

Design of smart input devices

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Abstract. As the size of the chip is getting smaller and the processing speed is getting faster and faster, various smart products are also constantly being upgraded. Multimedia is widely used in teaching. Traditional laser pointers can no longer meet people's needs. Electronic stylus chips can enhance the interaction between human and computer. The smart electronic stylus uses a gyroscope and accelerometer to collect position and speed information, then transmits the information to the smart display device via Bluetooth.

1 Introduction

Most of the stylus on the market is used to record text and edit text by contacting the screen. However, this kind of pen is more expensive, and there are conditions for the user's writing habits. It is required that the user cannot tilt more than a certain angle. As Steve Kolokowsky said, the use of stylus will make smart phones smarter, but the current stylus still faces many technical challenges [1-3]. Chalk contains heavy metals. If used too much, it can easily damage the body [4-6]. The smart handwriting electronic pen can transmit the location information of the pen via Bluetooth, reducing the material conditions and reducing the requirements for users.

2 Methods and Materials

2.1 Construction of development environment

First build a software environment and use software Lichuang EDA to create a chip schematic diagram and a chip printed circuit board diagram. In the drawing process, use the 'symbol' function to model the components, or download the model from the OPEN SOURCE library, collect the components, and draw them in a schematic diagram. Use software keil to input programs and simulation tests on physical objects. To build a physical environment, welding equipment, physical simulation tools, and test tools (voltmeter, etc.) are required.

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2.2 Component selection

The power supply part uses a TP4056 chip that prevents current backflow and can automatically adjust the charging current, and an HT7333 chip that can reduce the voltage. Use the MPU6050 chip to send location information. Use the RF-BM-ND08C Bluetooth low energy chip to send data. These chips have low power consumption, small size and easy to use.

2.3 Design the original circuit diagram

Use the RF-BM-ND08C Bluetooth low energy chip to process and send data, and the chip can also be simulated and tested. key1, key2, and key3 are the pins connected to the key module. When the key is pressed, data can be sent through an interrupt to achieve the purpose of switching modes. The two pins SWDIO and SWCLK are the pins of the input program. We connect these two pins through jlink to achieve the functions of the input program and the debugging chip. SCL and SDA are the pins for the sensor to transmit data. Through these two pins, the sensor and the MCU exchange data. As an important part of the identification system, Bluetooth beacon is currently widely used in many fields [7-9].

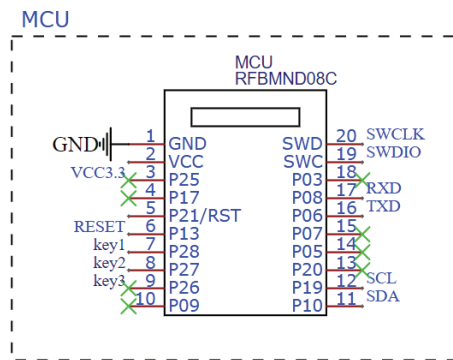


Fig. 1. Schematic diagram of Bluetooth control module.

TP4056 power supply charging module, its main function is to charge the lithium battery on the BAT pin with the voltage of VCC, and it also has functions such as anti-reverse, automatic current adjustment, and chip temperature limit. At the same time as charging, there is a light-emitting diode indicating whether the charging is complete.

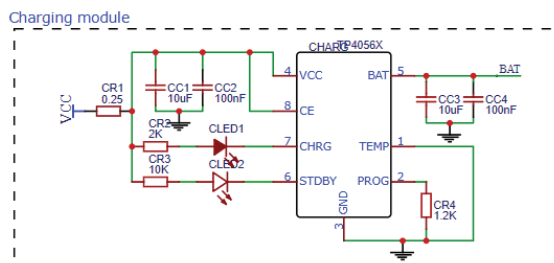


Fig. 2. TP4056 power charging modul.

The sensor module is an MPU6050 chip. MPU6050 has the function of an accelerometer, and the MEMS acceleration sensor has the advantages of high accuracy and small size [10-12]. We mainly use the two pins SDA and SCL to obtain the data on the chip. In addition, the AD0 pin can set the identification address of the chip.

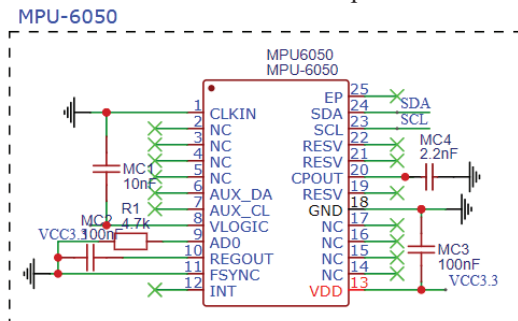


Fig. 3. MPU6050 chip schematic.

2.4 Design Printed Circuit Board

Some key points that need to be considered in PCB circuit design are arranged according to the arrangement principle of "large first, then small and then simple". That is to say, the space of the PCB board is limited, and important components must be selected first.

1. The layout of components should be easy to debug and maintain, that is, small components cannot be placed around large components, and there must be enough space around them, so that they are not too crowded and there is no place to start.

2. The heating elements should generally be evenly distributed to promote the heat transfer of the single chip microcomputer and the whole machine, and pay special attention to temperature-sensitive components. Except for temperature-measuring components, components with high heat should be kept away.

3. The layout must have a schematic diagram. According to the rule of the main signal to the single board, the basic components must meet the following requirements: the total connection line should be as short as possible, and the main signal line should be as short as possible; the decoupling capacitor circuit should be as close as possible to the power supply of the IC. The pin should be the shortest circuit between the power supply and the ground; reduce the signal transmission distance and prevent problems caused by too long transmission distance.

4. For the same structural part of the circuit, if possible, adopt a symmetrical standard layout; according to uniform distribution, center of gravity balance and beautiful layout

5. Inserted components of the same type should be placed in the same direction in the X or Y direction. Individual components of the same type of polarity should also be designed in the same order in the X or Y direction to facilitate production and verification.

According to the shape of the circuit board, according to the above summary, we divide the circuit board into three major blocks, from right to left: charging area, voltage regulation area and data transmission area.

The charging area generally has a large current, which will have a great impact on the signal line. If the distance is too close, the data cannot be transmitted normally, so put it on the far right and at the same time, the heat generated by charging will not deform the circuit board. Moreover, considering the external deformation of the circuit board caused by unplugging and plugging during charging, it is the best choice to place the charging module on the edge [13-15].

In the middle is the voltage regulation area, which is mainly responsible for reducing the 3.7v power supply of the lithium battery to the 3.3v working voltage and keeping the voltage stable. A voltage regulator chip is an integral part of the circuit design. It is an intermediary for converting high voltage into low voltage and a bridge between the two. Therefore, the voltage regulation module should act as a good bridge. We place it in the charging Between the area and the data transmission area, this can not only ensure that the data transmission is not disturbed, but also reduce the voltage, killing two birds with one stone.

Finally, there is the data transmission area. This area is full of high-frequency transmission wires, so pay attention to the placement of components. We first place the components according to the position of the schematic diagram, but we must also consider the chip itself. The characteristics and shape of the circuit board, such as the BM-ND08C module is a Bluetooth module, which has a system on a chip and can be used as a main control chip. At the same time, there is also a Bluetooth antenna on the module. The Bluetooth antenna needs to clear the surrounding circuits, so as to ensure the accuracy of the Bluetooth transmission data, so it is doomed not to be placed in the middle of the circuit board [16-19].

The final choice is to place the Bluetooth module on the far left and leave the Bluetooth antenna in the air. Then, place the MPU6050 on the bottom layer. If the MPU6050 is placed between the voltage regulation area and the Bluetooth module, there will be too many vias, not to mention the difficulty of wiring, and it will also occupy a large area of the circuit board, which may even increase the area of the circuit board. , if it is placed on the bottom layer, it will not only reduce the transmission distance of the wire, but also reduce the number of via holes, indirectly reduce the area of the circuit board, and bring convenience to users [20-22].

2.5 Hardware structure design

The displacement sensor module sends signals and data to the Bluetooth master chip, and the Bluetooth master chip sends the data out after collecting it. Press the button to switch the mode, and turn on the interrupt after pressing it. The interrupt program is widely used in microcontrollers [23-25] and switches the mode. The whole process is shown in Figure 4. When entering programs into the chip, you need to use a general-purpose input and output port (GPIO) and configure registers [26-29].

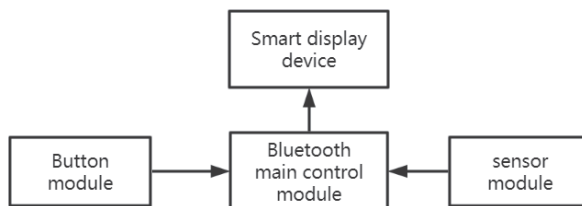


Fig. 4. Component function diagram.

The final PCB diagram is shown in Figure 5.

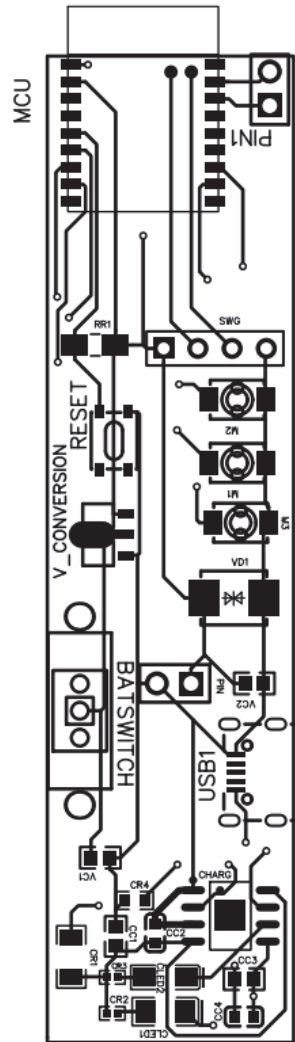


Fig. 5. Printed Circuie Board.

3 Results and Discussion

The official SDK package for Bluetooth connection is provided, and then find the ble_app_uart folder from the SDK package, open the project in the file, compile without problems, program the program into the microcontroller, and then open the phone to download the bluetooth software NRF connect. Connect [30-33]. The display controller based on the Bluetooth 5.0 chip nRF52840 can realize long-distance and wireless setting of the display terminal menu, as well as updating and maintaining the display terminal [34-40]. When Bluetooth is connected, data can be transmitted, and '123' is sent from the mobile phone to the smart electronic stylus. When viewed through the serial port, you can see that '123' was successfully sent (Fig. 6.).

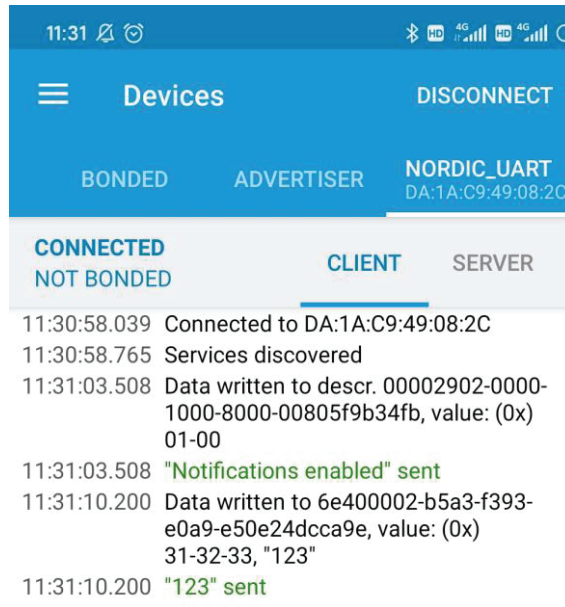


Fig. 6. SDK package for Bluetooth.

References

1. S. Y. Krotova, E.N. Ovchinnikova, T.V. Sarapulova, I.V. Remizova, *Production automation system for company manufacturing oil country tubular goods*, in IOP Conference Series: Materials Science and Engineering **976(1)** (2021)
2. I. V. Remizova, T.S. Krugovaya, S.Y. Krotova, E.N. Ovchinnikova, *Automation system for oil and gas service enterprises*, in IOP Conference Series: Materials Science and Engineering **905** (2020)
3. Y. E. Shklyarskiy, D.E. Batueva, *Journal of Mining Institute* **253** (2022) <https://doi.org/10.31897/PMI.2022.7>
4. R. N. Safiullin, A.S. Afanasyev, V.V. Reznichenko, *Journal of Mining Institute* **237** (2019) <https://doi.org/10.31897/pmi.2019.3.322>
5. T. A. Yakovleva, A.O. Romashev, G.N. Mashevsky, *Mining Informational and Analytical Bulletin*, **6(2)** (2022) https://doi.org/10.25018/0236_1493_2022_62_0_175
6. N. D. Senchilo, D.A. Ustinov, *Energies* **14** (2021) <https://doi.org/10.3390/en14217098>
7. B. N. Abramovich, I.A. Bogdanov, *Journal of Mining Institute* **249** (2021) <https://doi.org/10.31897/PMI.2021.3.10>
8. I. Beloglazov, K. Krylov, *Mathematics* **10** (2022) <https://doi.org/10.3390/math101>
9. E. Ushakov, T. Aleksandrova, A. Romashev, *Neural network modeling methods in the analysis of the processing plant's indicators* (2021) https://doi.org/10.1007/978-3-030-57453-6_4
10. C. Savard, E.V. Iakovleva, D.I. Ivanchenko, A. Rassolkin, *Energies* **14** (2021) <https://doi.org/10.3390/en14123493>
11. A. A. Korzhev, O.M. Bolshunova, I.N. Voytyuk, A.M. Vatlina, *E3S Web of Conferences* **140** (2019) <https://doi.org/10.1051/e3sconf/201914004012>

12. Y. A. Sychev, R.Y. Zimin, *Journal of Mining Institute* **247** (2021) <https://doi.org/10.31897/PMI.2021.1.14>
13. N. Korolev, A. Kozyaruk, V. Morenov, *Energies* **14(19)** (2021) <https://doi.org/10.3390/en14196074>.
14. E. I. Kabanov, G.I. Korshunov, V.A. Rodionov, *Gornyi Zhurnal* Issue **8** (2019) <https://doi.org/10.17580/gzh.2019.08.17>
15. E. Blinova, T. Ponomarenko, V. Knysh, *Sustainability* **14(13)** (2022) <https://doi.org/10.3390/su14138163>
16. I. Gorelova, D. Dmitrieva, M. Dedova, M. Savastano, *Administrative Sciences*, **11(3)** (2021) <https://doi.org/10.3390/ADMSC111030094>
17. M. S. Saleh, *Construction Materials and Products* **5(1)** (2022) <https://doi.org/10.34031/2618-7183-2022-5-1-54-59>.
18. P. I. Loshakov, *Construction Materials and Products* **5(1)** (2022) <https://doi.org/10.34031/2618-7183-2022-5-1-38-53>.
19. K. A. Otsokov, *Construction Materials and Products* **3(1)** (2020) <https://doi.org/10.34031/2618-7183-2020-3-1-7-13>.
20. Yu. V. Denisova, *Construction Materials and Products* **1(3)** (2018) <https://doi.org/10.34031/2618-7183-2018-1-3-33-42>.
21. S. V. Zhuykov, *Construction Materials and Products* **4(3)** (2021) <https://doi.org/10.34031/2618-7183-2021-4-3-23-40>.
22. L. A. Zakharov, D.A. Martyushev, I.N. Ponomareva, *Journal of Mining Institute* **253** (2022) <https://doi.org/10.31897/PMI.2022.11>
23. Y. L. Zhukovskiy, M.S. Kovalchuk, D.E. Batueva, N.D. Senchilo, *Sustainability* **13(24)** (2021)
24. T. A. Yakovleva, A.O. Romashev, G.N. Mashevsky, *Mining Informational and Analytical Bulletin* **6(2)** (2022) https://doi.org/10.25018/0236_1493_2022_62_0_175
25. M. Y. Zemenkova, E.L. Chizhevskaya, Y.D. Zemenkov, *Journal of Mining Institute* **258** (2022) <https://doi.org/10.31897/PMI.2022.105>
26. K. S. Nurgalieva, K.A. Abdullah, M.A. Seyed, N. Slavko, *Applied Sciences* **12** (2022)
27. E. Ushakov, T. Aleksandrova, A. Romashev, *Neural network modeling methods in the analysis of the processing plant's indicators* (2021) https://doi.org/10.1007/978-3-030-57453-6_4
28. E. V. Filippov, L.A. Zakharov, D.A. Martyushev, I.N. Ponomareva, *Journal of Mining Institute* **258** (2022) <https://doi.org/10.31897/PMI.2022.103>
29. I. R. Shamil, A. Grigoriev..., I.I. Beloglazov, S.A. Savchenkov, O.T. Gudmestad, *Symmerty* **7(13)** (2021)
30. R. R. Sultanbekov, I.I. Beloglazov, S.R. Islamov, M.C. Ong, *Energies* **8422(14)** (2021)
31. L. S. Brilliant, A.S. Zavialov, M.U. Danko, K.A. Andronov, I.V. Shpurov, V.G. Bratkova, A.V. Davydov, *Oil Industry* **2022(3)** (2022) <https://doi.org/10.24887/0028-2448-2022-3-48-53>
32. A. O. Romashev, N.V. Nikolaeva, B.L. Gatiatullin, *Journal of Mining Institute* **256** (2022) <https://doi.org/10.31897/PMI.2022.771>
33. A. Lutonin, J. Shklyarskiy, *E3S Web of Conferences* **266** (2021)
34. K. Holkar, L.M. Waghmare, *International Journal of control and automation* **3** (2010)

35. I. Brigadnov, A. Lutonin, K. Bogdanova, *Symmetry* **15** (2023) <https://doi.org/10.3390/sym15020344>
36. A. B. Makhovikov, S.B. Kryltsov, K.V. Matrokhina, V.Ya. Trofimets, *Tsvetnye Metally* **4** (2023) <https://doi.org/10.17580/tsm.2023.04.01>
37. K. V. Matrokhina, V.Y. Trofimets, E.B. Mazakov, A.B. Makhovikov, M.M. Khaykin, *Journal of Mining Institute* **259** (2023) <https://doi.org/10.31897/PMI.2023.3>
38. K. V. Matrokhina, A.B. Makhovikov, E.N. Trofimets, *E3S Web of Conferences* **266**, 09001 (2021)
39. S. Kryltcov, A. Makhovikov, M. Korobitcyna, *Symmetry* **13(3)**, 460 (2021)
40. E. Samylovskaya, A. Makhovikov, A. Lutonin, D. Medvedev, R.-E. Kudryavtseva, *Resources* **11(3)** (2022)