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E-BIKE SPEED CONTROLLER SYSTEM BY STM32

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Abstract: The "E-Bike speed controller system by stm32" is of large scope project designed to make protection and speed control operations. The system engages the services of sensors and motors to perform the parameters such as speed control and battery protection. Firstly, a battery is 8.4 volts is turned on, but the system works on 5v, so a bug converter is used to distribute the correct amount of voltage. When the motor starts the user accelerates to high speed and suddenly the E-bike crashes the motor wheel stops rotating then this system knows stall detected and stops the flow of current from the battery to the motor. If the E-bike in high speed and we keep on applying the load the system knows overload is detected, it stops the rotation of the motor and cuts the power supply from the battery to the motor. Overall, this system approaches protection and speed control by using sensors and MOSFET to create a secure environment.

Keywords: STM32 Microcontroller, Buck Converter, MOSFET, LCE display, I2c Module, Current Sensor, Motor, Battery.

I. INTRODUCTION

In this new era of developing technology and industrial areas, this speed controller system serves a major role. As the demand for efficient operation continuously grows, ensuring safety operations to make these challenges. The new technologies want to develop advanced systems for this generation.

The "E-Bike speed controller system by stm32" project presents a significant management of current sensor, Motor, and MOSFET-based platforms which all are connected to the Stm32 microcontroller which is the main part of our project and all are connected to make a single model which performs the operations are speed controlling of the E-Bike.

This project mainly focuses on the development of a new E-Bike speed-controlling system by stm32 microcontroller, this stm32 microcontroller plays a major role in this project. It is a part of the arm cortex family and is known for its high performance, low power consumption, and robust feature set, making it an ideal choice for real-time control applications in E-Bike.

The speed control system had various components, including sensors for speed and torque measurement, and power management unit, and a user interface for controlling and monitoring the data of the system. This helps in better performance, energy efficiency, and a smooth riding experience.

In addition to this, the system contains several safety features like overcurrent protection, different power modes, stall detection, and overload protection. The stall detection helps to identify that power is turned off when the motor suddenly stops, the power supply is completely turned off in this system. Overload protection helps to identify that if the motor is drawing more current than it designed then the motor stops and the power supply is turned off, which prevents the damage of the motor and battery for the users. These safety features help for E-Bike users in different harsh operating conditions.

Overall, this E-Bike speed-controlling system is more applicable for eco-friendly purposes for nature, it is particularly used in urban areas where so much traffic congestion and pollution are major concerns, it regulates the motor power output to ensure and reliable operation.

This paper demonstrates the effectiveness of the stm32 microcontroller based on speed controlling system in achieving these goals.

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The advanced capability of stm32 microcontroller performance and functionality of E-Bike is the speed control system, which plays a critical role in managing the motor power output to ensure smooth and comfortable operation. This contains additional benefits.

In this summary of speed-controlling systems that address performance and other safety challenges. By focusing on control, efficiency, and different modes of operation. The rapid advancement in E-Bike technology and the system remains effective in the long term for the users.

The development of this new technology not only helps in safety and performance but also helps in the experience and supports the maintainable and eco-friendly transportation system for the users.

II. BLOCK DIAGRAM

The block diagram of the project is shown in Fig. 1. It consists of the following

1. MOSFET, Motor with gear, capacitor, current sensor, etc.
2. The Stm32 Microcontroller is the core of the system which controls the algorithms and manages the communication between the components.
3. LCD with I2c module for monitoring and controlling E-Bike's speed and other parameters.
4. Buck converter is used to step down voltage from the input supply to its output load.

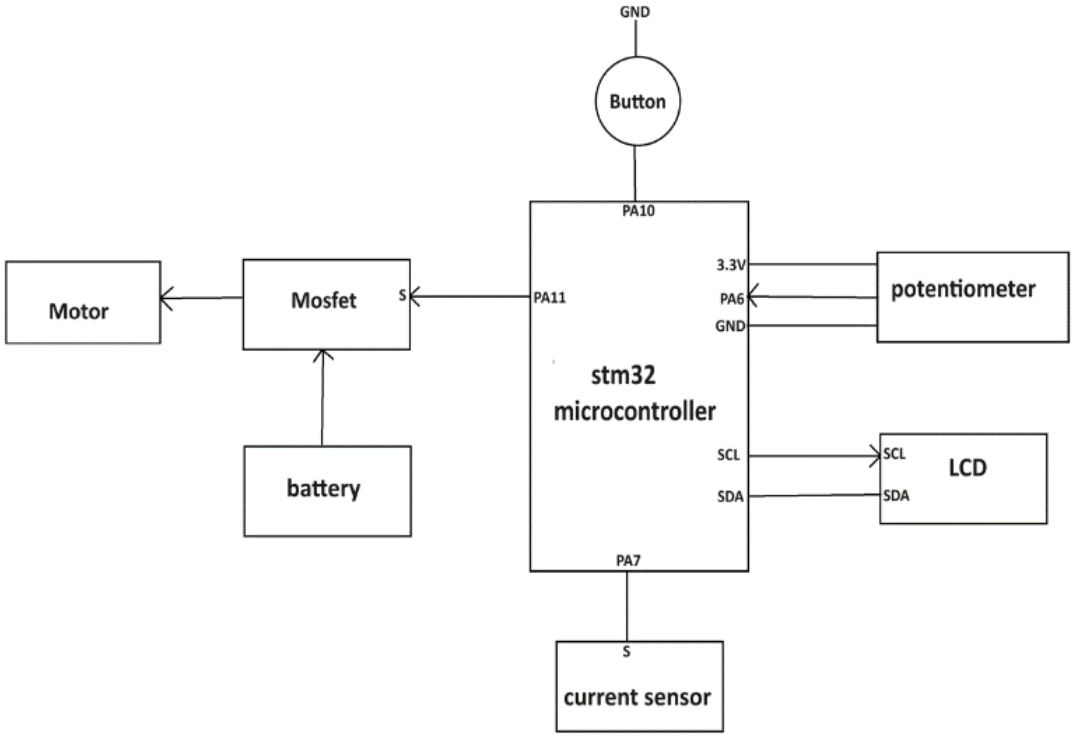

Fig 1: Block diagram

In this system, we can measure the current and speed by sensors. We can switch the motor speed from low power mode to high power mode also medium power mode. When we set the motor speed to high power mode as we increase the throttle the motor speed suddenly increases the other mode.

The MOSFET controllers the motor speed and stm32 microcontroller control algorithm and communication between the components. The motor driver gets the signals from the stm32 microcontroller and adjusts the power supply to the motor. The current sensor measures the current in the system and also prevents the motor from drawing excess current, and protects the E-Bike from damage.

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III. WORKING METHODOLOGY

The E-Bike speed controller system uses the STM32 microcontroller to process real-time data from speed and torque sensors. The MOSFET regulates the power delivery to the motor.

The acceleration input is obtained from the potentiometer, and safety features like overload protection monitor the current consumption and shut off the motor in case of overload. Stall protection cuts down the power from the battery to the motor when the stall is detected. The LCD shows the real-time data of the current, speed, and power modes. Power mode selection allows the users to select the low-power, medium-power, and high-power modes.

Different power Modes:
This E-Bike speed controller system offers various power modes to optimize the bike's performance. These modes can used in different riding conditions and user preferences. These are some common power modes and details functionalities.

The first mode is low power mode, in this mode speed of the bike is 40km/hr. We can improve the battery capacity and energy conservation is done in this mode. The second mode is medium power mode, in this mode speed of the bike is 70km/hr. We can balance the bike performance and energy efficiency for riding smoothly. It is better than low-power mode and gives smooth riding with decent performance. The third mode is high mode, in this mode speed of the bike is 100km/hr. It gives maximum performance and high-power riding. This gives aggressive power for steep roads.

Stall Detection Method:
Stall detection is a good feature in the E-Bike speed controller system, it is designed to stop the power supply from the battery to the motor when the motor suddenly stops its action. This condition called a stall, can occur due to various reasons, like mechanical injuries and motor failure. Stall protection mainly helps in the protection of the battery and motor of the E-Bike, it gives safe and reliable operation for the users. In the stall condition, the motor draws suddenly high current because it is trying to overcome a stationary position. If the high current and low speed are considered for a short period, it means that a stall is detected. By cutting off the power during a stall, the system suddenly prevents the motor from drawing current, which can cause overheating and burnout of the E-Bike.

Overload Detection Method:
Overload protection in the E-Bike speed controller system is designed to operate the motor beyond its capacity. This feature makes sure that the motor and other components are not subjected to heavy pressure that could lead to damage or failure of the motor. Overload protection helps the bike's durability and gives safe and consistence performance. The current sensor measures the current from the motor, in case excess current is drawn beyond its capacity it shows overload detected. Overload condition leads to increased temperature in the motor which damages the motor. It also ensures that the voltage supplied to the motor is within the safe limits, voltage drop indicates overload on the bike. If the overload is detected means the current flow from the battery to the load is cut off due to an increase in the power leading to damage to battery health. This mainly helps the people who are applying overload to the E-Bike beyond its capacity. The importance of overload protection is motor damage, enhances safety, improves reliability, facilitates good maintenance, responds to prevent damage, and ensures a safe ride.

IV. COMPONENTS REQUIRED

4.1 Geared Motor:

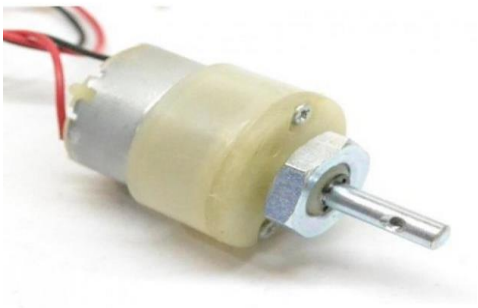

Fig 2: Geared Motor

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DC MOTOR-500RPM-12Volts geared motor is a simple DC motor with a gearbox attached to it. This can used in small devices and various robotics applications. Very easy to use and easily available in standard size, wide rpm.

4.2 MOSFET:

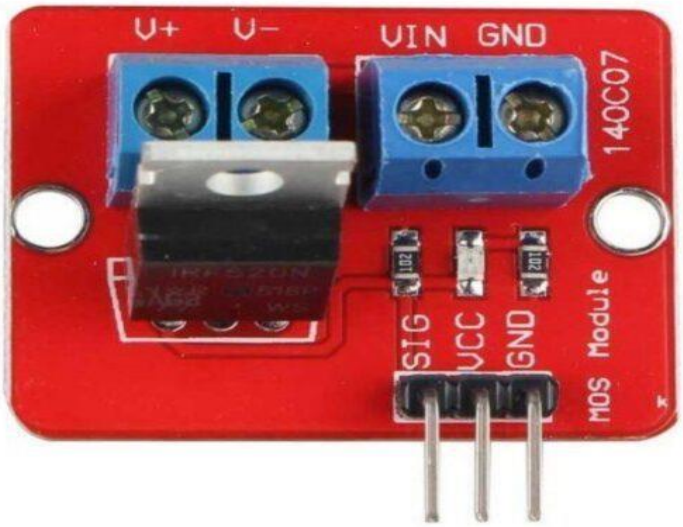

Fig 3: MOSFET

MOSFET is a device able to control voltage and current flow in the system. It controls the speed of the motor and supplies a stable current of electric power to the battery. It almost works like a switching instrument. Efficiently controls the motor speed and allows the current to the motor gear in a regulated manner.

4.3 Current Sensor:

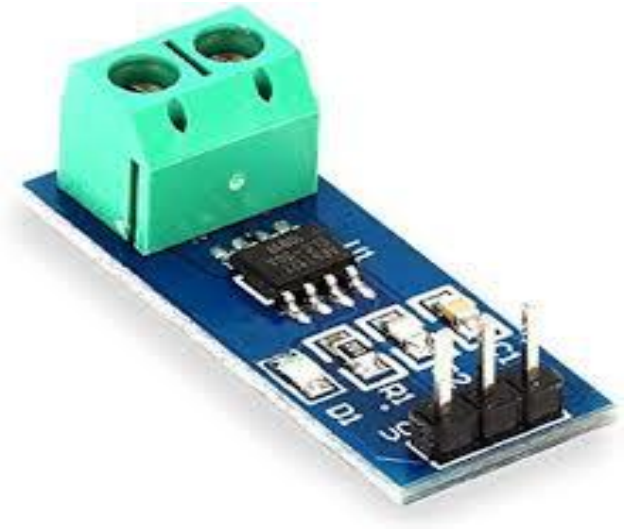

Fig 4: Current Sensor

The 20A current sensors module ACS712, can accurately detect the AC or DC. The maximum AC or DC can be reached to 20A and the present current signal can be read through Analog I/O ports Arduino. Sensing and controlling current flow is a fundamental requirement used in a wide variety of applications, including over-current protection circuits, battery charges switching modes power supply, and programmable current sources.

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4.4 STM32 Microcontroller:

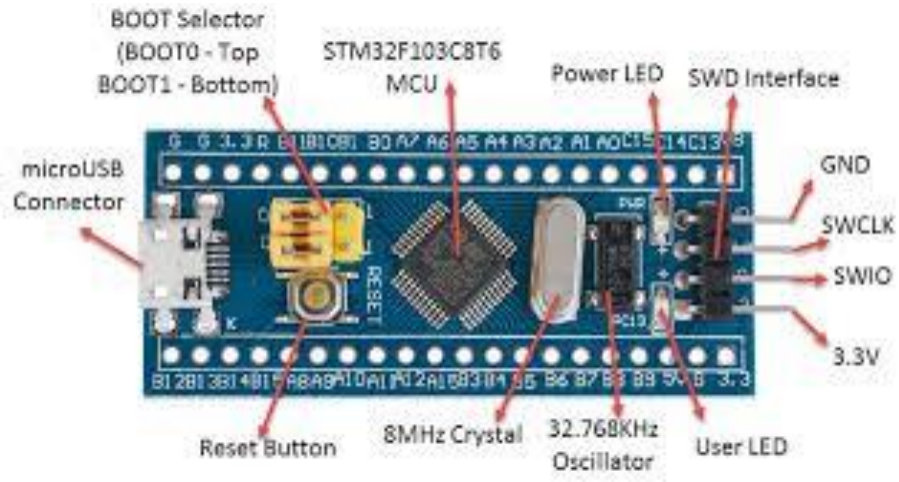

Fig 5: STM32 Microcontroller

This is the STM32F103C8TC minimum system board STM32 ARM core module. This board is a low-price minimum system development board for ARM microcontrollers. It is a 32-bit ARM processor core. Real-time data execution of internal or external memories. High-speed series and parallel memory interface up to 200mhz DTR. It provides better performance and efficiency than other microcontrollers.

4.5 LCD Display:

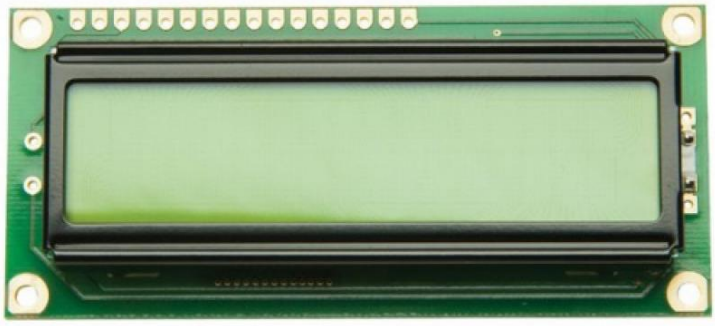

Fig 6: LCD Display

This is a basic 16-character by 2-line alphanumerical display. Black text on a green background utilizes the extremely common HD44780 parallel interface chipset. Works with almost any microcontroller in 4-bit and 8-bit modes. You will need a minimum of 6 general I/O pins to interface this LED screen. It includes LED black light.

V. RESULTS AND CONCLUSION

The development of the E-Bike speed-controlling system by stm32 represents significant advancements in electric technology and offers improved performance, safety, protection, and user experience. By integrating hardware components, control algorithms, and a user-friendly interface the speed control system shows the functionality of electric bikes and makes them more attractive transportation for urban commuters, delivery services, and recreational cyclists.

Through the hardware and software integration, the speed control system controls motor speed and power delivery, enabling a smooth riding experience. The protecting mechanisms like overload protection and stall protection, ensure the safety of the motor and other components and reduce the risk of damage or accident during bike riding. The LCD allows the users to monitor real-time data in different parameters and adjust the system setting according to their preferences and riding conditions. Furthermore, the system is reliable, capable of industry standards, and suitable for various applications.

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In conclusion, the STM32-based E-Bike speed controller system shows a balanced performance, safety, efficiency, and user satisfaction. It represents significant steps towards preparing a new E-Bike offering more safety, more efficiency, and more enjoyable riding experience for users. Further works are done in controlling algorithms and exploring additional features to improve overall functionality. This system shows a significant step forward development of advanced, efficient, and eco-friendly E-Bike technology.

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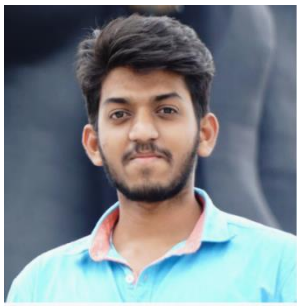

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