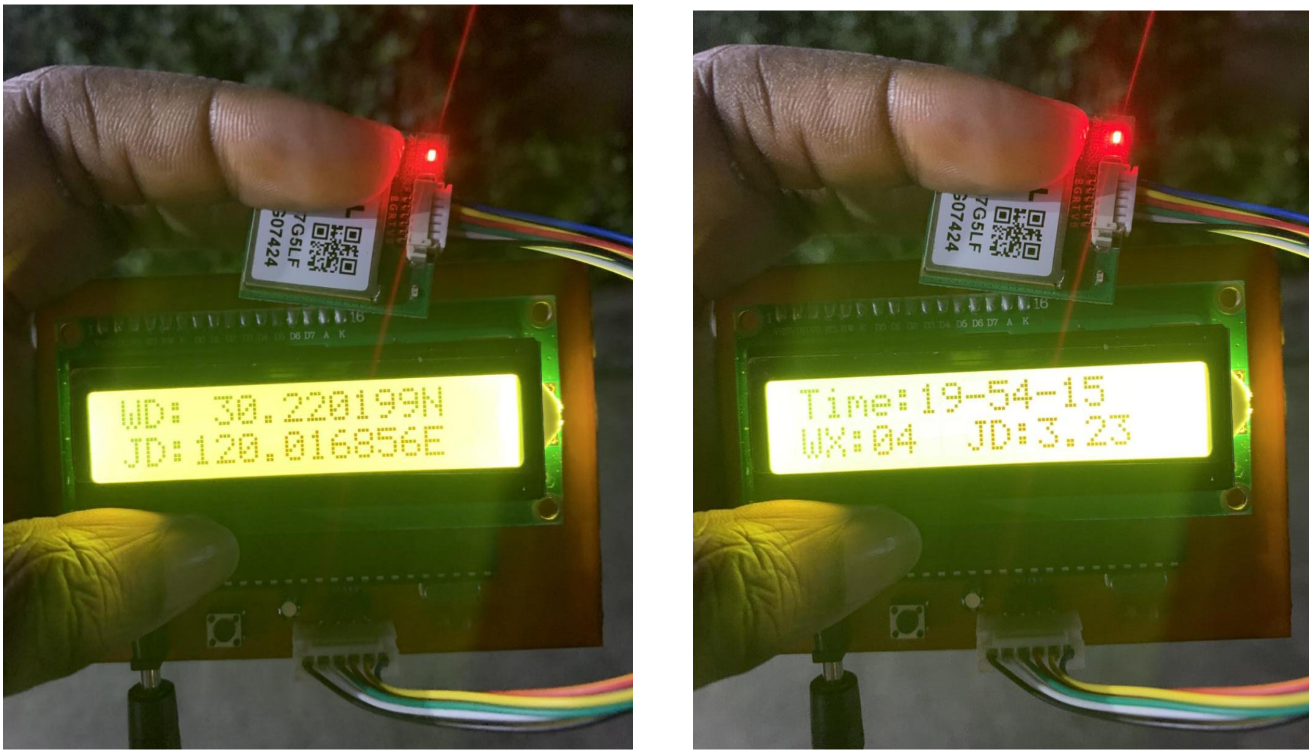


Image 7 Actual Prototype

The device has several aspects noted below.

3.2.1 Minimum system

The minimum system of a single-chip microcomputer , or the smallest application system , refers to a system that can work with a single-chip microcomputer composed of the fewest components . For the 51 series microcontroller , the minimum system should generally include: microcontroller, crystal oscillator circuit, and reset circuit . The following is a minimum system circuit diagram of a 51 microcontroller.

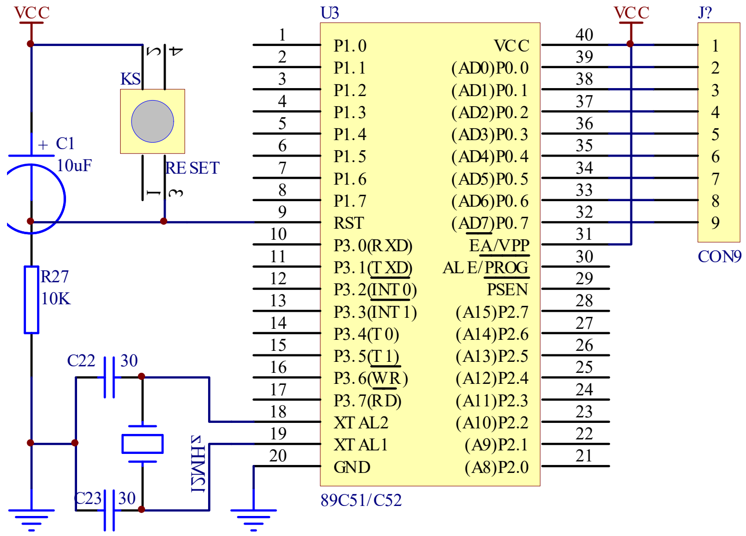


Figure 2 Minimum System Circuit

3.2.2 Reset circuit

The purpose of the reset circuit : The reset circuit of the microcontroller is like the restart part of the computer. When the computer crashes during use, press the restart button and the program inside the computer will be executed from the beginning. The same is true for microcontrollers. When the microcontroller system is running and the program runs away due to environmental interference, press the reset button and the internal program will automatically restart from scratch. The microcontroller reset circuit is as shown in figure 3.

The working principle of the reset circuit: To reset the 51 microcontroller, you only need to connect a high level to the 9th pin for 2US. So how is this process implemented? In a single-chip microcomputer system, the system is reset once when the system is powered on. When the button is pressed, the system is reset again. If the button is released and pressed again, the system will be reset again. Therefore, its reset can be controlled in the running system by opening and closing the button.

Does it reset when it is turned on : In the circuit diagram, the capacitor is 10uF and the resistor is 10k. Therefore, according to the formula, it can be calculated that the time required to charge the capacitor to 0.7 times the power supply voltage (the power supply of the microcontroller is 5V, so charging to 0.7 times is 3.5V) is 10K*10UF=0.1S. That is to say, within 0.1S of the microcontroller starting up, the voltage across the capacitor increases from 0 to 3.5V. At this time, the voltage across the 10K resistor decreases from 5 to 1.5V (the sum of the voltages in the series circuit is the total voltage). So within 0.1S , the voltage received by the RST pin is 5V~1.5V. In the 51 microcontroller that works normally at 5V, the voltage signal less than 1.5V is a low-level signal, and the voltage signal greater than 1.5V is a high-level signal. Therefore, within 0.1S of power-on, the microcontroller system automatically resets (the time of the high-level signal received by the RST pin is about 0.1S).

Why is the button reset when the button is pressed : 0.1S after the microcontroller is started, the voltage across the capacitor C continues to charge to 5V. At this time, the voltage across the 10K resistor is close to 0V, and RST is at a low level, so the system works normally. When the button is pressed, the switch is turned on. At this time, a loop is formed at both ends of the capacitor, and the capacitor is short-circuited. Therefore, during the process of pressing the button, the capacitor begins to release the previously charged power. As time goes by, the voltage of the capacitor is released from 5V to 1.5V or even less within 0.1S. According to the voltage of the series circuit being the sum of all places, the voltage across the 10K resistor at this time is 3.5V or even greater, so the RST pin receives a high level again. The microcontroller system automatically resets.

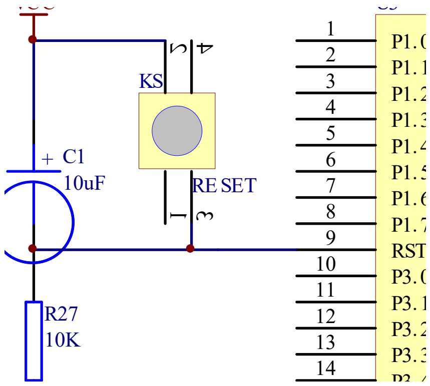


Figure 3 Minimum System Circuit

3.2.3 Crystal oscillator circuit

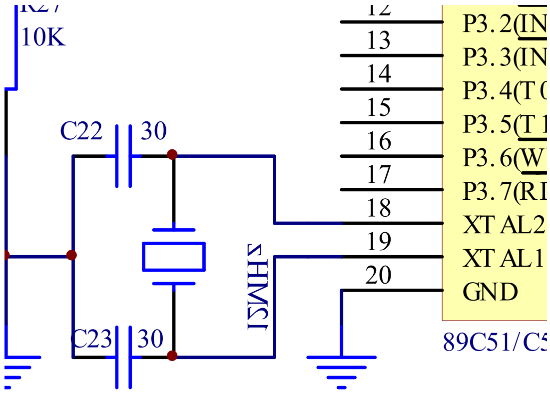


Figure 4 Minimum System Circuit

The crystal oscillator can be electronically compared to a two-terminal network that has a capacitor and a resistor connected in series and a capacitor and resistor connected in parallel. This network has two resonant spots electrically, which are split into lower ones based on frequency. The frequency is series resonance, while the higher frequency is parallel resonance. The two frequencies are fairly close in distance because of the properties of the crystal. The crystal oscillator is comparable to an inductor in this small frequency range, so long as its two ends connect in parallel, it can be used. The capacitor is going to create a resonant circuit in parallel. A sine wave oscillation circuit is created by adding this parallel resonant circuit to a negative feedback circuit. The frequency range of the crystal oscillator is quite small since it functions like an inductor, therefore even if the parameters of other components change greatly, there will not be a big change in the frequency of the crystal.

An important parameter of the crystal oscillator is to select a parallel capacitor whose load capacitance value is equal to the load capacitance value to obtain the nominal resonant frequency of the crystal oscillator.

Generally, the crystal oscillator circuit is connected to the crystal oscillator at both ends of an inverting amplifier (note that the amplifier is not an inverter), and two capacitors are connected to both ends of the crystal oscillator. The other end of each capacitor is then connected to ground. The capacitance value of two capacitors connected in series should be equal to the load capacitance. Please note that the pins of general ICs have equivalent input capacitance, which cannot be ignored.

The load capacitance of a general crystal oscillator is 15pF or 12.5pF. If you consider the equivalent input capacitance of the component pin, it is a better choice to use two 22pF capacitors to form the oscillation circuit of the crystal oscillator.

The crystal oscillator provides working signal pulses to the microcontroller. This pulse is the working speed of the microcontroller. For example, the working speed of a 12M crystal oscillator microcontroller is 12M per second. Of course The operating frequency of the microcontroller has a range It can't be too big. Generally, it won't go up if it's 24M, otherwise it will be unstable.

Composed of the crystal oscillator and the pins XTAL0 and XTAL1 of the microcontroller will produce simultaneous waves (that is, waves of other frequencies that are not expected to exist). This wave has little impact on the circuit but will reduce the stability of the clock oscillator of the circuit. For the sake of circuit stability, ATMEL only recommends connecting two 10pf-50pf ceramic capacitors to the ground at the two pins of the crystal oscillator to reduce the impact of co-waves on the stability of the circuit. Therefore, the capacitance of the crystal oscillator should be between 10pf-50pf. The time is ok, there is no calculation formula.

Pull-up resistor of port P0 :

When the P0 port is used as an I/O port output, the output low level is 0 and the output high level is high configuration (not 5V, which is equivalent to floating state). That is to say, the P0 port cannot really output a high level to provide current to the connected load, so a pull-up resistor must be connected (a resistor is connected to VCC), and the power supply provides current to the load through this pull-up resistor. Since there is no pull-up resistor inside the P0 port and it is open-drain, no matter how big its driving capability is, it means that it has no power supply and needs an external circuit to provide it. In most cases, the P0 port must add a pull-up resistor.

1. Generally, the P0 port of the 51 microcontroller is not connected to a pull-up resistor when used as address/data multiplexing.

2. When used as a general I/O port, since there is no internal pull-up resistor, a pull-up resistor must be connected.

3. When the P0 port is used to drive the PNP tube, there is no need for a pull-up resistor, because the low level is effective at this time; 4. When the P0 port is used to drive the NPN tube, a pull-up resistor is needed, because at this time, only when P0 is 1, the subsequent stage can be turned on.

31 pin EA/Vpp is connected to the power supply.

STC89C51/52 or other 51 series compatible microcontrollers : For pin 31 (EA/Vpp) , when connected to high level , the microcontroller starts execution from 0000H of the internal ROM after reset . When connected to low level , the microcontroller starts execution from the external ROM starts execution at 0000H , which is easily overlooked by beginners .

3.2.4 Details of GPS Receiving module and MCU-GPS connection

Features: Industry standard GPS antenna of 25 * 25 * 4mm, with high sensitivity

Optional interface: UART/TTL, RS232

High-precision TCXO of KDS 0.5PPM

Built-in SQI flash to set the parameters as required

Built-in RTC crystal and capacitors to start quickly

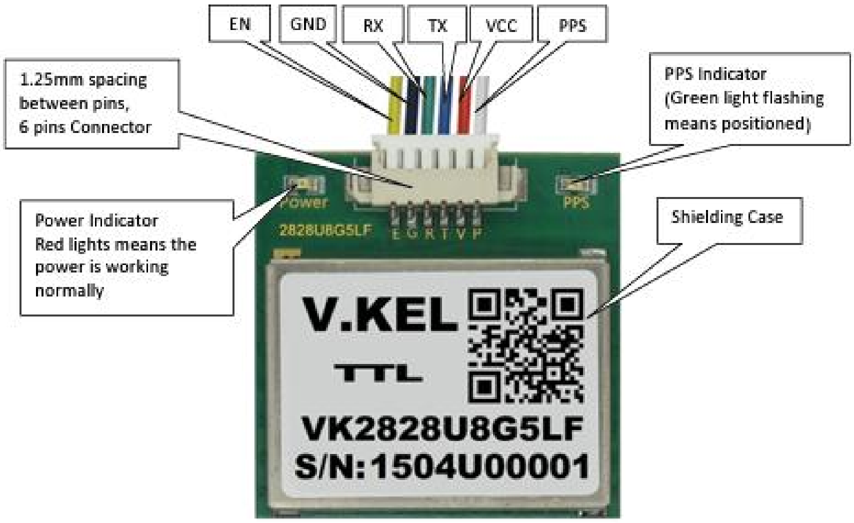
Built-in LNA

Optional frequency of data refreshing: 1Hz-10Hz

Supports A-GPS service: Assist Now Online and Assist Now Offline

Hybrid engine: GPS, GALILEO, SBAS (WAAS, EGNOS, MSAS, GAGAN)

Image 8 GPS Module



Pins' Definition

Name	Function Description
PPS	Output time pulses (pulses per second)
VCC	The main power supply is +3.3V~+5V, and the power consumption is 50mA in one hour
TX	UART/TTL interface, and RS232_TXD is optional
RX	UART/TTL interface, and RS232_RXD is optional
GND	Connect to the ground
EN	Power Enable: high level means the module works, low level means the modules is closed.

Image 9 GPS Configuration

The GPS module is connected to the microcontroller (MCU) using serial communication, with the TX (transmit) pin of the GPS connected to the RX (receive) pin of the MCU, and vice versa, establishing a bidirectional data exchange.

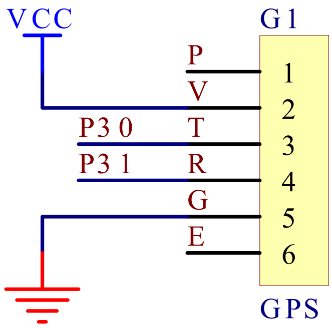


Figure 5 GPS Circuit Connection

3.2 Introducing the CH340 module

Image 10

To download the program onto the microcontroller, a CH340 module is connected to the board and used.

Before using this module, you need to install the driver, as shown:

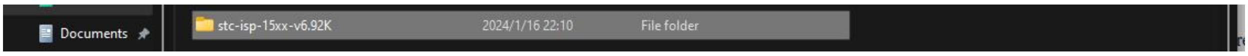


Image 11

Module CH340 Wiring: Regardless of whether the single-chip microcomputer uses a 5V or 3.3V power supply, the TxD of the CH340 module is connected to P3.0, the RxD is connected to P3.1, and GND is connected to the single-chip microcomputer power supply GND. A jumper cap can be bridged between Vcc and 3V3.

3.3 Software Development Environment

3.3.1. Proteus 8 Professional to Simulate

I used Proteus to first simulate the circuit. Of course, in order to display the full capabilities of the device being created, the exact hardware circuit is not followed in the simulation. For example, the crystal circuit is not shown because the parameters of the crystal can not be simulated. It can be changed however by right clicking the microcontroller and adjusting it there.

Procedure

(a) Start a new project

Image 12

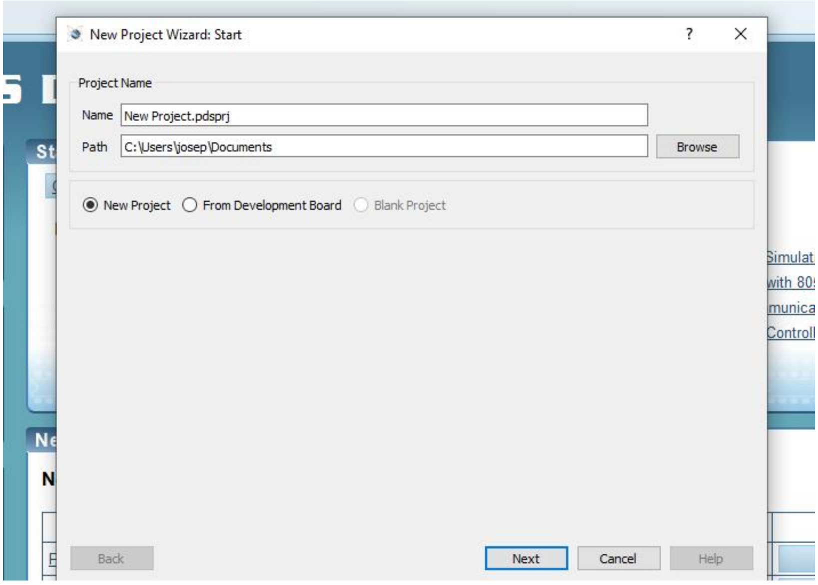


Image 13

(b) Select a landscape suitable for the schematic, Do not create PCB layout or Firmware. And successfully create your project.

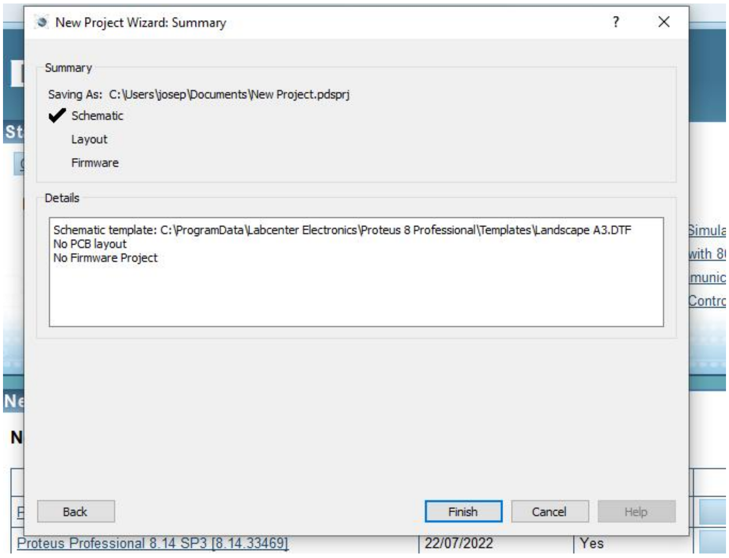


Image 14

(c) Started to assemble the components on the schematic sheet

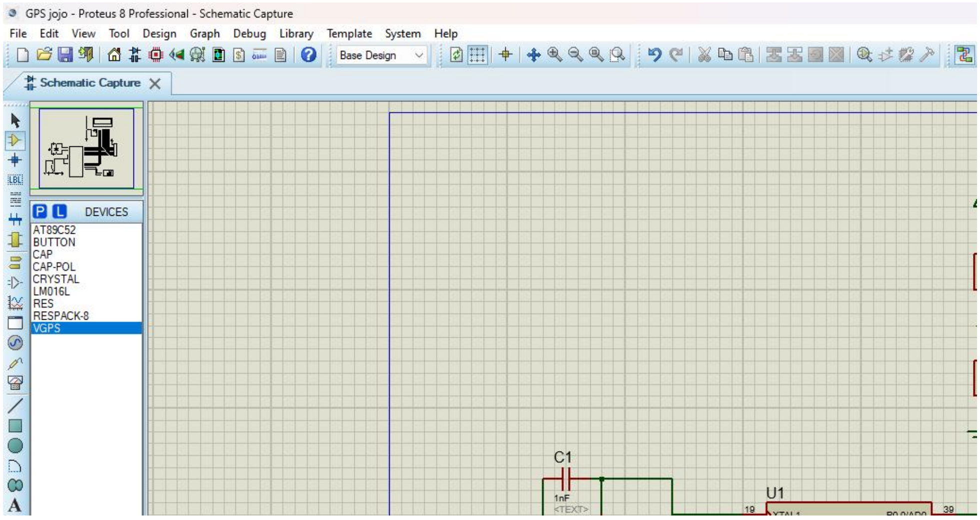
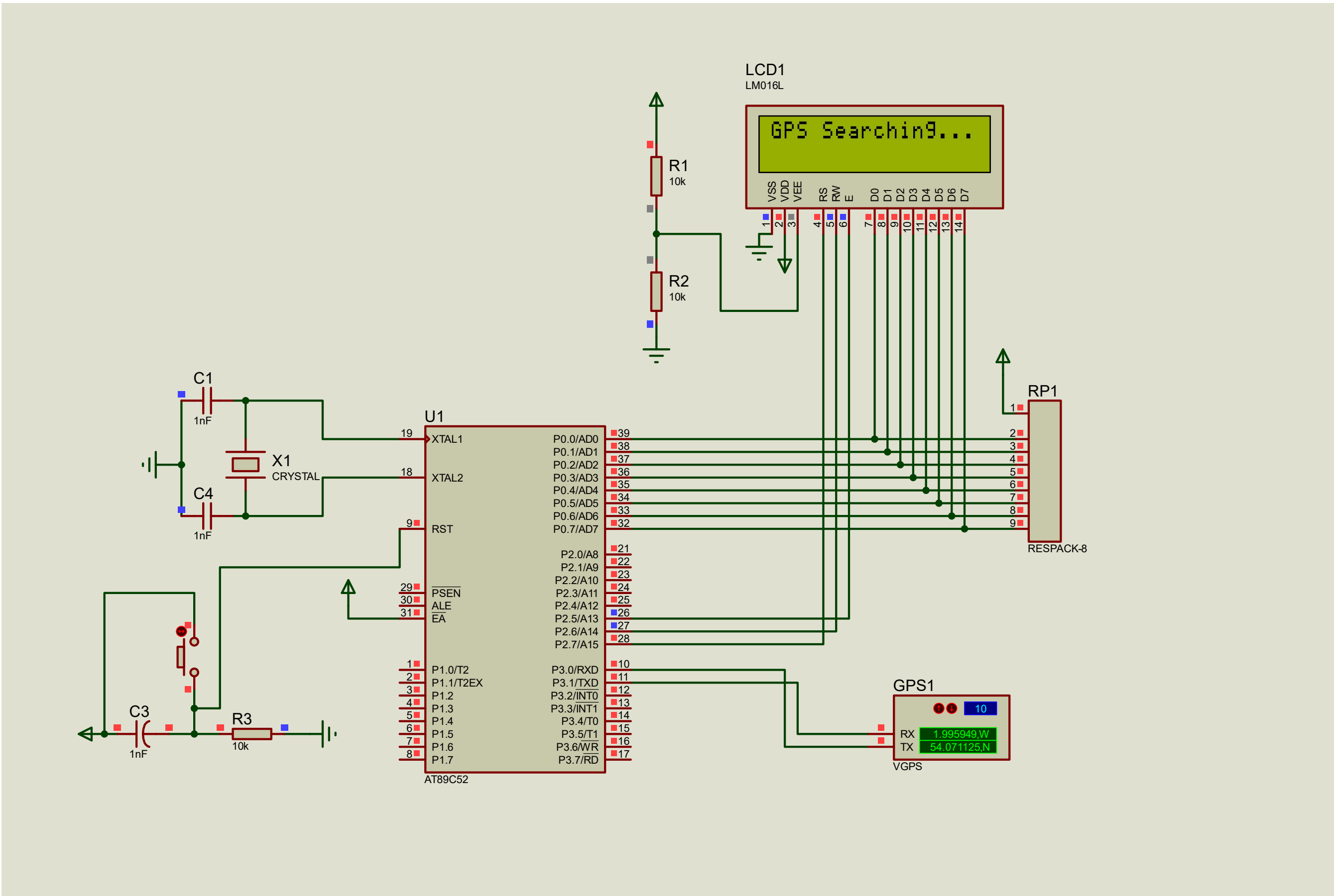


Image 15



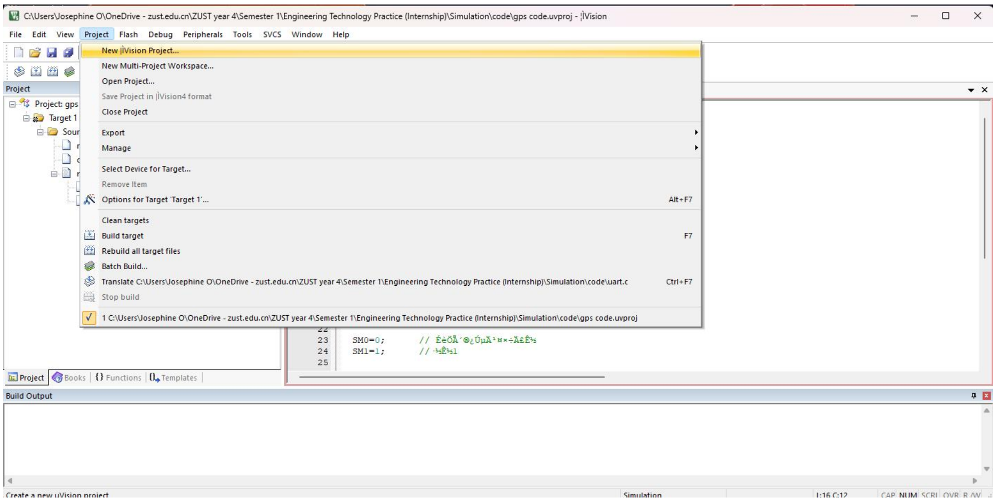
Final Simulation Result

3.3.2. Keil C15

This software was used to generate the hex file with the source code provided.

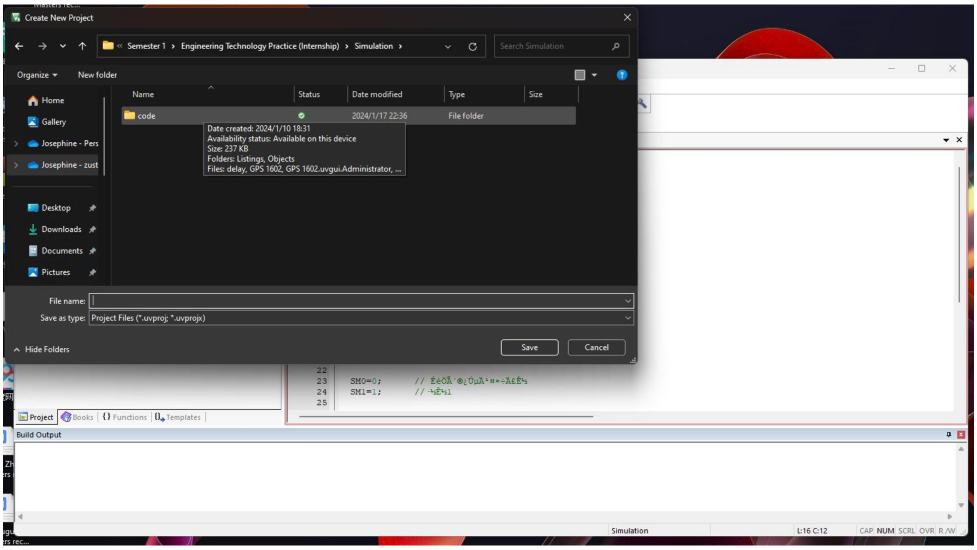
Procedure followed:

(a) I ran the KeilC51 program and selected the menu project, choosing the option "new project"



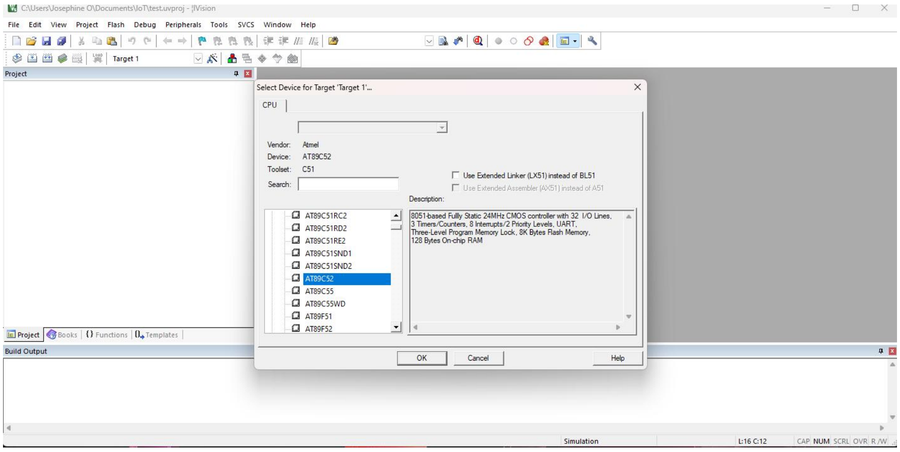
<u>*Image 16*</u>

(b) Choose the location you want to save the project file and label it accordingly



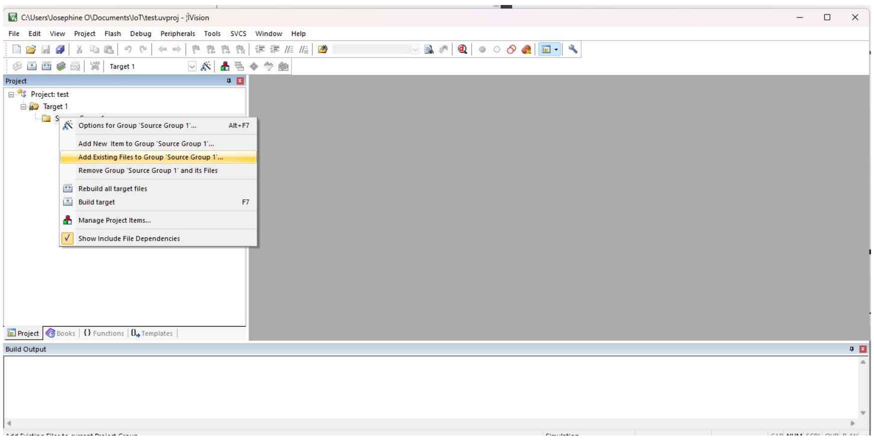
<u>*Image 17*</u>

(c) Then ensure you choose the correct microcontroller in the next step, I.e. 89C52.



<u>*Image 18*</u>

(d) You can then upload existing files to the project



<u>*Image 19*</u>

(e) Once the existing files have been added to the project, compile the program to generate the hex file.

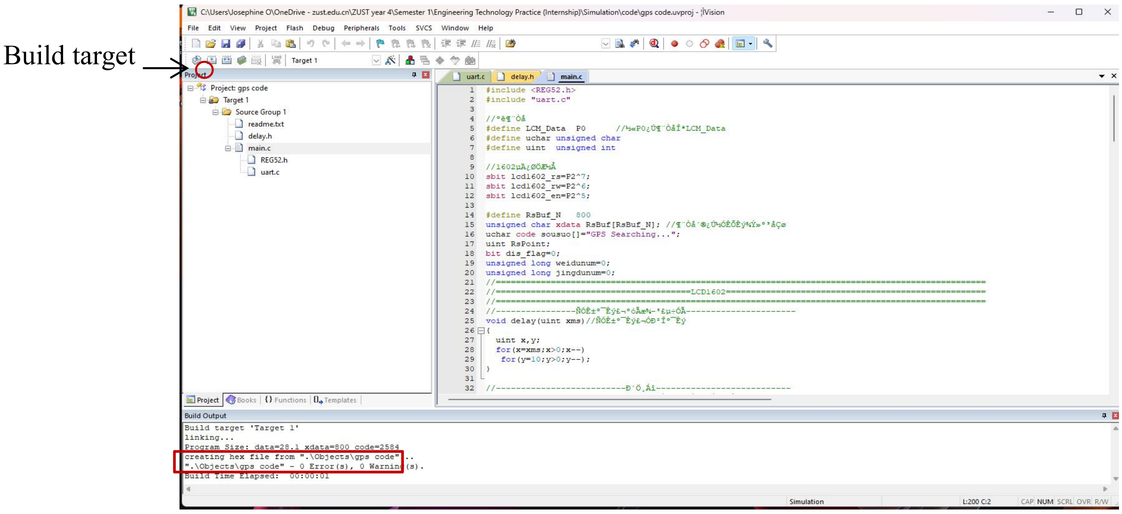


Image 20

(f) The hex file is found in the Objects folder of your chosen file location from earlier

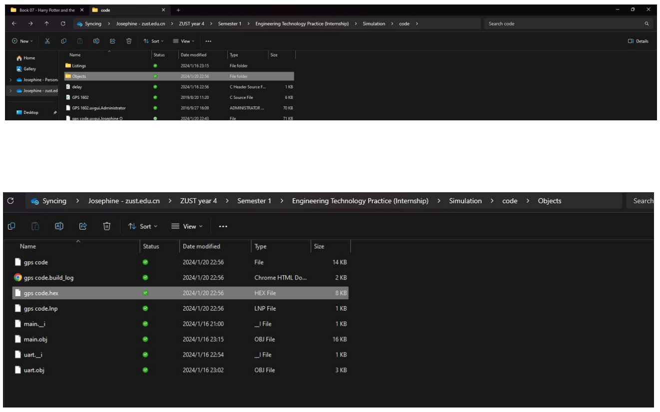


Image 21

3.3.3. Stc-isp-15xx-v6.92K

I used this software following instructions I found on a website. It was used to get the program onto the microcontroller so that the device would function.

Procedure

(a) Launch program

Image 22

(b) Make sure the MCU type and the port your CH340 module is using is selected. When this is done, download the program.

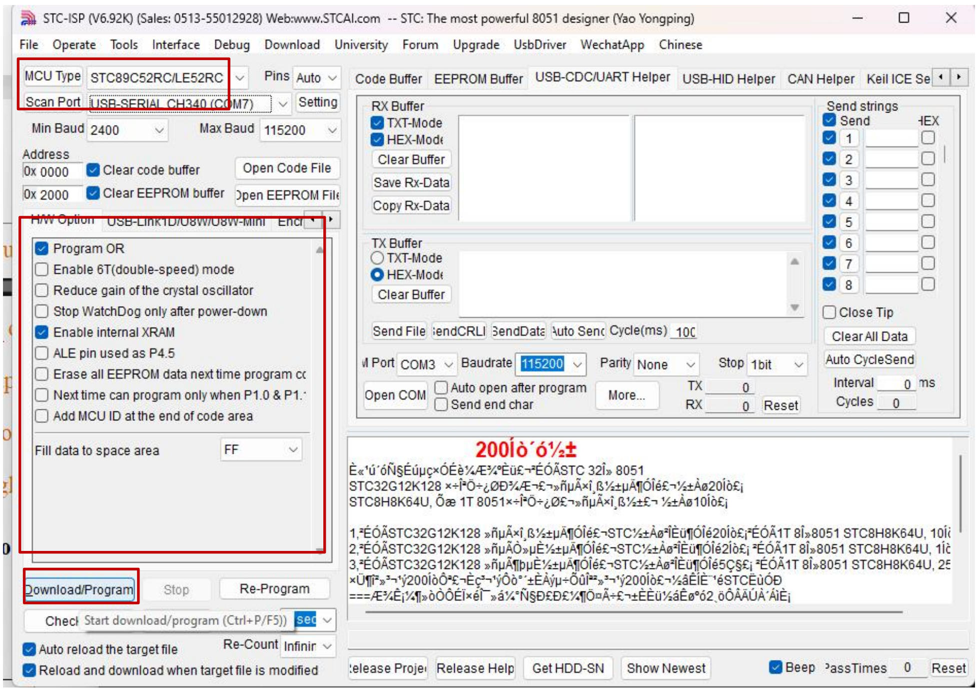


Image 23

Chapter 4 Troubleshooting Hardware and Software

Following the completion of hardware design, production, and software programming, system debugging—addressing both hardware and software—is essential to ensure the system operates as intended.

4.1 Hardware Debugging

The main task of hardware debugging is to eliminate hardware faults, including design errors and process failures. I did this by:

- Checking whether all the components and pins on the circuit board are correct. A digital multimeter can be used to check each point to see if there is a short circuit between the wires.

- The input of 5v and the ground connection had to be connected correctly. Upon the first try, this was not done well and as a result the GPS and CH340 were blown. The components were replaced and presently it is functioning normally.

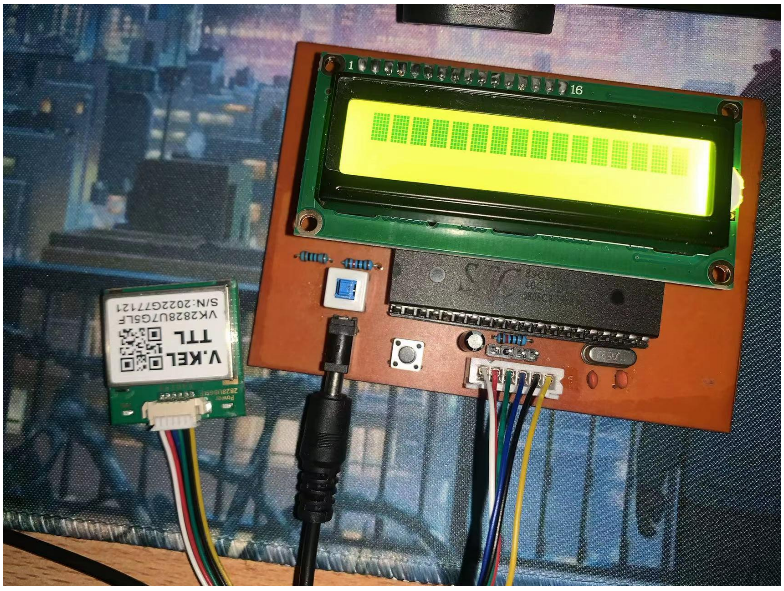


Image 24

4.2 Software Debugging

The task of software debugging is to use development tools to conduct online simulation debugging, discover and correct program errors, and also discover hardware faults. Software debugging is done module by module. First, individually debug whether each subroutine can function as expected and whether the control of the interface circuit is normal. Finally, debug the entire program. Pay special to whether parameters can be transferred correctly between modules.

-Check the LCD module program to see if the corresponding characters can be displayed on the LCD.

- Check the GPS module program and understand the GPS signal reception status by observing the LCD display.

Chapter 5 Industry and International Standards

Particularly in the field of robotics, the Global Positioning System (GPS) technology is essential because it allows precise localization, navigation, and control of robotic devices. Understanding the governmental and commercial guidelines that control the use of GPS in robotics applications is important for those like myself who are interested in the research field of simultaneous localization and mapping (SLAM) and its potential large scale applications.

5.1 Industry Standards

1. ISO 25178: Geometrical product specifications (GPS) – Surface texture: Areal

The International Organization for Standardization (ISO) created this standard, which is especially pertinent to robotics applications where accurate measurements are essential. It focuses on surface texture. It contributes to the overall performance and durability of a robotic system by guaranteeing that the surface properties of its component parts fulfill predetermined specifications.

2. Industrial automation systems and integration according to ISO 194 standard series

Aspects of industrial automation like as interoperability, safety, and communication protocols are covered by this set of standards. Standards like ISO 19440 (Communication between systems) are relevant in the context of GPS-enabled robotics since they guarantee that robotic parts can exchange GPS data and communicate with each other in an efficient manner.

5.2. International Standards

1. ANSI/INCITS 415-2006: Information technology – Storage command set (SCSI) – 3

The American National Standards Institute (ANSI) standard INCITS 415-2006 addresses storage command sets for information technology, which is relevant in the context of robotic systems that rely on GPS data storage. This standard ensures compatibility and consistency in how GPS data is stored and retrieved within robotic devices.

2. IEC 61158 series: Industrial communication networks – Field bus specifications

The International Electrotechnical Commission (IEC) 61158 series focuses on industrial communication networks, including field bus specifications. In the realm of robotics, these standards help establish a common framework for communication between GPS modules and other components in a robotic system, ensuring seamless integration and data exchange.

Compliance with industry and national standards is essential for the successful integration of GPS technology into robotic systems. These standards ensure that GPS-enabled robotics operate reliably, safely, and effectively, meeting the requirements of diverse applications. As a robotics intern, staying informed about these standards is crucial for contributing to the development and deployment of cutting-edge robotic technologies in accordance with established norms.

Chapter 6 Non-technical Considerations

China has witnessed rapid economic development and urbanization, leading to an increased demand for advanced technologies such as GPS in engineering projects. While technical considerations are essential, non-technical factors play a crucial role in shaping the success of GPS technology implementation.

These challenges were considered through the lens of a foreigner in China.

6.1 Analysis of Restrictions and Responsibilities in the China

1. Social Factors:

- Public Perception: The acceptance and adoption of GPS technology may vary based on societal attitudes towards privacy and data security. Enterprises must navigate public concerns and communicate transparently to build trust.

- Regulatory Compliance: China's strict regulations on data privacy and security may pose challenges. Adhering to these regulations is crucial to avoid legal repercussions and gain public trust.

2. Environmental Factors:

- Satellite Visibility: Environmental conditions such as atmospheric interference can affect satellite visibility, impacting the accuracy of GPS signals. Engineers should account for these factors in project planning and develop technologies to mitigate their effects.

3. Safety Factors:

- Navigation Safety: Reliable GPS signals are critical for various safety-critical applications, including autonomous vehicles and navigation systems. Ensuring the robustness of GPS technology in challenging conditions is a responsibility that engineers must uphold.

4. Economic Factors:

- Budget Constraints: Economic fluctuations can impact project funding, potentially leading to delays or cutbacks. Enterprises should adopt cost-effective strategies and contingency plans to navigate financial challenges.

5. Political Factors:

- International Relations: Foreign engineers working in China may encounter political challenges, such as strained international relations affecting data sharing or collaboration. Staying informed about geopolitical developments is essential for effective project management.

6.2 Responsibilities of Enterprises and Engineers

1. Risk Assessment and Mitigation:

- Conduct thorough risk assessments to identify potential challenges related to non-technical factors.

- Implement robust mitigation strategies to address identified risks and ensure project resilience.

2. Adherence to Regulations:

- Stay informed about local regulations and compliance standards in China, particularly those related to data privacy and security.

- Establish internal protocols to ensure that projects align with regulatory requirements.

3. Community Engagement:

- Foster transparent communication with local communities to address concerns related to privacy and data security.

- Collaborate with local stakeholders to garner support and build positive relationships.

4. Innovation for Resilience:

- Encourage innovation in GPS technology to overcome environmental challenges and improve signal reliability.

- Invest in research and development to stay ahead of emerging non-technical issues.

Chapter 7 Summary of Experience

During my internship, I had the unique opportunity to contribute to the design of a GPS based on the 8052 microcontroller. This experience was particularly exciting for me as it marked my first foray into soldering, a skill I had not previously acquired. I am grateful for the flexibility that allowed me to complete my internship within the school environment, especially given the challenges in securing an external placement. Being immersed in the practical aspects of robotics has been a privilege, and having access to materials under the guidance of grounded and experienced professors enriched my learning experience. Overall, this internship provided a hands-on introduction to hardware design, expanding my skill set in this field.

Chapter 8 Appendices

8.1 Appendix A

Table 1. Hardware components List

	Type	Function	Application
1.	STC89C52 MCU	The brain of the project, serving as the central processing unit.	It executes the firmware, processes data, and controls the overall functioning of the GPS device.
2.	LCD screen	A display module that visually communicates information. It consists of 16x2 character cells, allowing for the presentation of alphanumeric characters and symbols.	Displaying relevant information such as real-time GPS coordinates, altitude, and time
3.	Resistor	A passive electronic components that limit or control the flow of electric current in a circuit.	Resistors in the GPS project involving the 8052 microcontroller may be used for voltage division, current limiting, or to set the

			operating conditions of various components. For example, they can be employed in conjunction with sensors or interfaces to ensure proper signal levels and protect sensitive parts of the circuit.
4.	Capacitor	Capacitors store electrical energy in an electric field.	They can be incorporated in the power supply circuit to reduce voltage fluctuations and ensure stable operation of the microcontroller and other sensitive components.
5.	PCB 7*9	A rigid board with conductive pathways etched or printed onto the surface.	Used for the permanent assembly of the electronic components.
6.	GPS module	Module receives signals from GPS satellites to determine the device's geographical location. It	It interfaces with the MCU to receive satellite signals, extract NMEA sentences, and

		typically provides information such as latitude, longitude, altitude, and time.	provide accurate location and time data.
7.	USB power cord	Provide power to the circuit	
8.	Solder	A low-melting-point metal alloy used to join electronic components and wires by melting the solder and creating a conductive bond when it solidifies	
9.	Wires	Link components	
10.	Self-locking switch	A self-locking switch, also known as a latching switch, maintains its state (either ON or OFF) without the need for continuous pressure. It remains in the last toggled position until intentionally changed.	a power switch to turn the device ON or OFF
11.	30pF capacitance*2	Capacitors store electrical energy and are	

		often used for filtering, coupling, and tuning in electronic circuits.	
12.	Push button	Input device that creates a momentary electrical contact when pressed.	
13.	11.0592M crystal oscillator	provides a stable and precise clock signal to synchronize the operation of the microcontroller.	
14.	10uF capacitance		
15.	1k resistor		
16.	10K resistors*2		
17.	16P single row receptacle		
18.	16p single-row pins		
19.	XH-6P seat		
20.	40-pin IC mount		
21.	CH340 module	a USB-to-serial adapter, enabling communication between the	Download program to MCU.

		microcontroller and a computer.	

Table 2. Software List

S/n	Type	Function	Application
1.	Proteus 8 Professional		
2.	Keil C15		
3.	Stc-isp-15xx-v6.92K	CH340 module driver used to download the program to the MCU	

8.2 Appendix B

(i) Source code - GPS

```
//main code

#include <REG52.h>

#include "uart.c"


#define LCM_Data    P0

#define uchar unsigned char

#define uint    unsigned int
```

```
sbit lcd1602_rs=P2^7;
sbit lcd1602_rw=P2^6;
sbit lcd1602_en=P2^5;

#define RsBuf_N        800

unsigned char xdata RsBuf[RsBuf_N];
uchar code sousuo[]="GPS Searching...";
uint RsPoint;
bit dis_flag=0;
unsigned long weidunum=0;
unsigned long jingdunum=0;

void delay(uint xms)
{
    uint x,y;
    for(x=xms;x>0;x--)
      for(y=10;y>0;y--);
}
```

```
void write_1602com(uchar com)
{
    lcd1602_rs=0;
    lcd1602_rw=0;
    P0=com;
    delay(1);
    lcd1602_en=1;
    delay(1);
    lcd1602_en=0;//
}

void write_1602dat(uchar dat)
{
    lcd1602_rs=1;
    lcd1602_rw=0;
    P0=dat;
    delay(1);
    lcd1602_en=1;
    delay(1);
    lcd1602_en=0;
}
```

```
void lcd_init(void)
{
    uchar i;
    write_1602com(0x38);
    write_1602com(0x0c);
    write_1602com(0x06);
    write_1602com(0x01);
    delay(1000);
    write_1602com(0x80);
    for(i=0;i<16;i++)
    write_1602dat(sousuo[i]);
}

void uart_rx(void)    interrupt 4    using 3
{
    EA=0;
        if((RsPoint<RsBuf_N)&&RI)
      {
        RI=0;
        if(SBUF=='$')
        RsPoint=0;
        RsBuf[RsPoint++]=SBUF;
```

```
    }
  EA=1;
}
void main(void)
{
  uint i;
  uchar shi;
  lcd_init();
  Uart_init();
  for(i=0;i<RsBuf_N;i++)
  RsBuf[i]='0';
  while(1)
  {

if(RsBuf[0]=='$'&&RsBuf[1]=='G'&&RsBuf[2]=='P'&&RsBuf[3]=='G'&&RsBuf[4]=
='G'&&RsBuf[5]=='A'&&RsBuf[44]!='0')
      {

  if(RI==0&&((RsBuf[30]-48)*100+(RsBuf[31]-48)*10+(RsBuf[32]-48))>=0&&((
RsBuf[30]-48)*100+(RsBuf[31]-48)*10+(RsBuf[32]-48))<=180)
      {
        TR0=1;
```

```
if(dis_flag==0)
{
    write_1602com(0x80);
    write_1602dat('T');
    write_1602dat('i');
    write_1602dat('m');
    write_1602dat('e');
    write_1602dat(':');
    shi=((RsBuf[7]-0x30)*10+(RsBuf[8]-0x30)+8)%24;
    write_1602dat(shi/10+0x30);
    write_1602dat(shi%10+0x30);
    write_1602dat('-');
    write_1602dat(RsBuf[9]);
    write_1602dat(RsBuf[10]);
    write_1602dat('-');
    write_1602dat(RsBuf[11]);
    write_1602dat(RsBuf[12]);
    write_1602dat(' ');
    write_1602dat(' ');
    write_1602dat(' ');

    write_1602com(0xc0);
```

```
    write_1602dat('W');
    write_1602dat('X');
    write_1602dat(':');
    write_1602dat(RsBuf[46]);
    write_1602dat(RsBuf[47]);
    write_1602dat(' ');
    write_1602dat(' ');

    write_1602com(0xc7);
    write_1602dat('J');
    write_1602dat('D');
    write_1602dat(':');
    write_1602dat(RsBuf[49]);
    write_1602dat(RsBuf[50]);
    write_1602dat(RsBuf[51]);
    write_1602dat(RsBuf[52]);
    write_1602dat(' ');
    write_1602dat(' ');
}
else
{
    weidunum=
```

```
((RsBuf[17]-48)*10000000+(RsBuf[18]-48)*1000000)
                    +(((((RsBuf[19]-48)*10)+(RsBuf[20]-48))*100000)/6)

+(((((RsBuf[22]-48)*1000)+((RsBuf[23]-48)*100)+((RsBuf[24]-48)*10)+(RsBuf[
25]-48))*10)/6);
        write_1602com(0x80);
        write_1602dat('W');
        write_1602dat('D');
        write_1602dat(':');
        write_1602dat(' ');
        write_1602dat(weidunum/10000000+0x30);
        write_1602dat(weidunum%10000000/1000000+0x30);
        write_1602dat('.');
        write_1602dat(weidunum%1000000/100000+0x30);
        write_1602dat(weidunum%100000/10000+0x30);
        write_1602dat(weidunum%10000/1000+0x30);
        write_1602dat(weidunum%1000/100+0x30);
        write_1602dat(weidunum%100/10+0x30);
        write_1602dat(weidunum%10+0x30);
        write_1602dat(RsBuf[28]);
        write_1602dat(' ');
        write_1602dat(' ');
```

```
jingdunum=
(((RsBuf[30]-48)*100000000)+((RsBuf[31]-48)*10000000)+((RsBuf[32]-48)*100
0000))
+(((((RsBuf[33]-48)*10)+(RsBuf[34]-48))*100000)/6)

+(((((RsBuf[36]-48)*1000)+((RsBuf[37]-48)*100)+((RsBuf[38]-48)*10)+(RsBuf[
39]-48))*10)/6);
write_1602com(0xc0);
write_1602dat('J');
write_1602dat('D');
write_1602dat(':');
write_1602dat(jingdunum/100000000+0x30);
write_1602dat(jingdunum%100000000/10000000+0x30);
write_1602dat(jingdunum%10000000/1000000+0x30);
write_1602dat('.');
write_1602dat(jingdunum%1000000/100000+0x30);
write_1602dat(jingdunum%100000/10000+0x30);
write_1602dat(jingdunum%10000/1000+0x30);
write_1602dat(jingdunum%1000/100+0x30);
write_1602dat(jingdunum%100/10+0x30);
write_1602dat(jingdunum%10+0x30);
write_1602dat(RsBuf[42]);
```

```
                    write_1602dat(' ');
                    write_1602dat(' ');
                }
            }
        }
    }
}
void T0_time() interrupt 1
{
    uchar mm;
    TH0=0x4b;
    TL0=0xff;
    mm++;
    if(mm>=60)
    {
        mm=0;
        dis_flag=!dis_flag;
    }
}
```

Chapter 9 References

1) Adventures with a STC89C52 development board- https://hackaday.io/project/170540-adventures-with-a-stc89c52-development-board

2) GPS Module and STM32 || NEO 6M || Get coordinates, Date, Time, Speed, etc - https://youtu.be/tq_RoaPLahk?si=qQTnYM3CGbur0anr

3) He, Yong & Chen, Yanan. (2016). Design of Global Positioning System Based on Single Chip Microcontroller. 10.2991/icmmita-16.2016.183.

4) How to interface GPS with 8051 Microcontroller (AT89C51)- (Part 36/45) By Himanshu Choudhary- https://www.engineersgarage.com/how-to-interface-gps-with-8051-microcontroller-at89c51-part-36-45/

5) Interfacing GPS with 8051 Microcontroller - https://www.electronicshub.org/interfacing-gps-8051-microcontroller/

6) Six-pin switch pin diagram and function definition - https://www.ruidan.com/infomation/detail/249616

7) What is a GPS? How does it work? - https://www.loc.gov/everyday-mysteries/technology/item/what-is-gps-how-does-it-work/

8) Introduction to ZUST - https://en.zust.edu.cn/About_ZUST/Introduction_To_ZUST.htm

9) What Is Trilateration? How GPS devices use mathematics to determine positioning By Fred Zahradnik_Updated on August 28, 2021 -

https://www.lifewire.com/trilateration-in-gps-1683341

10) Parkinson, B. W., & Spilker, J. J. (1996). Global positioning system: theory and applications (Vol. 1). American Institute of Aeronautics and Astronautics.

11) Kaplan, E. D., & Hegarty, C. J. (Eds.). (2005). Understanding GPS: Principles and applications. Artech House.

12) Teunissen, P. J., & Montenbruck, O. (2017). Springer handbook of global navigation satellite systems. Springer.

13) Groves, P. D. (2013). Principles of GNSS, inertial, and multisensor integrated navigation systems (Vol. 29). Artech House.

14) ISO - International Organization for Standardizationhttps://www.iso.org/

15) ANSI - American National Standards Institute https://www.ansi.org/

16) IEC - International Electrotechnical Commission https://www.iec.ch/

17) Robotics Industries Association (RIA) https://www.robotics.org/

18) National Institute of Standards and Technology (NIST) https://www.nist.gov/

19) Chen, J., & Wang, Y. (2019). The impact of national culture on cross-cultural project management: Evidence from Chinese and Western project managers. International Journal of Project Management, 37(3), 309-329.

20) China National Administration of Surveying, Mapping, and Geoinformation. (2022). Regulations on Administration of Mapping and Surveying.

21) Liu, Y., & Yu, Y. (2020). Privacy concerns about location-based services: An empirical study of Chinese users. Computers in Human Behavior, 104, 106147.

22) World Bank. (2021). China Overview. Retrieved from https://data.worldbank.org/country/china

23) What Is GPS and how do global positioning systems work? - https://www.geotab.com/blog/what-is-gps/

24) How GPS Receivers Work – Trilateration vs Triangulation - https://gisgeography.com/trilateration-triangulation-gps/

25) V.KEL Communications Equipment(SHENZHEN）Co., Ltd VK2828U7G5LF DataSheet

26) Steps to download the program to STC microcontroller_stc how to use the microcontroller downloader-CSDN Blog https://blog.csdn.net/billliu66/article/details/121480389

Chapter 10 Acknowledgement

I would like to thank all those who made this possible. Laoshi Chao, my supervisor for his guidance. Laoshi Wang Xia for helping me with the hardware debugging and teaching me about the multimeter. Laoshi Huang, for his part in this whole process and also answering all my numerous questions. I appreciate you all in making this project possible.

Report Reviews

Reviews from the company: Authorized Signature: ________Year____Mon____Day
Instructor Views: Instructor Signature: ________Year____Mon____Day
Internship Grade (Assessed by Five-tier System):   Authorized Signature: ________Year____Mon____Day