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Compact Foldable Hoverboard for Disable Person with BMS

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Abstract: Millions of people around the world face mobility challenges due to aging, disabilities, or injuries. Traditional wheelchairs often pose additional difficulties as they tend to be bulky, heavy, and not easily portable, limiting users' independence and convenience. Moreover, there is a significant gap in the market for affordable, lightweight, and foldable electric wheelchairs that can address these issues effectively. This highlights the urgent need for innovative mobility solutions that are both accessible and user-friendly so the development of a compact, foldable hoverboard with a built-in Battery Management System (BMS) represents a significant leap in mobility solutions for people with disabilities.
Keywords: Hub Motor, BMS, 12v Battery, Controller.

I. INTRODUCTION

Mobility is a fundamental need, yet millions of people around the world face challenges due to physical disabilities, ageing, or injuries [1]-[4]. The Portable Electric hoverboard is designed as a modern solution to enhance mobility and improve the daily lives of individuals with limited movement [5]-[8]. Hoverboard serve their purpose, they often fall short in terms of portability, ease of use, and advanced features that can meet the diverse needs of users. The proposed design will be particularly beneficial for seniors, people with disabilities, and individuals recovering from injuries-offering them more freedom and confidence in their movement [9]-[12]. By combining convenience, safety, and intelligent functionality, this innovative Hoverboard seeks to provide users with a greater sense of independence and comfort, ultimately enhancing their overall quality of life [13]-[15].

II. FLOW CHART OF WORK

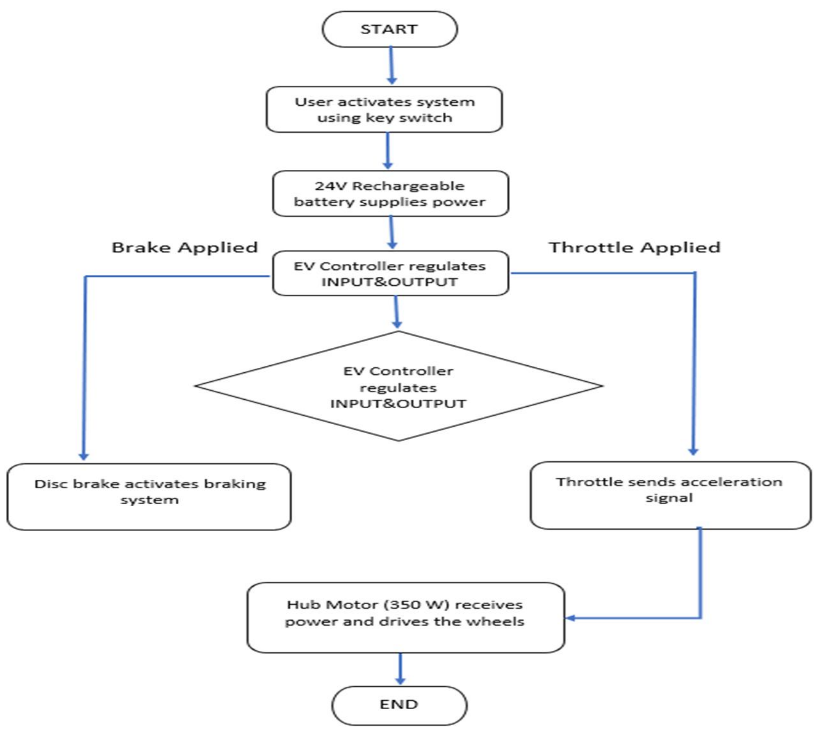

Fig.1. Flow Chart

A. *Key Functionalities of the Flowchart*

1) Throttle (Handle Mounted): The throttle allows the user to control the speed of the hoverboard. When the user presses the throttle, it sends a signal to the controller to adjust the motor's power output accordingly.
2) 24V Lead-Acid Battery: This battery acts as the main power source for the entire system. It supplies the necessary energy to the motor, controller, and other electronics to keep the hoverboard running.
3) Controller: The controller serves as the brain of the system. It reads the input from the throttle, manages how much power is sent to the hub motor, communicates with the display, and ensures the hoverboard operates safely and smoothly.
4) Display: The display provides important real-time information to the user, such as battery status, speed, and system alerts. This helps users monitor the hoverboard's performance while riding.
5) Hub Motor: The hub motor receives power from the controller based on the user's throttle input. It is responsible for driving the wheels and moving the hoverboard forward or stopping it when needed.
6) Protection Circuit: The protection circuit is designed to safeguard the system from electrical faults like overcurrent, short circuits, or voltage spikes. It acts as a safety layer to protect both the battery and the motor.
7) Battery Management System (BMS): The BMS oversees the health and efficiency of the battery. It manages charging and discharging cycles, prevents overcharging or deep discharging, and helps extend the overall life of the battery.
8) Compact Foldable Hoverboard: All components work together to power a lightweight, foldable hoverboard that is easy to carry and operate. It provides a safe, reliable, and convenient mobility solution, especially for users who need extra support in their daily movements

B. *Algorithm*

1.START
2.User activates the system using a key switch.
3.A 24V rechargeable battery begins to supply power.
4.Power is routed to the EV Controller, which manages input and output signals.
5.The controller checks:
Is the brake applied?
Yes → Activates Disc Brake → Goes to Hub Motor.
No → Checks next condition.
Is the throttle applied?
Yes → Throttle sends acceleration signal → Controller sends power to Hub Motor.
No → System idles.
6.Hub Motor (350 W) receives power from the controller and drives the wheels.
7.END

Table of content

Key (K)	Brake (B)	Throttle (T)	Battery Power (P)	Disc Brake (D)	Motor Output (M)	Wheel Status
0	0	0	0V	0	0	Not Moving
0	1	0	0V	0	0	Not Moving
1	1	0	24V	1	0	Braking
1	1	1	24V	1	0	Braking
1	0	0	24V	0	0	Idle (Not Moving)
1	0	1	24V	0	350W	Moving (Driving)

Explanation of the Table Columns:

- Key (K): Power switch — must be ON (1) to activate the system.
- Brake (B): When pressed (1), motor cuts off and disc brake activates.
- Throttle (T): When pressed (1), motor starts only if the brake is not pressed.
- Battery Power (P): Output from the battery (24V when Key = 1).
- Disc Brake (D): Active when brake is applied.
- Motor Output (M): 350W when throttle is pressed and brake is not.
- Wheel Status: Describes vehicle state: moving, braking, or idle.

C. Mathematical Formula

1) Power Activation Condition

If the key switch is ON:

$$K = 1 \Rightarrow P = 24V$$

$$K = 0 \Rightarrow P = 0V$$

(1)

Where:

- KKK: Key state (1 = ON, 0 = OFF)
- PPP: Battery power output

2) Brake Condition

If the **brake is applied**, the disc brake activates and motor power is cut off:

$$B = 1 \Rightarrow D = 1, \quad M = 0$$

(2)

Where:

- BBB: Brake input
- DDD: Disc brake state (1 = active, 0 = inactive)
- MMM: Motor power (W)

3) Throttle Acceleration Condition

If the **brake is not applied** and the **throttle is ON**, the motor powers the hub:

$$B = 0 \wedge T = 1 \Rightarrow M = 350W, \quad D = 0$$

(3)

Where:

- TTT: Throttle input
- M=350WM = 350WM=350W: Motor receives full power
- D=0D = 0D=0: Brake is not active

4) Motor Power Output Function

We can define the motor output MMM using a piecewise function:

$$M = \begin{cases} 0 & \text{if } K = 0 \quad \text{(system OFF)} \\ 0 & \text{if } B = 1 \quad \text{(brake applied)} \\ 350 & \text{if } K = 1 \wedge B = 0 \wedge T = 1 \quad \text{(acceleration)} \\ 0 & \text{otherwise} \end{cases}$$

(4)

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5) Wheel Drive Condition

Based on motor output:

$$\text{Wheel Status} = \begin{cases} \text{Driving} & \text{if } M = 350W \\ \text{Idle or Braking} & \text{if } M = 0 \end{cases} \tag{5}$$

6) Complete Control Function

We can model the entire system with a conditional control function F (K, B, T):

$$F(K,B,T) = \begin{cases} (P=0, M=0, D=0) & \text{if } K=0 \\ (P=24, M=0, D=1) & \text{if } K=1 \wedge B=1 \\ (P=24, M=350, D=0) & \text{if } K=1 \wedge B=0 \wedge T=1 \\ (P=24, M=0, D=0) & \text{otherwise} \end{cases} \tag{6}$$

III. PROPOSED SYSTEM

The aim of this project is to create a foldable electric hoverboard that improves mobility for individuals who face physical challenges—such as people with disabilities, senior citizens, or those recovering from injuries. Unlike many traditional models, which are often bulky and difficult to handle, this design focuses on being lightweight, easy to fold, and simple to operate, making it more practical for everyday use in both indoor and outdoor settings. At the centre of the system is a controller, which manages signals from the throttle (mounted on the handle), regulates power from the 24V lead-acid battery, and drives the hub motor accordingly. A display is used to show basic information to the user, like battery level or system status. To keep the system safe and reliable, a protection circuit prevents electrical faults such as overvoltage or overheating. Alongside this, the Battery Management System (BMS) plays a critical role in managing the battery's health, controlling the charge/discharge cycles, and ensuring optimal performance over time. This hoverboard doesn't include complex features like obstacle detection sensors but focuses on delivering a stable, safe, and easy-to-use experience. Its compact design and straightforward controls make it an ideal mobility aid for users seeking more freedom and comfort in their daily movements.

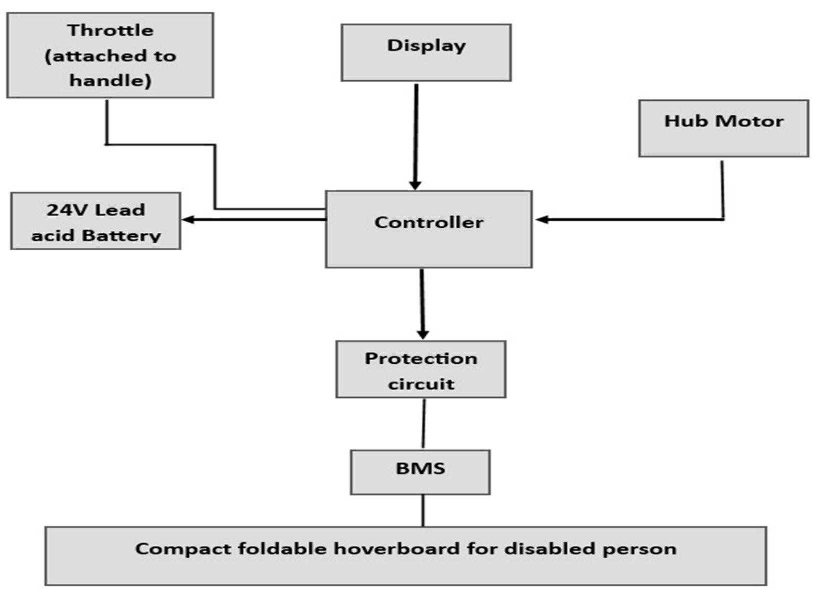

Figure 1. Block Diagram

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A. EV Controller

An EV controller is like the brain of an electric vehicle. It manages how power flows from the battery to the motor, controlling the speed, acceleration, and overall performance of the vehicle. When the driver presses the accelerator, the controller decides how much electrical energy to send to the motor, depending on how fast or slow the vehicle needs to move. It also monitors things like battery voltage, motor temperature, and current levels to ensure everything is running safely and efficiently. In some systems, it even handles regenerative braking, which helps recharge the battery when slowing down. In short, the EV controller plays a key role in making the vehicle smooth, responsive, and energy-efficient. Without it, the vehicle wouldn't know how to properly manage the power needed for movement.

Figure.3. EV Controller

B. Hub Motor

A hub motor is an electric motor built directly into the wheel of a vehicle, like a bicycle, scooter, or electric wheelchair. Instead of using chains or belts to move the wheels, the motor itself spins the wheel from the inside. This makes the design simpler, quieter, and more efficient. Since the motor is placed right in the hub of the wheel, there's no need for extra mechanical parts. This not only reduces weight and maintenance but also allows for smoother and more direct power delivery. Hub motors can be used in either the front or rear wheels-or both-for better performance. They are commonly used in electric vehicles because they save space, reduce mechanical losses, and are easy to install. Overall, hub motors are a smart choice for modern electric mobility solutions, especially where compact and efficient design is important.

Figure.4. Hub motor

C. Throttle

A throttle is a device that controls how fast an electric vehicle or machine goes. It works like an accelerator. When you twist it on a handlebar or press it with your thumb or foot, it tells the motor to speed up by sending more power from the battery. The more you press or twist, the faster the motor runs. In electric vehicles like e-bikes, scooters, or wheelchairs, the throttle gives the user easy control over the speed without much effort. It's very responsive and helps the user speed up, slow down, or maintain a steady pace smoothly. Overall, the throttle acts like a communication tool between the user and the motor, making it simple and convenient to control movement.

Figure.5. Throttle

D. BMS Module

A BMS module is a small but smart part of a battery system that helps monitor and manage how the battery works. Think of it as a mini control unit that keeps track of the battery's health, performance, and safety. It checks important things like voltage, current, and temperature for each battery cell. If something goes wrong like overheating, overcharging, or low voltage the BMS module quickly takes action to prevent damage. Some modules also help balance the cells so that they all charge and discharge evenly, which makes the battery last longer.

Figure.6. BMS Module

E. 12V Lead Acid Battery

A 12V lead-acid battery is a common type of rechargeable battery that's been used for many years in vehicles and other power systems. It gets its name from the materials inside—lead plates and an acid-based liquid (electrolyte)—which work together to store and release electrical energy. The "12V" means the battery provides 12 volts of power, which is perfect for running things like car engines, backup power systems, electric scooters, and even small solar setups. These batteries are reliable, affordable, and easy to find. However, the can be heavy and need proper care—like avoiding deep discharges and keeping them charged—to last longer. They're also sealed or maintenance-free in many modern versions, which makes them easier to handle. In short, a 12V lead-acid battery is a sturdy and dependable power source for a wide range of everyday uses.

Figure.7. 12V Lead Acid Battery

F. Display System

The display system on a compact, foldable hoverboard for disabled users plays an important role in keeping the rider informed and safe. It's usually a small screen placed within easy view, showing useful details about the hoverboard's condition and performance. This screen can display key information like battery level, speed, distance travelled and system alerts. With the help of the built-in Battery Management System (BMS), the display can also show warnings for things like overheating, low battery, or charging issues—helping the user avoid sudden breakdowns or safety risks. The design of the display is kept simple and user-friendly, with clear icons or numbers so it's easy to read read even for those who may have vision or cognitive challenges. Some systems may also include voice alerts or vibration feedback for added accessibility. In short, the display system keeps the user aware, in control, and confident while using the hoverboard.

Fig.8.Display System

G. Wheel

A wheel is a round part that helps things move easily. It rolls on the ground, so instead of dragging something heavy, you can just push or pull it with less effort. Wheels are used in many things like cars, bicycles, wheelchairs, and even suitcases. The wheel works by turning around a centre point, which helps whatever it's attached to move smoothly. It saves energy and makes travel faster and easier. Some wheels are made with rubber for better grip, while others are strong enough to carry heavy weight. In devices like hoverboards or wheelchairs, wheels are extra important because they help give a smooth, steady, and safe ride.

Figure. 9.Wheel

IV. WORKING METHODOLOGY

The compact, foldable hoverboard is specially designed to support the mobility needs of disabled individuals by offering a smart, safe, and easy-to-use solution. The working process begins when the user switches on the hoverboard. As soon as it's turned on, the Battery Management System (BMS) becomes active. It starts checking the battery's charge level, temperature, and overall condition to ensure that everything is functioning safely before movement begins. The user then gives input using a simple control system like a joystick or throttle which sends a signal to the motor. The motor receives these signals and powers the wheels accordingly, adjusting speed and movement direction based on the user's needs. To make the ride safe and smooth, sensors built into the hoverboard continuously monitor balance and stability. These sensors help the hoverboard stay steady on different surfaces and during turns, giving the user better control and confidence while riding. A small digital display shows key details like battery percentage, current speed, and system warnings, so the user always knows what's going on. If there's an issue, such as low battery or overheating, the system gives a clear alert. When not in use, the hoverboard can be easily folded and carried or stored without taking up much space. Its lightweight design makes it ideal for everyday use. In summary, this hoverboard combines smart technology with practical design to offer disabled users greater independence, comfort, and safety in their daily mobility.

V. LITERATURE SURVEY

Mobility devices have evolved significantly over the years to better serve individuals with physical disabilities. Hoverboard, while effective, often lack features like portability and advanced control options. Recent innovations have focused on creating lightweight, foldable, and electric-powered solutions that offer greater freedom and comfort. Researchers have explored using hub motors for smoother and quieter movement, while battery management systems (BMS) are now essential for safe and efficient energy use. Studies highlight the importance of integrating smart controls such as speed regulation, obstacle detection, and user-friendly interfaces to improve safety and usability. Foldable designs also make transportation and storage easier, especially for users who travel frequently. Additionally, modern mobility aids are increasingly incorporating eco-friendly power sources like rechargeable batteries, reducing dependence on manual effort. Overall, recent developments aim to give users more independence, convenience, and confidence in their daily mobility, addressing both physical and practical challenges.

VI. HARDWARE OUTCOME

This is the hardware of the compact foldable hover board for disable person with BMS, it gives successful out come

Figure.10. Prototype of Hardware implementation

The Portable Electric hoverboard is designed as a modern solution to enhance mobility and improve the daily lives of individuals with limited movement. Hoverboard serve their purpose, they often fall short in terms of portability, ease of use, and advanced features that can meet the diverse needs of users. By combining convenience, safety, and intelligent functionality, this innovative Hoverboard seeks to provide users with a greater sense of independence and comfort, ultimately enhancing their overall quality of life.

VII. RESULTS AND DISCUSSION

Figure.11 Output of Digital Display

The handlebar of the compact foldable hoverboard features a digital display that gives users real-time updates, making it easier and safer to use. It clearly shows the current speed in miles per hour, so users always know how fast they're going. There's also a power assist level indicator, which tells how much help the motor is giving — with level 1 meaning light support, perfect for slow and steady movement. A battery icon shows how much charge is left, helping users plan their rides and avoid getting stuck with a dead battery. The odometer tracks the total distance travelled , and in this case, it shows that the hoverboard has covered 6.33 miles. The screen also shows the current mode, like 'L' for low-speed operation, which is great for saving energy and ensuring smoother control. This simple, easy-to-read display helps users — especially those with mobility challenges — feel more confident, comfortable, and in control while using the device.

VIII. CONCLUSION

This project presents a thoughtful and practical mobility solution for individuals with physical disabilities by combining smart technology with a user-friendly design. The compact, foldable hoverboard not only offers ease of transport and storage but also ensures a safe and comfortable ride through its intelligent Battery Management System (BMS) and stability-enhancing features. By using lightweight materials, reliable motors, and accessible controls, the device empowers users to move more freely and confidently in their daily lives. The BMS plays a vital role in protecting the battery, optimizing power use, and ensuring long-lasting performance, which adds both safety and efficiency to the system. Overall, this innovative hoverboard is more than just a mobility device it supports independence, reduces daily challenges, and improves the quality of life for people with limited mobility. Its practical design and modern features make it a valuable addition to the world of assistive technology.

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