Design of Microcontroller based Wireless Pendrive

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Abstract - *The ESP32 micro controller is used in this paper to study and develop a Pen drive or USB drive for wireless data transfer. D ue to the rising need for accessible and portable data storage, USB drives are becoming a popular alternative for both consumers and enterprises. However, using cables for data transit limits their versatility and could be troublesome in some situations. In order to resolve this problem, this paper proposes the use of wireless technology, specifically WiFi, to enable wireless data transfer between a USB drive and other devices.*

Among the elements required for the implementation of wireless data transfer that are covered in the opening section of the paper are the ESP32 microcontroller, which is used for both WiFi connectivity and USB communication, and the TP4056 lithium battery charger, which enables portable and rechargeable power. The design and implementation of the system, including the hardware and software components employed, are then thoroughly reviewed in the paper. The emphasis the potential uses of this technology, such as in settings where cables are cumbersome or impracticable, including during presentations or demonstrations. The report also analyses this method's drawbacks and difficulties, such as the potential for signal interference and security issues.

The study into and application of a USB drive for wireless data transfer is thoroughly summarised in this article, along with its benefits and limitations, and the potential applications of this technology are discussed.

Key Words: USB, Wireless, Wi-Fi, Pendrive, Data Transmission, ESP32, TP4056.

1. INTRODUCTION

An ESP32 microcontroller, which supports USB and Wi-Fi connectivity, serves as the foundation of the proposed system. Utilising the TP4056 lithium battery charger, rechargeable lithium batteries power the portable USB drive. Because of how the system is configured, the ESP32 can connect to the local WiFi network and create a hotspot for other devices. With this setup, the user can wirelessly transfer data from the USB drive to other devices without the need for wires.

One of the main advantages of this technology is that it allows for more convenient and mobile data transfer, which can be especially useful when utilising cables would be problematic or burdensome. It can be used, for instance, in situations that call for mobility, such presentations and demonstrations. Due to the system's ability to operate on rechargeable batteries, which enable it to be used for extended periods of time without having an external power source, it is even more portable.

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Despite these challenges, there are numerous potential uses for wireless technology for USB devices. For instance, it may be used in classrooms to allow students to wirelessly communicate their assignments to teachers for grading. It can also be utilised in offices so that staff members can wirelessly communicate with one another without the need for wires.This paper provides a comprehensive overview of the study on the usage of a USB drive for wireless data transfer while also highlighting its benefits and drawbacks. Future technological development and expansion are anticipated, allowing for even greater comfort and mobility in data sharing.

2. LITERATURE REVIEW

Olga Mordvinova , Julian Martin Kunkel and Christian Baun, in the paper “USB Flash Drives as an Energy Efficient Storage Alternative [3]” compared the energy efficiency of cheap flash SSDs with traditional hard drives. Their objective was to determine whether using USB flash drives in place of hard drives is a practical and affordable solution to construct energy-efficient servers. Despite hard discs' high throughput, testing revealed that flash drives perform better per joule.

Tushar Sawant ,Bhagya Parekh and Naineel Shah, in their paper“ Computer Independent USB to USB Data Transfer Bridge [4]” data transfer from one USB flash drive to another that is independent of the computer is accomplished. The fact that their technology is battery-operated and portable is an added benefit. It is an integrated response to a real-world issue.

Naresh Kumar Reddy, N. Venktram and T. Sireesha in their paper "An Efficient Data Transmission by Using Modern USB Flash Drive [6]"Suggest a pen drive with a touch screen LCD, Wi-Fi, Bluetooth, USB, and memory card slots. Without using a computer, this gadget permits direct data transmission between USB flash drives. It can transfer up to 16GB of data and has an inbuilt battery for charging. It can be difficult to implement an operating system and CPU on a USB flash drive. Data transfer is now simple and portable thanks to this device, which eliminates the need for additional wires.

Abhijeet Ashish, Gaurav Gautam and Arjun Sahi in the paper, "Data Communication Via Bluetooth Between Pen drive Using ARM [7]" I discovered that without a PC, one may share data straight from pen drive to pen drive using a pen drive. This method is incredibly efficient and can help users save time and effort.Users will feel at ease and be able to transfer info with ease. We need a tiny power source to the pen drive's nearly 9-volt DC power supply in order for it to operate.

Monika T. Shinde1, Mr. Ramchandra. K. Gurav2 in their paper "USB to USB Data Transfer using Raspberry Pi and ARM [11]" describe utilising the Raspberry Pi and ARM7 to create a portable system for USB device data transfer. It connects to several USB devices and enables graphical display of file transfer progress. The technology is portable and does not need a laptop or PC. Linux can be powered by a power supply or batteries and offers additional security. The initiative meets the demand for portable data transfer.

Rohan Kulashresta, Rajeev Ranjan and Shreyas Barati, in their paper "Wireless Data Transfer Of USB Devices Using WiFi Technology [12]" presented a concept for wireless data transfer for USB devices without the use of USB cables or computer connections. As a result, we may simply transfer data using this device from a pen drive to computers or smartphones and vice versa.

Alexander Maier, Andrew Sharp, Yuriy Vagapov in their paper "Comparative Analysis and Practical Implementation of the ESP32 Microcontroller Module for the Internet of Things [13]" ESP32 is a low-cost, low-power system on a chip microcontroller with support for Wi-Fi and Bluetooth. The ESP32 is compared to other IoT modules, its technological merits are highlighted, and a real-world application as a portable wireless oscilloscope is given as an example. The ESP32 is excellent for hobbyist, educational, industrial, and small-sized solutions since it comes in a variety of form-factors. In general, it is anticipated that the ESP32 will be crucial in developing future embedded systems and IoT systems.

3. BLOCK DIAGRAM

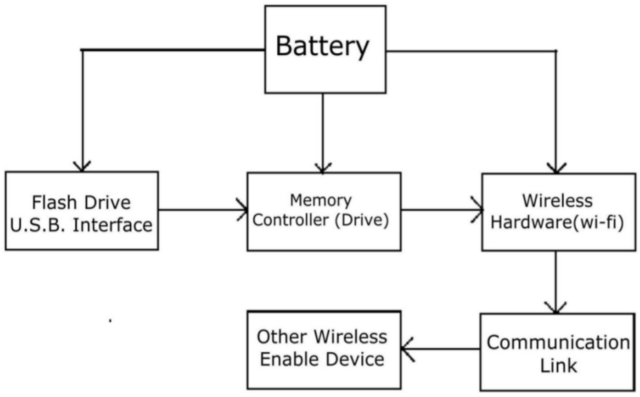

Fig. 4.1 Diagram Of Wireless Pendrive

4. HARDWARE DISCRIPTION

4.1. ESP32

Fig. 4.2 Wi-Fi Module ESP32-S2-SOLO

The Xtensa LX6 CPU core, which enables multi-threading and has a top speed of 240 MHz, serves as the foundation of the ESP32. It also features a sizable variety of integrated peripherals, including SPI, I2C, UART, ADC, DAC, capacitive touch, temperature, and hall sensors, as well as an internal amplifier for external speakers [1].

The Xtensa LX6 CPU core, which can run at a top speed of 240 MHz and enables multi-threading, serves as the foundation of the ESP32. It also includes numerous built-in peripherals, including SPI, I2C, UART, ADC, and DAC, as well as capacitive touch, temperature, and hall sensors, as well as an internal amplifier for external speakers [1].

It features 520KB of SRAM and 4MB of flash memory and supports a variety of programming languages, including the Arduino IDE, MicroPython, and ESP-IDF. Due to its low power consumption and capacity to run in low-power modes to save energy, the ESP32 is a viable option for IoT projects. There is a deep sleep mode that can reduce power consumption to just 10 A [5].

The ESP32, a microcontroller-based platform with WiFi and Bluetooth connectivity, is a fantastic choice for IoT projects. Due to its dual-core processors and low power consumption, it is a popular choice among manufacturers and developers [14].

The ESP32 is used in wearable technology, smart agriculture, home and industrial automation, as well as do-it-yourself projects. The ESP32 DevKitC and ESP-WROVER-KIT boards are just two of the many ESP32 development boards that are available, giving makers and developers even more adaptability and versatility [14].

4.2. USB

Fig. 4.3 Male USB Connector

The interface is enjoyable to use for a multitude of reasons since usability was a fundamental design aim for USB.

Many devices, one interface: Almost any conventional PC peripheral function can be handled by the USB standard because to its flexibility.

One interface supports many peripheral functions rather than needing a different connection and cable type for each one [10].

Automated configuration: Upon connecting a USB device, the operating system recognises it and loads the necessary software driver. The operating system may ask the user to input a disc containing driver software the first time a device connects, but after that, installation is automatic. The device does not require a reboot before use [10].

Simple to link Hubs make it simple to add more USB ports without wireless capabilities to a normal PC's plethora of USB ports: Current technologies allow wireless connections with USB devices without opening the PC, despite the fact that USB was initially a wired interface [10].

4.2. Flash Memory

Fig. 4.4 Flash Memory Storage

A specific kind of EEPROM chip is flash memory. Each cell has two transistors at each intersection of its column and row grid. (See illustration below. A thin oxide layer separates the two transistors from one another. The floating gate transistor is one of the transistors, and the control gate transistor is the other. Only at the control gate do the floating gate and the row, or word line, make contact. The cell has a value of 1 while this link is active.

The floating-gate transistor behaves like an electron cannon as a result of this charge. The thin oxide layer acquires a negative charge as a result of the excited electrons being forced through and trapped on the other side of the layer. The control gate and the floating gate are separated by these negatively charged electrons. The amount of charge travelling through the floating gate is monitored by a special device called a cell sensor. A value of 1 is given when the gate's flow reaches 50% of the charge. The value becomes zero as soon as the charge travelling through is less than 50%. Each cell in a blank EEPROM has a value of 1, as every gate is fully open.

4.4. TP4056

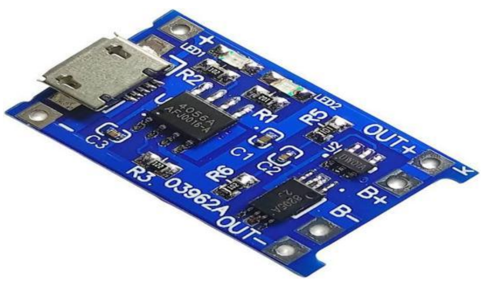

Fig. 4.5 Charging Module

A linear charger designed exclusively for single-cell lithium-ion batteries is the TP4056. Due to its compact SOP container and low external component count, it is ideal for portable applications. The integrated PMOSFET architecture eliminates the need for a blocking diode and avoids negative charge current. The charger regulates the charge current to limit the die temperature in high power operation or high ambient temperature conditions [1]. The TP4056 features a preset 4.2V charge voltage with 1.5% accuracy and can charge a single cell Li-Ion battery straight from a USB port. It also includes soft-start limitations to lessen inrush current. The TP4056 is available in an optional radiator that must be linked to GND.

The charge voltage is fixed at 4.2V, and the charge current can be programmed using just one external resistor. The TP4056 terminates the charge cycle when the charge current exceeds 1/10th of the specified value following the achievement of the final float voltage. Additionally, it has attributes like current monitoring, two status pins that display input voltage and charge termination, under voltage lockout, and automated recharging[5].

4.5. Lithium Polymer Battery

Fig. 4.6 Lithium Polymer Battery

The LiPo (Lithium Polymer) battery is a popular rechargeable battery type used in many electronic devices, such as smartphones, drones, and remote-control automobiles. This particular type of lithium-ion battery is lighter and more flexible since it uses a polymer electrolyte rather than a liquid electrolyte [16].

LiPo batteries are able to store more energy in a smaller space than other rechargeable batteries because they have a higher energy density. Because they also have a fast discharge rate, they are ideal for high-performance applications that demand a lot of power quickly. However, LiPo batteries require particular handling and care due to their sensitivity to overcharging, overheating, and punctures, which can cause them to catch fire or explode[16].The LiPo (Lithium Polymer) battery is a popular rechargeable battery type used in many electronic devices, such as smartphones, drones, and remote-control automobiles. This particular type of lithium-ion battery is lighter and more flexible since it uses a polymer electrolyte rather than a liquid electrolyte [16].

The lithium-polymer batteries utilised in this investigation have three cells in total, and it will be chosen whether to charge each cell independently or all at once. The 1800 mAh Li-Po battery utilised features a constant current regulation of 0.8 A and a constant voltage regulation of 4.2 V. [18].

5. WORKING

A flash drive is a small, portable storage device that may be used for both transferring and storing digital data. NAND flash memory, a type of non-volatile memory, is used to store data. The ability of NAND flash memory's memory cells to be electrically programmed and erased allows for rapid read and write rates.

The NAND flash memory is controlled by a memory controller, which also manages data transfers. A tiny chip within the flash drive called the memory controller communicates with the host device to control data transfers and ensure data integrity.

A Wi-Fi module is attached to a flash drive in order to make it wireless. An ESP32 Wi-Fi module is utilized in this situation. The ESP32 is a Wi-Fi and Bluetooth combination chip that is low-cost, low-power, and highly integrated. It may be used both independently and as a slave in a larger system.

The memory controller transfers data from the flash drive to the ESP32 Wi-Fi module and then wirelessly over the air to another Wi-Fi enabled device. The data is transmitted using a communication protocol, such as Wi-Fi Direct or TCP/IP.

The memory controller, flash drive, and Wi-Fi module are all powered by batteries. In this scenario, a lithium polymer (LiPo) battery is chosen due of its high energy density and light weight. The battery is charged using a TP4056 battery charger module, a small, low-cost module that provides a regulated 5V output for charging the LiPo battery.

In general, a wireless flash drive offers a practical means of storing and transferring data without the requirement of a direct physical connection to a host device. Many different applications, including media streaming, backup and restore, and file sharing, can use it.

6. CONCLUSIONS

This review paper has looked at the design and potential applications of a wireless USB drive that makes use of the ESP32 microcontroller and the TP4056 lithium battery charger. The wireless method of data transfer makes it easier and more portable, making it helpful in a number of situations. However, there can be drawbacks like security concerns and signal interference. Due to its benefits, wireless data transfer is still a promising technology that has a lot of promise for usage in business and educational contexts. The distribution of wireless USB drives is anticipated to increase as technology develops, facilitating more practical and efficient data transfer.

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