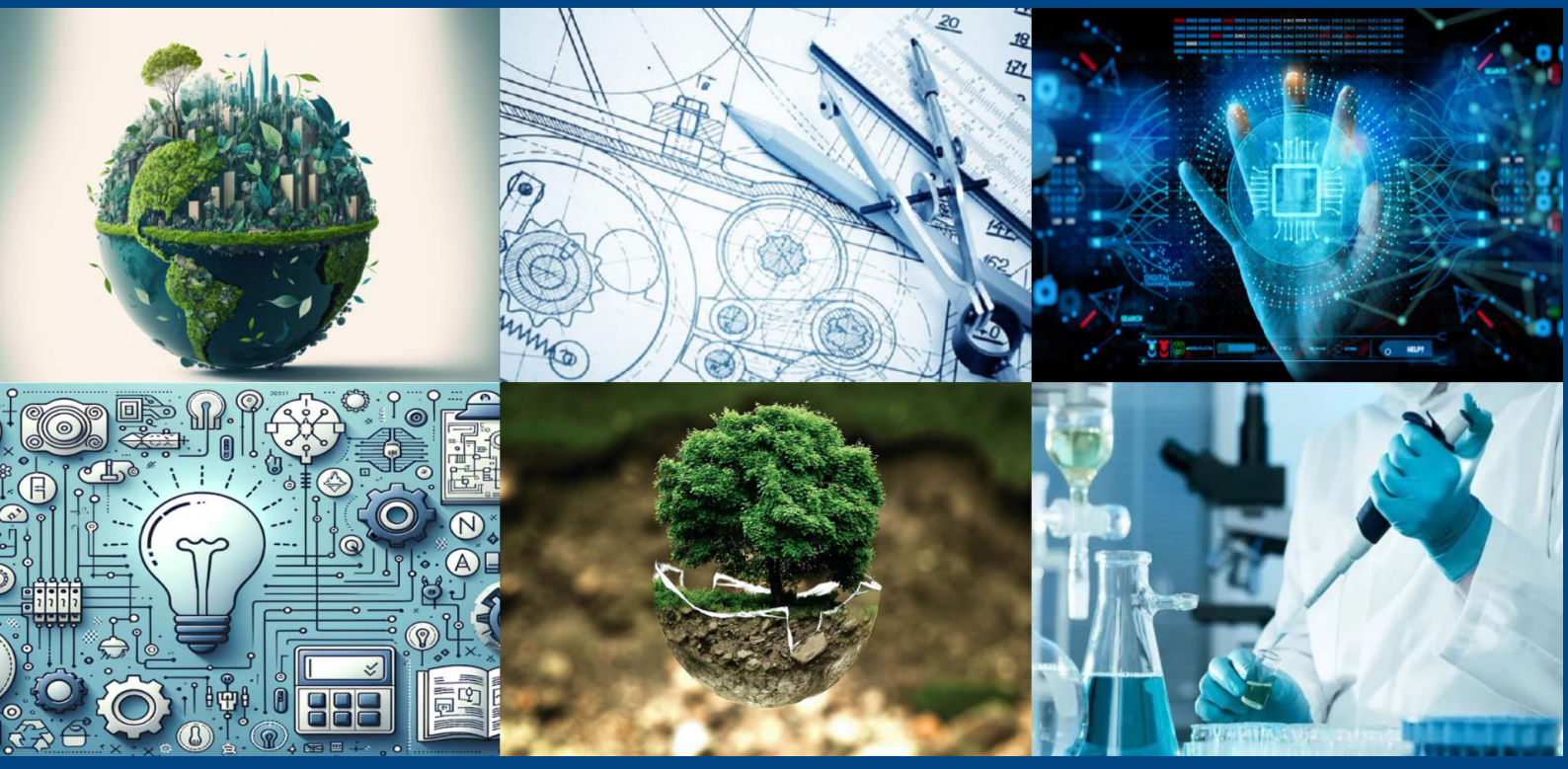
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206

Volume 8, Issue 4, April 2025

© 2025 IJMRSET | Volume 8, Issue 4, April 2025| DOI:10.15680/IJMRSET.2025.0804354

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Mini Computer Using Raspberry Pi : A Compact and Portable Computing Solution

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ABSTRACT: The increasing demand for portable, cost-effective, and energy-efficient computing solutions has led to the development of compact mini computers. In this paper, we've designed and built a compact mini computer using the BusyBirds chip. The system includes a built-in power bank for better portability, an HDMI port for connecting to high-definition displays, and Bluetooth 5.0 for reliable wireless communication. It's developed as a simple, affordable computing option for students, developers, and professionals who need a small, efficient system for different tasks.

The BusyBirds Chip is used as the main processing unit, offering better performance while keeping power usage low. One of the standout features of this mini computer is that, unlike regular desktops or laptops that rely on being plugged in all the time, this one can run on battery power. That makes it a handy option for working in places where there's no easy access to electricity. The in-built power bank helps keep the system running smoothly without interruptions, which makes it especially useful for learning activities and IoT projects. Modern systems need strong connectivity options, and this setup includes both HDMI and Bluetooth 5.0 to improve usability. The HDMI output lets you connect to high-quality displays, while Bluetooth 5.0 makes it simple to pair devices like a mouse, keyboard, or speakers. After testing its performance, results showed that the mini computer works as expected offering a good mix of portability, efficiency, and low cost.

KEYWORDS: Mini Computer, Raspberry Pi 5, Portable Computing, In-Built Power Bank, Connectivity, Low-Power Devices, IoT

I. INTRODUCTION

The way computing technology has advanced over the years has increased the need for small, energy-saving, and affordable devices. Big desktop computers and laptops use a lot of power and are difficult to carry around, making them less practical for people who need devices they can easily move. The BusyBirds chip is a good option because it's a powerful, small computer that works well for many uses. This mini computer comes with important features like HDMI connectivity, Bluetooth 5.0, and a built-in power bank. This lets users run it without always needing to plug it into an electric outlet. The system is very helpful for schools, developers, and people working on IoT projects, where both mobility and energy efficiency matter.

This device is designed to save power while still giving good, smooth performance to people working in places where electricity is limited or hard to access. Along with being easy to carry, it has high-definition display output through HDMI, so it works well for presentations, watching videos, or coding. Bluetooth 5.0 makes it simple to connect to wireless devices like keyboards, mice, and IoT tools, making it useful for many different areas.

The built-in power bank makes it even easier to carry, making it a good choice for students, researchers, and professionals who need a computer they can use anywhere. Also, its small size and wireless abilities make it perfect for smart home setups, real-time data monitoring, and automation. The BusyBirds Chip is faster and has better connectivity, making it more useful in schools and for professional work. This project aims to solve the limits of regular computers by showing how mini computers can be powerful, efficient, and a better option for the future. This paper explains how the system was built, what hardware and software were added, and how these parts work together to improve the mini computer's performance.

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The built-in power bank boosts portability, making it a smart tool for students, researchers, and people who need mobile computing. Also, its compact build and wireless features are great for projects like automation, processing data in real-time, and controlling smart homes. BusyBirds Chip faster speed and better connections make it ideal for both study and office use.

This project focuses on fixing the weak points of traditional devices and proves how mini computers can be strong, adaptable, and eco-friendly options for different uses in the future. It explains how the hardware and software come together to make the system easy to use, and it also describes how performance tests were done to check if it works well in the real world. The results show how small single-board computers can be turned into smart, practical tools that suit a wide range of users and tasks.

II. LITERATURE REVIEW

2.1. Single-Board Computers for Portable Computing :-Single-board computers, also known as SBCs, have completely changed how computing systems are designed for small, portable use. Many studies have looked into how SBCs are being used in areas like education, IoT, and embedded systems. Researchers have examined how these devices help create affordable computing options, especially in places with limited resources or where it's hard to get proper computer systems. This project focuses on showing how the BusyBirds Chip can be a great portable computing solution by using parts that save power and offer wireless connections.

2.2. Power Optimization in Mini Computers :-Saving power is one of the most important things to consider when building portable computers. Regular computers need to stay plugged in, which limits how portable they can be. Many studies have tested different types of batteries, ways to manage power, and components that use less energy to improve portability in these devices. In this project, adding a built-in power bank follows research that stresses the need for reliable and eco-friendly power solutions that allow continuous computer use without interruptions.

2.3. Wireless Connectivity and IoT Applications :-Wireless connectivity is a key feature that makes mini computers more useful. Bluetooth and Wi-Fi help these systems connect easily with other devices, so they can be used with extra gadgets or connect to cloud-based apps. Many studies have also shown how Bluetooth 5.0 increases data transfer speed and makes connections more stable in IoT-based projects. This project adds wireless features to improve how well the mini computer works and how easy it is to use, making it a good option for IoT-focused applications.

III. EXISTING PROBLEM STATEMENT

Right now, portable computers face several problems because of limits in how efficiently they use power, how well they connect to other devices, and how much processing power they offer. Regular laptops and desktop computers use a lot of electricity, are big and heavy, and need to stay plugged into a power outlet, which makes them a bad choice for people who need computers in remote places or while traveling. Even though mini computers are available, most of them still don't have built-in power systems or good enough connectivity features. Some of the biggest problems include:

3.1. Power Dependency and Limited Battery Life :-

Most mini computers still need to be plugged into a power source or use simple rechargeable batteries that don't last very long. This makes them difficult to use for a long time in places where no power supply is available. Without a built-in power bank, users deal with frequent shutdowns, which affects portability and makes it tough to use these computers in faraway areas.

3.2. Lack of Seamless Wireless Connectivity :-

Many of the mini computers available today don't come with the latest wireless features like Bluetooth 5.0 or high-speed Wi-Fi. Because of this, they struggle to connect smoothly with other devices and IoT systems. Without solid wireless connections, these computers are hard to use in smart projects or situations where data needs to be shared quickly and reliably.

3.3. Limited Processing Power for Multi-Tasking :-

Even though mini computers are small and easy to carry, many of them have weaker performance when handling

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demanding tasks. They often slow down when running programs for coding, video work, or handling data for IoT projects. Without better processing power, their speed drops, which reduces how useful they can be for serious work.

3.4. Lack of Display Output Flexibility :-

A lot of current mini computers also don't have proper display options, which limits their use in things like watching videos, giving presentations, or teaching. If they don't support high-definition displays like HDMI, it becomes harder for people to use these devices for different types of everyday tasks.

These issues clearly show that there's a need for a better mini computer that comes with a reliable power supply, strong wireless connection options, better processing abilities, and support for HD displays. This project focuses on building a Raspberry Pi 5-based mini computer that solves these problems and offers a dependable, energy-saving, and portable computing solution.

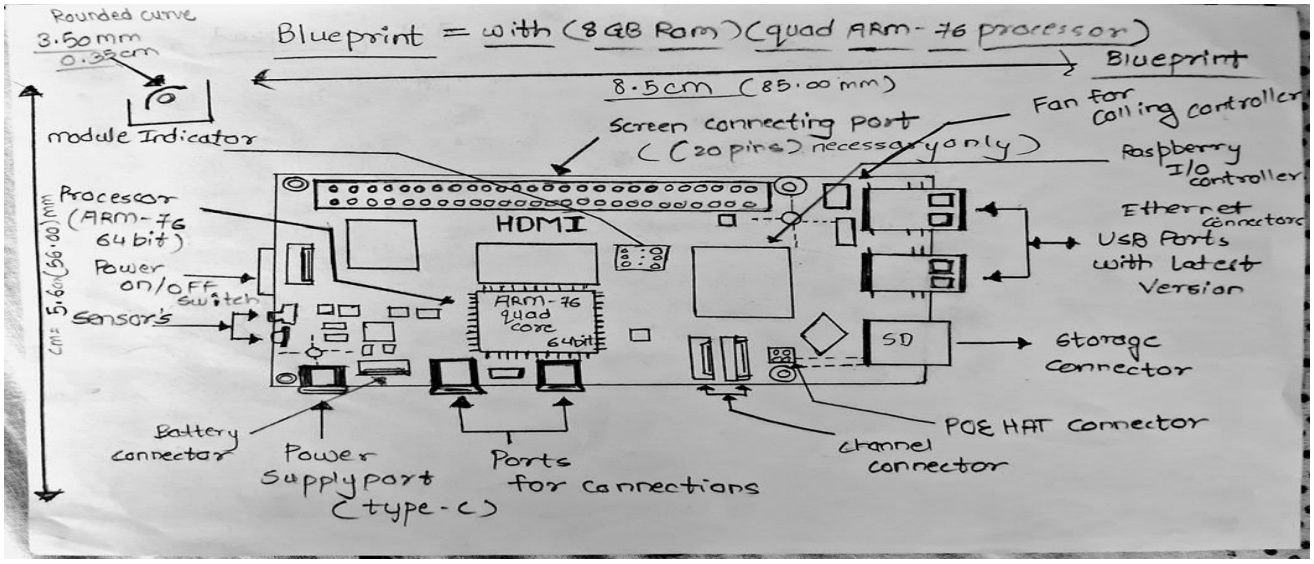

Fig 1: Construction of BusyBirds Chip(With Reference of Raspberry pi)

3.5. Inefficient Power Management :-

A lot of mini computers today have poor power management, which causes them to use more electricity than needed and shortens their working life. Because the power isn't regulated properly, these devices often overheat and their battery life drops quickly. This makes them unreliable for people who need to use them for long hours without interruptions.

3.6. Limited Scalability and Customization :-

Most mini computers don't offer much room for upgrades, whether it's for hardware or software. It's often hard for users to improve things like processing speed, memory, or connection options. This makes it difficult for people to adjust or upgrade their system later on when their needs change or when new technologies become available.

The problems listed above show why there's a need for a better mini computer that includes a strong, built-in power source, smooth wireless connections, faster processing, and support for high-definition displays. This project is focused on solving those issues by creating a Raspberry Pi 5-based mini computer that can handle these challenges and offer a dependable, energy-saving, and portable computing option.

IV. PROPOSED SYSTEM

The system we're proposing is designed to give a better solution for portable computing by using Raspberry Pi technology, creating a compact and energy-saving device. It's built to solve the problems found in regular desktops and laptops by offering portability, built-in power, and smooth wireless connections. At the center of this system is a

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Raspberry Pi 5-based mini computer with a rechargeable power bank, Bluetooth 5.0, HDMI display output, and options for remote monitoring.

4.1. BusyBirds Chip with Enhanced Performance :-

Unlike large, heavy computers, this system uses the Raspberry Pi 5, which has better processing power, uses less energy, and takes up less space. It allows users to multitask smoothly, making it a good choice for coding, IoT projects, and general computer tasks.

4.2. Solar-Powered System :-

The system can optionally run on solar power, making it useful in areas where regular electricity isn't available. The solar panel charges a battery, which then powers the computer, even when there's not much sunlight. This eco-friendly option removes the need for constant power sources or battery changes, making the setup more reliable and budget-friendly.

4.3. Microcontroller for Power and Connectivity Management :-

An ESP32 microcontroller manages the system, taking care of how power is distributed, handling Bluetooth and Wi-Fi connections, and helping improve energy efficiency. It monitors the battery, keeps track of tasks, and manages communication with other devices, ensuring the computer runs smoothly for different uses.

4.4. Mobile Application for Remote Control :-

A mobile app is included with the system, letting users check and control the computer from their phone. The app shows real-time updates like battery levels, network settings, and power use. It also lets users adjust system settings to improve how it performs for activities like data work, IoT projects, and learning environments.

4.5. Customizable Connectivity Options :-

The system offers several ways to connect, such as HDMI for HD displays, Bluetooth 5.0 for easy pairing with devices, and Wi-Fi for online and cloud-based activities. The mobile app helps manage these connections, so users can easily switch between different setups based on what they need.

4.6. Environmental Monitoring Sensors :-

To improve how well the system adapts to different environments, it includes sensors to keep track of things like temperature and power use. These sensors help the system adjust its performance depending on the situation, making sure power is used wisely and preventing overheating. This is especially helpful in tough conditions or remote areas.

Bringing all these features together makes this mini computer highly portable, power-saving, and capable of managing different

V.METHODOLOGY

5.1. Problem Identification :-

This project focuses on solving the issues found in traditional computers, like high power use, limited portability, and needing constant access to external power. The aim is to build a mini computer that includes a built-in power bank, smooth wireless connections, and strong performance, while keeping it affordable and energy-efficient.

5.2. Hardware Selection and Integration :-

The hardware parts for this system were chosen based on how well they perform, how little power they use, and how compact they are. The main components include:

- **Raspberry Pi 5:** Chosen for its fast processing, low energy use, and small size.
- **Power Bank Module:** A rechargeable lithium-ion battery is added to keep the system running without interruptions, supporting portable use.
- **Connectivity Modules:** Bluetooth 5.0 and Wi-Fi modules provide simple and reliable wireless connections to devices and the internet.
- **HDMI Output:** Lets the computer connect to HD displays for better use.
- **Compact Enclosure:** A strong yet lightweight case is made to protect the hardware while keeping the system easy to carry.

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5.3. Software Implementation :-

A lightweight, Linux-based operating system is installed on the BusyBirdsto improve speed and power saving. Important software parts include:

- **Custom User Interface:** A simple, easy-to-use interface for better navigation.
- **Pre-installed Development Tools:** Built-in coding environments and software libraries to help with tasks like programming, IoT projects, and media work.
- **Power Management Software:** A program is added to check battery levels and manage tasks, helping save power when possible.

5.4. Mobile App Integration :-

A special mobile app is made to let users control and monitor the mini computer from their phones. Features include:

- **Battery Level Monitoring:** Shows real-time battery use and remaining backup.
- **Performance Tracking:** Keeps a record of how the system is running like CPU usage, connection status, and system health.
- **Remote Control:** Lets users adjust system settings, manage connections, and control various system options from their phones.

5.5. Testing and Validation :-

To make sure the system works well and is dependable, the following tests are carried out:

- **Power Consumption Analysis:** Checks how long the battery lasts under different workloads.
- **Connectivity Stability Testing:** Tests how stable Bluetooth 5.0 and Wi-Fi connections are during use.
- **Performance Benchmarking:** Measures how fast the BusyBirds Chip works and how well it can multitask.
- **Durability Testing:** Makes sure the case protects the computer's parts and keeps it portable.

5.6. Scalability and Future Enhancements :-

This system is built to allow future upgrades and improvements. Some planned upgrades include:

- **Touchscreen Integration:** Adding a touchscreen to make using the system even easier.
- **Extended Battery Life:** Looking into newer battery technology for longer backup times.
- **AI-Based Optimization:** Using AI to help improve power management and system speed.
- **Cloud Integration:** Adding cloud storage and online processing features for even more options.

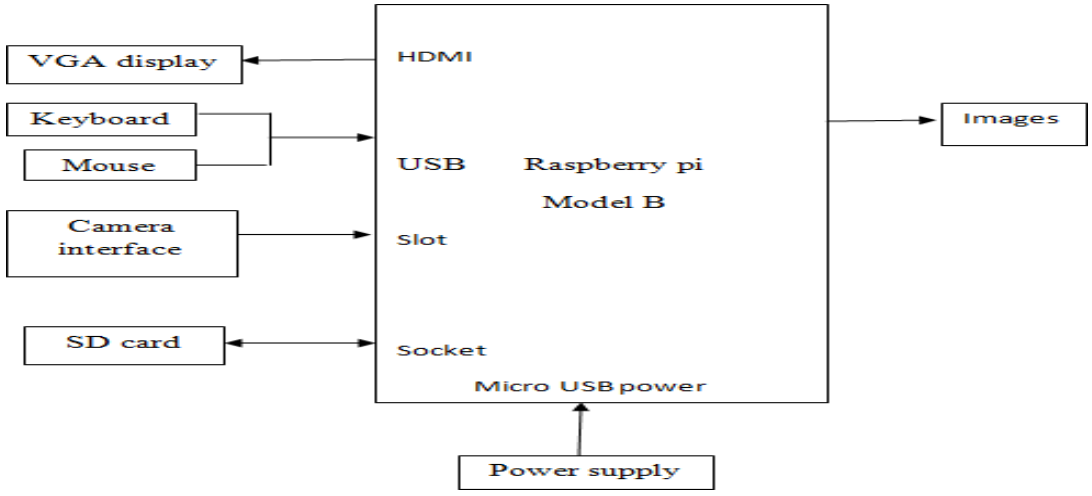

Fig 2: Working flow of IoT based Smart Mini PC Computer

5.7. Data Input and Peripheral Connectivity :-

The mini-computer connects different input devices to the Raspberry Pi Model B using several ports:

- **Keyboard and Mouse (USB ports):** Let users navigate and give commands to the system.
- **Camera Interface (Slot connection):** A camera can be connected to take pictures and process images.

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- **SD Card (Socket connection):** Holds the operating system and user data, working as the main storage device.

These devices help the system receive commands, handle data, and work with different kinds of input smoothly.

5.8. Display and Power Management :-

- **VGA/HDMI Display (HDMI port):** The Raspberry Pi sends images to an external screen through HDMI, letting users work with a graphical interface.
- **Power Supply (Micro USB Power):** The system runs on a micro-USB connection, keeping the computer stable and preventing sudden shutdowns.
- **Image Processing (Output):** When connected to a camera, the system captures images, processes them, and displays them on the screen. The images can be stored or shared depending on the task.

VI. CONCLUSION

The mini-computer system based on the Raspberry Pi Model B is an efficient, compact, and affordable computing solution suitable for a variety of applications, including education, automation, image processing, and general computing. This system integrates essential peripherals such as a keyboard, mouse, VGA/HDMI display, SD card storage, and a camera interface, providing users with a seamless experience. The USB and HDMI interfaces enable easy connectivity with external devices, offering great versatility for different computing tasks. One key advantage of this system is its low power consumption. Powered through a micro-USB connection, it ensures energy-efficient operation while maintaining solid performance. The inclusion of an SD card slot for storage enhances flexibility, allowing users to install multiple operating systems and run a range of applications without the need for bulky hard drives. Additionally, the camera interface expands the range of possibilities, enabling users to explore image processing, surveillance, and AI-based projects. This Raspberry Pi-based system is portable and easy to use, making it an ideal choice for students, developers, and hobbyists. Its compact design allows it to function as a personal workstation, embedded system, or even a media center, meeting the needs of various users. Furthermore, the open-source nature of the platform promotes innovation, enabling users to modify and enhance the system to fit their specific requirements. In conclusion, this mini-computer system is a cost-effective, scalable, and efficient solution that bridges the gap between functionality and affordability. Its ability to support multiple peripherals and applications makes it a practical alternative to traditional computers, offering a modern approach to computing with a focus on flexibility and cost-effectiveness.

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