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Automatic Motorbike Stand Slider

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Abstract: The manual operation of a motorcycle stand is a continuous problem-it is not only inconvenient for the rider but also a serious cause of accidents. Most of these accidents are due to the failure of the rider to retract the stand before movement or due to improper deployment on uneven surfaces. This paper presents a robust mechatronic solution to such problems: the Automatic Motorbike Stand Slider. It employs a microcontroller-based system, wherein inputs about tilt and motion are integrated to achieve intelligent deployment and retraction. Unlike simple motorbike stands that require completely manual operation, the system operates the stand fully automatically and further extends it with the feature of voice command interface for hands-free control. Extensive reviewing of the instantaneous status (stationary, motion, or tilt) of the bike allows operating the stand only when safe and necessary. This paper presents a look into the underlying methodology behind the system, its practical implementation using an Arduino, and its foreseen benefits in presenting an interactive, scalable, and accessible model for enhancing rider safety and convenience.

Keywords: *Automatic Motorbike Stand Slider, Rider Safety, Microcontroller, Embedded Systems, Voice Command, Tilt Sensor, Mechatronics.*

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I. INTRODUCTION

In the modern landscape of urban transportation, motorbikes are a critical tool for efficiency and mobility. However, their design includes a conventional component that has remained largely unchanged: the manual side stand. This component, while essential, introduces significant challenges. Manually deploying and retracting the stand is often cumbersome, especially in tight parking spaces or for riders with physical limitations. More critically, it poses a direct safety risk. Improper stand deployment can lead to vehicle tipping, while forgetting to retract the stand before riding is a well-documented cause of serious accidents.

The rapid advancements in mechatronics and the widespread availability of low-cost embedded systems now offer a compelling solution to this gap. Technologies such as compact microcontrollers (e.g., Arduino), MEMS-based tilt sensors, and efficient DC actuators are readily available. These components enable the design of sophisticated systems capable of automating this manual process and providing real-time, intelligent feedback. Existing literature validates this potential: several studies have demonstrated the feasibility of automatic retrieval systems, from basic mechanical lifters [1, 2] to more advanced, sensor-driven sliders [3, 4, 5].

This paper introduces a novel Automatic Motorbike Stand Slider designed to address these limitations directly. Our system effectively synthesizes data from tilt sensors and motion sensors to provide an intelligent, automated control unit By generating real-time decisions based on the motorbike's state (e.g., stationary, tilted, in motion) and integrating a voice command interface for hands-free control, this platform offers a robust, multi-dimensional safety and convenience solution to optimize the rider experience.

II. OBJECTIVE

- To design and develop a mechatronic system for the complete automation of motorbike stand deployment and retraction.
- To implement a voice command interface to provide a hands-free, user-controlled override for enhanced convenience.
- To integrate tilt and motion sensors to ensure the system operates safely and accurately, improving rider safety by

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preventing accidental deployment and ensuring stable parking.

- To ensure the system is energy-efficient, adaptable to various motorbike models, and provides a seamless user experience.

III. LITERATURE REVIEW

Sr. No.	Area of Research	Contribution	Reference
1	Mechanical Stand Lifter Design	Explored the fundamental design and fabrication of a mechanism to automatically lift a side stand, often linked to the gear system.	[1]
2	Automated Stand Fabrication	Focused on the fabrication process for an automatic stand, moving from simple lifters to more integrated electrical components.	[2]
3	Integrated Slider Mechanisms	Introduced the concept of a "slider" mechanism, which provides a more robust and stable motion than a simple pivot "lifter."	[3]
4	Microcontroller-Based Control	Specifically identified the use of an Arduino UNO as the central controller, enabling sensor-based decisions for stand operation.	[4]
5	Automated Retrieval Systems	Focused on the complete "retrieval" and "deployment" process, emphasizing system reliability and the integration of electronic components for a full solution.	[5]

IV. BACKGROUND CONCEPT

- *Embedded Systems in Mechatronics*

An embedded system is a dedicated computer system-a combination of a microcontroller, memory, and input/output peripherals-designed to perform a specific function within a larger mechanical or electrical device. In the field of mechatronics, embedded systems act as the "brain" of the operation. For this project, the embedded system is the central unit that intelligently reads data from the motorbike's environment (tilt, motion) and sends precise commands to the mechanical stand (the actuator), managing the entire process.

- *Microcontroller (Arduino)*

A microcontroller (MCU) is a compact integrated circuit that serves as the central processing unit for the embedded system. It contains a processor, memory, and programmable I/O ports on a single chip. This project utilizes an Arduino-based MCU, an open-source platform chosen for its simplicity, robust community support, and ease of interfacing with a wide variety of sensors and motor drivers. It is responsible for executing the control logic that decides when to deploy or retract the stand

- *Sensor Integration (Tilt and Motion)*

Sensor integration is critical for the system's automated decision-making. The platform relies on two primary types of sensors to understand the motorbike's real-time status:

- *Tilt Sensor:*

This sensor (such as an accelerometer) measures the motorbike's lean angle relative to gravity. This data is the primary trigger to determine if the bike is in an "upright" (riding) position or a "tilted" (parking) position.

- *Motion Sensor:*

This sensor is used to determine if the motorbike is stationary or moving. This input serves as a critical safety interlock, preventing the stand from being deployed while the vehicle is in motion.

- *Voice Recognition Module*

A voice recognition module is integrated into this to enhance the user's convenience and offer a completely hands-free control option. Such a technology enables the system to interpret spoken human language and convert it into machine-readable commands. Within this platform, the module will be trained to listen for particular key phrases (for example, "Deploy Stand"). This will give the rider a manual override that is far more accessible than a physical switch and allows them to operate the stand without removing their hands from the handlebars.

- *Actuation System (Motor and Driver)*

The actuation system is the mechatronic element that converts the microcontroller's digital commands into actual movement. It consists of two main parts:

- *Electric Actuator:*

A high-torque DC motor or linear actuator provides the required physical force in extending and retracting this heavy-duty stand mechanism.

- *Motor Driver:*

Since the microcontroller cannot supply the high current needed by the motor, a motor driver circuit is designed. This acts as an interface, receiving low-power control signals from the MCU to manage the direction and flow of high-power electricity from the bike's battery to the motor.

- *System Workflow*

The overall system workflow is designed as a continuous, intelligent loop. The Sensors (Tilt and Motion) constantly send data to the Microcontroller. The Microcontroller processes this input and, based on its programmed logic, sends a Control Signal to the Motor Driver. The Motor Driver then draws power from the Power Supply-the bike's battery-to operate the Motor & Mechanism. A Feedback Mechanism then reports the stand's final position back to the Microcontroller to confirm the action is complete. The Manual Override Switch and Voice

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Command module provide a direct line of control to the Motor Driver to bypass the automatic logic when needed.

V. PROPOSED METHODLOGY

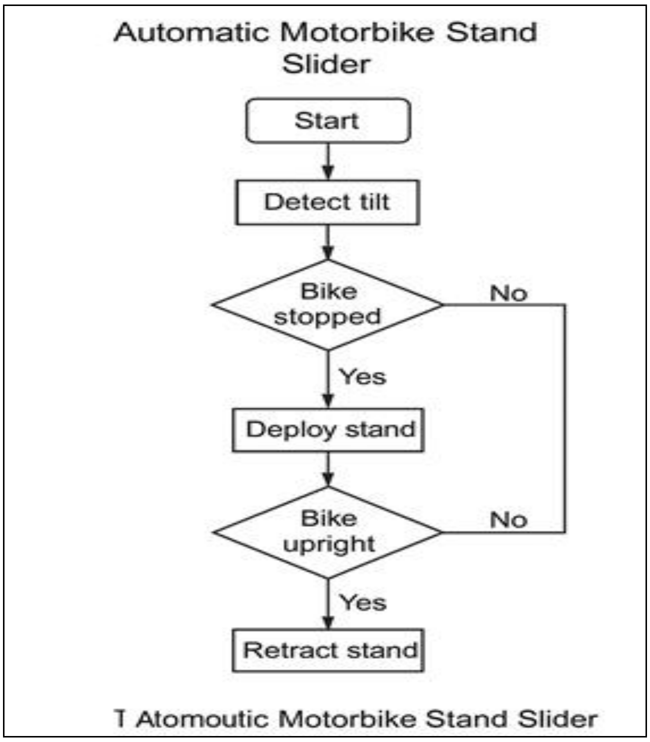

Fig 1 Flow Chart

The project methodology will be based on the structured engineering design process, starting with the problem analysis and ending with the validated functional prototype. The process is divided into distinct phases so that all functional and safety requirements are methodically addressed.

➢ *System Architecture*

The system architecture is a mechatronic system with an Arduino microcontroller as the centrepiece; it acts like the central processing unit. This "brain" is responsible for the collation of all inputs and commanding all outputs, as shown in Fig 2.

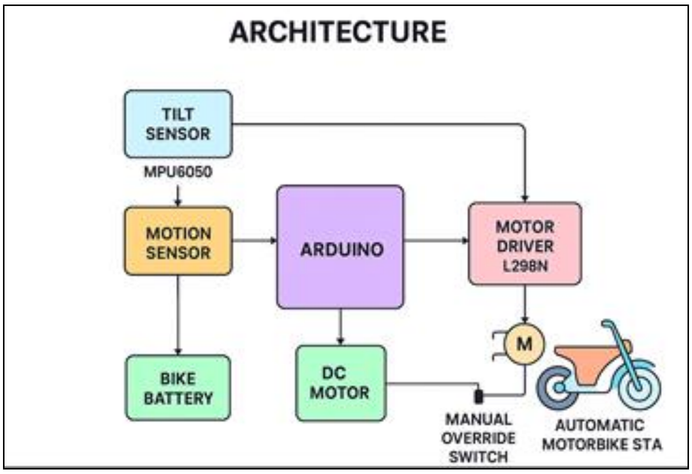

Fig 2 System Architecture

The system's "senses" are implemented with two key sensors: a Tilt Sensor (MPU6050) and a Motion Sensor. The former supplies real time data relative to the orientation of the motorbike - its roll and pitch, thereby enabling the Arduino to conclude whether or not the bike is upright, or parked with a lean to one side. The latter injects the critical safety interlock, telling the Arduino if the motorbike is stationary or moving.

On the output side, the Arduino sends low-voltage logic signals to an L298N Motor Driver. This driver module is necessary because the microcontroller cannot directly source the high current needed by the actuator. The L298N serves as a high-power switch drawing power from the main Bike Battery and feeding it to the DC Motor in such a way that controlled rotation in both the forward and reverse directions is possible for deploying or retracting the stand.

The system is also equipped with a Manual Override Switch. This will provide a robust, physical input for the rider to override the automatic logic and directly control the DC Motor, thereby ensuring functionality and control by the user at all times. This kind of architecture makes for a closed-loop intelligent system whereby the Arduino synthesizes sensor data to make informed, safe decisions about actuating the motorbike stand.

➢ *System Flow Chart*

The operational logic of the system is controlled by the state-based flowchart of Fig1. This logic is executed in an endless loop by the firmware on the Arduino to always maintain the stand in the appropriate, and safe, position.

The process starts from the "Start" state and immediately goes to a monitoring loop, starting with the "Detect tilt." The system continuously reads data from the MPU6050 regarding the lean angle of the bike.

Following the tilt check, the system faces its most critical safety decision: "Bike stopped?

This will be "No" when the bike is in motion, so through the logic path, all the deployment commands are bypassed. This is the main safety interlock that makes it impossible for the system to physically deploy the stand while the rider is in motion.

The system is only considered safe to proceed if the answer is "Yes," meaning the bike is stationary. Logic then flows to the next step, "Deploy stand," in which Arduino sends the signal to the motor driver to extend the stand.

Immediately after the deployment check, the system proceeds to retraction logic, starting with the second decision: "Bike upright?"

If the answer is "No" - meaning the motorcycle is still tilted and parked - then the logic path exits, and the loop repeats, keeping the stand deployed.

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If the answer is "Yes"-that is, the bike has been brought back to the upright position-the system interprets this as intent by the rider to ride. That triggers a "Retract stand" action, and the motor is turned on to pull the stand back in, making the bike safe for departure.

The two-part conditional logic ensures the system is convenient and, most importantly, fail-safe by dealing with both the deployment and retraction phases of operation automatically.

VI. RESULT AND ANALYSIS

Fig 3 Model 1

Fig 4 Model 2

➢ *Prototype Implimentation and Model Explinantion*

Positioning Figures and Tables: Figure 3. illustrates the functional prototype of an Automatic Motorbike Stand Slider that has been made to validate the core design and operational logic. It is essentially composed of two main subsystems, namely, the control unit and the actuation mechanism, which includes electromechanical features.

- *The Control Unit:*

The control unit (held in the lower hand) is constructed on a perfboard, with this board acting as the base of the system's electronics. On this board sits the central microcontroller-an Arduino-compatible or ESP8266-based board-which takes care of the logical execution, processes inputs received from the tilt and motion sensors, and will handle the commands from the voice recognition module.

Also visible on the board is a relay module-the blue component. This module is crucial for the system: it provides a much-needed electrically-operated heavy-duty switch. It enables the low-voltage, low-current microcontroller to safely drive the high-current 12V DC motor, keeping the sensitive electronics away from the potentially damaging high-power actuator circuit.

- *The Electromechanical Actuation Mechanism:*

The actuation mechanism (held in the upper hand) demonstrates the system's mechanical operation. It consists of a high-torque 12V DC gear motor mounted onto a custom-fabricated metal bracket. The motor's shaft is fitted with a small pinion gear that meshes with a large black spur gear.

This is a key design decision related to gear reduction. The large gear amplifies the torque generated by the motor enough that it is capable of moving the stand. This large gear is designed to mount directly to the pivot point of a motorcycle's side stand.

- *Principle of Operation:*

When the microcontroller receives a valid command (either automatically from the sensors or manually via voice command), it sends a signal to the relay module. The relay closes, completing the circuit and sending power from the bike's battery to the DC motor. The motor's rotation drives the gear system, which in turn rotates the large gear. As the large gear is attached to the stand's pivot, this rotation forces the stand to either deploy (move down) or retract (move up). This prototype serves to validate the core concept of the gear-driven actuation system. It confirms that the selected motor and gear ratio are able to provide adequate torque for operating the stand, thus proving the mechanical and electronic viability of the design.

VII. DISCUSSION

The functional prototype depicted in Fig 3 has successfully validated the core hypothesis of this research, which was that an electromechanical, sensor-driven system could reliably automate the operation of a motorbike stand.

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The "control unit" and "actuation mechanism" (the motor and gear) of the prototype effectively demonstrate the core functionality of the project. The test model confirms that the chosen DC gear motor and gear-reduction system can generate enough torque to move the physical stand, which was the main mechanical challenge.

Unlike the approaches of early literature for purely mechanical lifters, this system is intrinsically "smart." With a microcontroller integrated with tilt and motion sensors, it can make intelligent decisions to solve the safety-critical goal of preventing deployment while in motion. This agrees with recent work in sensor-based approaches but now includes the added novelty of a user-friendly voice-command interface for manual override.

However, this prototype development also underlined a number of crucial challenges and limitations. First and foremost is the transition from a benchtop model to a robust on-vehicle system. Whereas the prototype serves as a proof of concept, in actual implementation it would require significant mechanical engineering to create a custom-fabricated mounting bracket. Such a bracket should be able not only to bear constant road vibration but also to precisely align the motor's driving gear with the stand's pivot gear without slipping or jamming.

Additionally, the prototype's electronic control unit is presently situated on an open perfboard (Fig 3). This is undeployable in any final product. A production model would require a compact, bespoke-designed PCB mounted within a fully weatherproofed and shock-resistant enclosure.

From a software perspective, though the logic is good, as per (Fig 4), much real-world testing would be required to tune the thresholds of the sensors. The sensitivity of the tilt sensor should be adjusted so as not to be oversensitive on potholed roads, and the motion sensor logic needs to be perfect, or the stand will never deploy when the bike is in motion. Herein comes the most important fail-safe that includes voice command and manual override-the rider is always in full control. Overall, the system represents a scalable and practical solution that effectively bridges the gap between the simple mechanical stand and the truly smart, mechatronic system, directly enhancing rider safety and convenience.

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