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DESIGN AND FABRICATION OF SPLIT HELMET

* Prof. Shivashankar C[1], Prof. Gangadhar Biradar[1], Salman[2], Syed Faizan[2], M. A. Faizan[2]

ABSTRACT

This study presents a novel design for a split helmet that is easy to manufacture and suitable for large-scale production. The helmet casing is made of carbon fiber to enhance durability, while an integrated cooling towel and adjustable ventilation system improve user comfort. A key safety feature is the foam liner, designed to absorb impact energy during accidents. The study aims to develop a motorcycle helmet with an optimized energy-absorbing liner using engineering design methods, including design of experiments and response surface modeling. The proposed helmet's performance is evaluated through simulations and compared with existing commercial helmets, showing reduced head injury criteria and lower maximum acceleration in most impact scenarios.

In addition, the study explores behavioral factors influencing helmet usage among motorcyclists, particularly in low road-safety environments. Using detailed empirical data, it is observed that risk-averse and well-informed individuals are more likely to wear helmets and adopt safer driving behaviors. Increased awareness and education significantly improve helmet usage. The findings suggest that enforcing helmet laws, promoting awareness, and improving infrastructure are essential strategies to reduce road fatalities.

A helmet serves as a crucial protective device against head injuries, yet negligence and lack of awareness result in significant fatalities, especially in India. According to NCRB data, two-wheeler accidents claim numerous lives daily, often due to the absence of helmets. To address portability concerns and encourage usage, this study proposes a split helmet design that is compact and easy to carry.

[1] Assistant Professor, Mechanical Engg., GNDEC, Bidar, India
[2] Student, Mechanical Engg., GNDEC, Bidar, India

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1. INTRODUCTION

In recent years, the popularity of motorbikes—especially among younger generations—has increased significantly. However, this rise has also led to a higher number of road accidents. In India, a large percentage of motorcyclist fatalities occur due to not wearing helmets. While accidents cannot always be prevented, the severity of injuries can be greatly reduced by using proper safety gear.

A major challenge is the preference for comfort over safety, which discourages helmet use. To address this issue, this project proposes the design of an intelligent split helmet system that enhances convenience and encourages regular usage.

Road accidents occur due to various factors such as driver error, poor road conditions, and negligence by other road users. Among all injuries, head injuries are the most severe, often leading to paralysis or death. Helmets play a critical role in

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preventing such outcomes by protecting the rider's head during collisions.

Studies show that riders who do not wear helmets face higher medical costs, longer recovery periods, and reduced quality of life. Non-fatal brain injuries can still result in long-term complications, including spinal damage and permanent disability. Therefore, promoting helmet usage is essential for improving road safety and reducing fatalities.

2. COMPONENTS OF PROJECT

Aluminum strips: Aluminum strips are widely valued for their durability and high quality, and are offered at competitive industrial prices. They find extensive applications in areas such as wrapping, aluminum-plastic composite pipes, electrical transformers, radiators, flexible pipes, Venetian blinds, lamp caps, and closure manufacturing.

One of aluminum's key advantages is its light weight, with a density of 2.72 t/cum compared to 7.84 t/cum for steel. This significant difference reduces overall deadweight, allowing for greater cargo capacity. As a result, many modern vessels use aluminum in their superstructures, which helps lower the center of gravity and improves stability.

Despite being lightweight, aluminum offers strength comparable to steel and performs better at lower temperatures. Unlike steel, which can become brittle and prone to cracking in cold conditions, aluminum maintains its integrity, making it ideal for use in LPG and LNG carrier tanks. Additionally, aluminum has excellent corrosion resistance and is non-magnetic, preventing interference with navigation instruments such as compasses. This non-magnetic property is especially beneficial in naval applications, where it reduces vulnerability to magnetic mines.

Furthermore, the reduced hull weight of aluminum vessels requires less propulsion power or enables higher speeds with the same power. For this reason, many fast ferries, hovercrafts, and catamarans are constructed using aluminum alloys.

Fig. 1: Aluminum strips

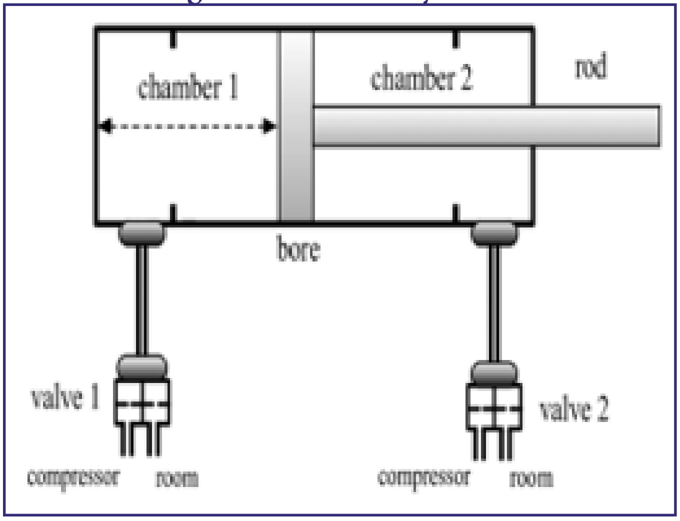
Pneumatic cylinder

Pneumatic cylinders, also referred to as air cylinders, are mechanical devices that use compressed gas to generate force through a reciprocating linear motion. Similar to hydraulic cylinders, they operate by converting stored potential energy into kinetic energy. In this case, compressed air expands in an effort to reach atmospheric pressure, driving a piston in the desired direction. The piston, typically shaped as a disc or cylinder, is connected to a piston rod that transmits the generated force to the object being moved.

Engineers often prefer pneumatic systems because they are quieter, cleaner, and require less space for fluid storage compared to hydraulic systems. Since the working medium is air, any leakage does not result in fluid spills or contamination, making pneumatic cylinders especially suitable for applications where cleanliness is critical.

However, one of the main challenges associated with pneumatic cylinders is the compressibility of air. This property can affect the precision and positioning accuracy of the system, particularly under varying load conditions. When subjected to vertical loads—where the cylinder bears the full weight—the compressibility of the air can lead to noticeable deviations in performance. Studies, such as those conducted at National Cheng Kung University in Taiwan, have shown that positioning accuracy can vary by approximately ±30 mm. While this level of accuracy may still be acceptable for many applications, it highlights the inherent limitations of pneumatic systems in tasks requiring high precision.

Fig. 2: Pneumatic Cylinder



5/2 dc Solenoid Valves (12v)

A DC solenoid valve is an electromechanical device used to control the flow of air or fluid in a system by converting electrical energy into mechanical motion. It operates using a coil energized by a direct current (DC) supply, typically 12V, which generates a magnetic field to actuate an internal plunger or spool mechanism.

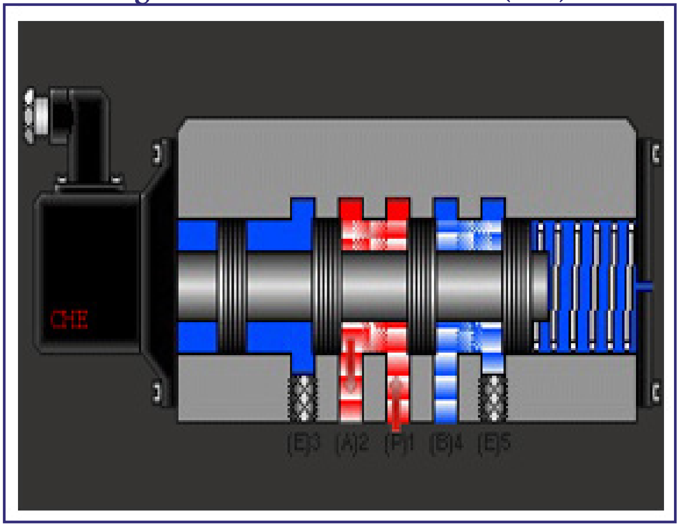
In a 5/2-way solenoid valve configuration, the valve consists of five ports and two switching positions, commonly used to control double-acting pneumatic actuators. When the solenoid coil is energized, the magnetic field shifts the spool, allowing compressed air to flow into one chamber of the actuator while simultaneously venting the opposite chamber. When de-energized, the valve returns to its original position, reversing the airflow path.

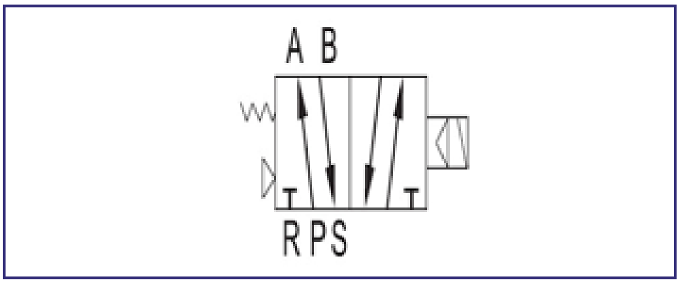
Solenoid valves are classified as normally closed (NC) or normally open (NO) based on their default state when not energized. Direct-acting solenoid valves operate purely through electromagnetic force and are suitable for low-pressure applications, whereas pilot-operated valves use system pressure to assist operation, enabling higher flow rates and pressure handling.

Key parameters include operating voltage, response time, pressure range, flow coefficient (Cv), and power consumption. DC solenoid valves are widely used in pneumatic and fluid control systems due to their fast switching capability, reliability, and ease of integration with electronic control units such as microcontrollers.

In this project, the DC solenoid valve regulates airflow within the pneumatic system, enabling controlled actuation of the split helmet mechanism.

Fig. 3: 5/2 dc Solenoid Valves (12v)





IR Sensor

An infrared (IR) sensor is a transducer that detects infrared radiation (wavelength range ≈ 0.7 µm to 1 mm) and converts it into an electrical signal for sensing applications. It typically consists of an IR emitter (infrared LED) and a photodetector (photodiode or phototransistor), forming an optoelectronic pair for active sensing.

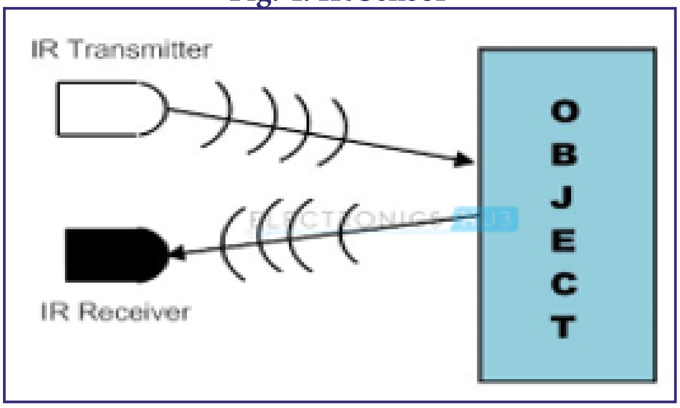
In active IR sensing, the emitter generates radiation in the near-infrared region (≈700–1400 nm), which propagates through the medium and reflects off a target object. The reflected radiation is incident on the photodetector, producing a photocurrent proportional to the received optical power. This photocurrent is then amplified and processed using signal conditioning circuits (e.g., transimpedance amplifiers, filters, and comparators) to determine object presence, distance, or motion.

The operation of IR sensors is governed by radiative heat transfer principles. The emitted spectral radiance follows Planck's Radiation Law, while total emitted energy is described by the Stefan–Boltzmann Law (E T^4). The peak wavelength of emission is determined using Wien's Displacement Law ($\lambda\_max = b/T$). For passive IR (PIR) sensors, detection is based on changes in incident infrared radiation from objects, typically within the far-infrared range (≈3–14 µm), corresponding to human body thermal emissions.

Key performance parameters include responsivity, detectivity (D*), signal-to-noise ratio (SNR), response time, and field of view (FOV). Environmental factors such as ambient temperature, surface reflectivity, and interference from external IR sources can affect sensor accuracy.

IR sensors are widely integrated into embedded systems for applications such as proximity detection, obstacle avoidance, thermal sensing, and motion detection, often interfaced with microcontrollers via analog or digital signal outputs.

Fig. 4: IR Sensor



Microcontroller

A microcontroller is a highly integrated embedded system-on-chip (SoC) designed to perform dedicated control tasks within electronic systems. It typically combines a central processing unit (CPU), memory units (RAM, ROM/Flash), and input/output (I/O) peripherals on a single chip, enabling efficient real-time control and data processing.

The CPU executes instructions stored in program memory, while temporary data is handled through RAM. The microcontroller interacts with external components via its I/O ports, which may include digital pins, analog-to-digital converters (ADC), digital-to-analog converters (DAC), timers, counters, and communication interfaces such as UART, SPI, and I^2C.

In operation, the microcontroller continuously reads input signals from sensors, processes the data based on programmed logic, and generates corresponding outputs to actuators or other devices. This closed-loop control mechanism allows precise automation and decision-making in embedded applications. Microcontrollers are widely used in systems requiring compact size, low power consumption, and high reliability. In this project, the microcontroller functions as the central control unit, coordinating inputs from sensors (such as IR sensors) and controlling outputs like relays, solenoid valves, or pneumatic systems to ensure proper operation of the split helmet mechanism.

Relay

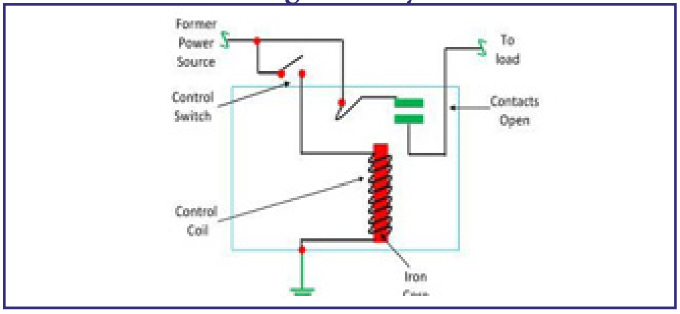
A relay is an electrical device used to open or close contacts in order to control the operation of another circuit. It plays a key role in detecting abnormal or undesirable conditions within a system and sends signals to circuit breakers to isolate the affected section, thereby protecting equipment from damage.

Relays operate on the principle of electromagnetic attraction. When the relay detects a fault current, it energizes a coil that generates a temporary magnetic field. This magnetic field acts on an armature, causing it to move and either open or close the electrical contacts.

In simpler relays, there may be a single contact, while higher-power relays can have multiple contacts to handle more complex switching operations. Internally, a relay consists of an iron core wound with a control coil. When power is supplied to this coil through a control switch, current flows and produces a magnetic field around the core.

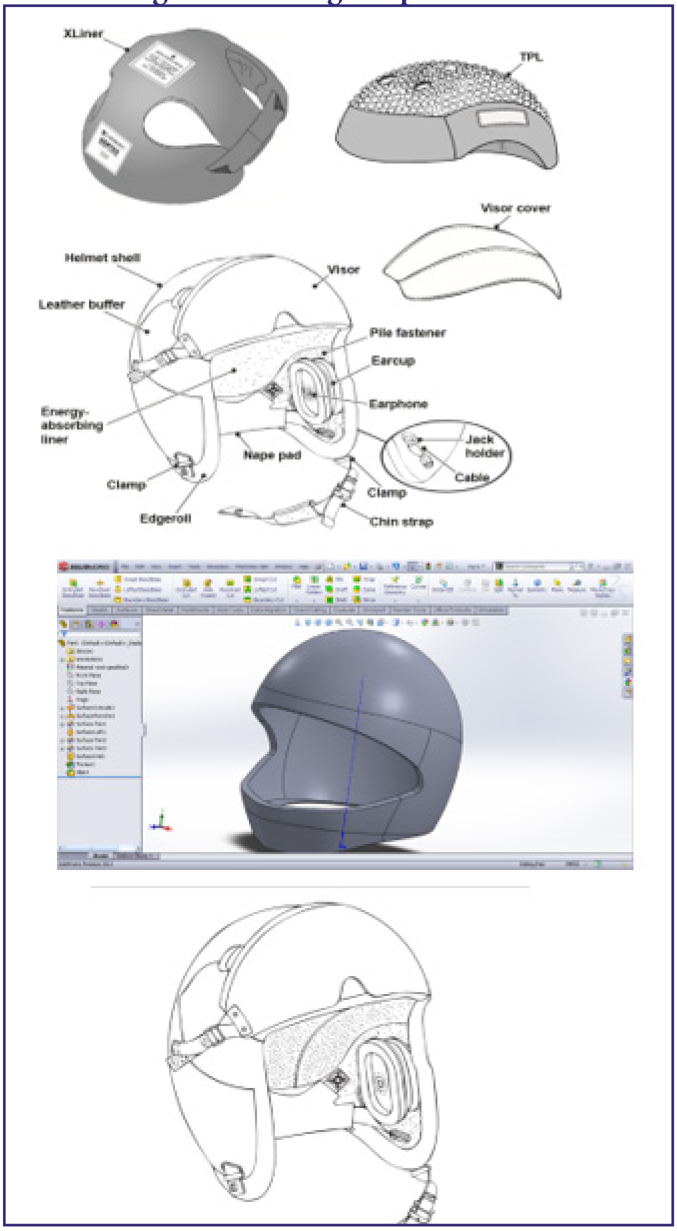
This magnetic field causes the movable armature to be attracted toward the core, resulting in the closing of contacts and allowing current to flow through the load. If the contacts are already closed, the movement of the armature in the opposite direction can open the circuit instead. This switching action enables relays to effectively control and protect electrical systems.

Fig. 5: Relay



3. RESULTS

Fig. 6: Modeling of Split Helmet



Below mentioned is some of the outcome of split helmet

1. Wearing the helmet significantly reduces injury severity
2. Split helmet is easy to carry in different ways
3. Split helmet is portable and it can foldable.
4. Most of the impact energy absorbed by the helmet, rather than head and brain
5. Spilt helmet fit properly to head

4. CONCLUSIONS

Split helmet has good real life scope, it is implemented by government. It can be help to reduce lot of road accidents of the two-wheeler as it is the major cause of deaths in the whole world. By undertaken keeping in view of traffic, the traffic rules and also the safety of people. Split helmets are easy to carry, portable and they are better than the common helmets. Space occupied by split helmet is much less.

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