DESIGN AND DEVELOPMENT OF AUTOTRONICS SIMULATION MODEL FOR CAR LIGHTING SYSTEM

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ABSTRACT: *Currently the Philippines has no available trainer model for Autotronics Simulation Model for Car Lighting System (ASMCLS). Hence, the study aimed to design and develop an ASMCLS that can be used as a training tool for automotive practitioners and technicians. The device is equipped with the latest technology that is embedded in the vehicle, such as a modern lighting system, 360-degree camera, and parking assist sensor. A developmental research design method was used during the conduct of study. The Input-Process-Output (IPO) model provided the general structure and guide for the direction of this study. This device has a significant impact on automotive practitioners and technicians and can be used as training tool for the students. This device is safe and reliable for the laboratory performance of students and practitioners. Moreover, this innovation also helps the learners to upgrade their knowledge and skills to adopt the modern technology of the vehicle, it also addressed the need for new technology training equipment in the automotive industry.*

Keywords: Trainer Model, Autotronics, Simulation Model, Automotive System, Car Lighting

1. INTRODUCTION

The automotive industry has been undergoing significant technological advancements in recent years, particularly in the areas of Artificial Intelligence (AI) and Advance Driver Assistance Systems (ADAS), leading to a growing need for automobile service centers to be equipped with skilled experts and resources to handle related demands and issues. As such, there is a pressing need for instructional materials that can replicate, test, and gather detailed data about the operation of these electronic systems. In this regard, the use of vehicle mock-up models and interactive trainer models has been proposed to enhance students' and technicians' understanding of modern automobile technology. However, despite the efforts of competent instructors and trainers to explain the underlying theories, there is still a need for additional diagnostic practice time to improve students' readiness to utilize physical resources available. A study conducted by [1] suggests that the technique of teaching and learning styles affects the kind of instructional materials used to boost student learning. Thus, diverse teaching materials within the vehicle mock-up model are recommended for successful student learning. However, with the constantly changing designs of modern automobiles, students and technicians find it challenging to apply theoretical knowledge to workplace practices. This calls for the use of instructional mock-ups or trainers to enhance a better understanding of the principles presented. To improve students' diagnostic practice time and readiness to utilize the available physical resources, the efficacy of using interactive trainer models' mock-ups is developed. Many students express that they lack sufficient hands-on experience to feel comfortable diagnosing electrical and autotronic systems. According to [2] this study can help bridge this gap. According to [3] the most popular methodology is the naturalistic driving study (NDS), which removes the bias of a controlled environment and enables researchers to comprehend how drivers behave in real-world situations.

The research conducted by [4] highlights the importance of monitoring driver condition as a potential way to reduce accidents during rush hour congestion. Similarly, [5] study emphasizes the effectiveness of a vehicle monitoring system equipped with a camera that captures video or still photo data during a detected accident. Another approach to preventing accidents in traffic, according to [6] is to track the driver's condition. Recent advancements in technology for Intelligent Parking Assist systems (IPAs) have led to a significant reduction in parking accidents and driver fatigue, as revealed by [7] subjective evaluation technique based on a typical parking scenario. In addition, [8] study indicates that the primary objective of the parking assist system is to prevent vehicle collision with any obstacle. [9] also suggests that tools to assist drivers while parking are readily available in today's vehicle equipment. Sensor technology has gained widespread use and attention in the past decade, with applications in healthcare [10] agriculture [11], forest [12] and vehicle 999and marine [13] monitoring. The use of sensors has aided in the development of several transportation-related applications, including traffic management, safety, and entertainment.

This study aimed to design and develop, an autotronics simulation model for car lighting systems that can accurately replicate the behavior and functionality of real-world car autotronics systems, and can serve as a reliable tool for training and testing automotive technicians and students. To achieve this goal, the study first investigated the current state-of-the-art in autotronics simulation models for car lighting systems, with the aim of identifying gaps and opportunities for improvement in this area. The study then developed a comprehensive understanding of the principles and components involved in the design and operation of car lighting, 360° view camera, and park assist sensor systems, and used this knowledge to inform the development of an accurate and realistic simulation model. Finally, the study identified potential future directions for research and development in the field of autotronics technology and proposed recommendations for further improvement and refinement of the technology.

2. MATERIALS AND METHODS

The study employed a developmental research design method wherein the Autotronics Simulation Model for Car Lighting System (ASMCLS) is generally designated as the device that performs electrical system and autotronic simulations such as: car lighting, 360° view camera, and park assist sensor systems that can help automotive practitioners and technicians to upgrade their knowledge and skills.

The research study is divided into two stages: planning and designing, and production. In the planning and designing stage, the researcher gathered the specific data and materials needed, design a prototype, canvassed the materials needed, and budgeting. In the *production stage*, the researcher constructed the trainer model, which includes purchasing materials needed, fabrication, assembling, testing and fine-tuning, and final testing.

2.1 Designing and Planning

The innovator considered the study a necessity in the hands-on part of explaining the advanced automotive car lighting, 360° camera with monitor, park assist sensor, and audio system. To avoid lost contact and minimize wire connectors, the proper connection and arrangement of components and terminals are ensured. Component terminal symbols are installed to guide the wiring. The design considered the safety features in the use of the device.

It included protection against short-circuit and emergency shutdown. The frame is made up of locally available materials, preferably round bar, angle bar steel, cartwheel, marine plyboard, and plywood. The simulation board was made of a plywood board on which the components and connecting terminals were mounted. The base is designed vertically with a frame for easy mobilization

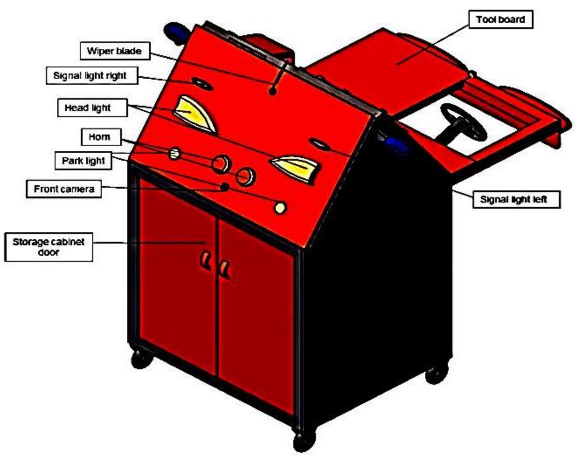

Figure 1. Front isometric view

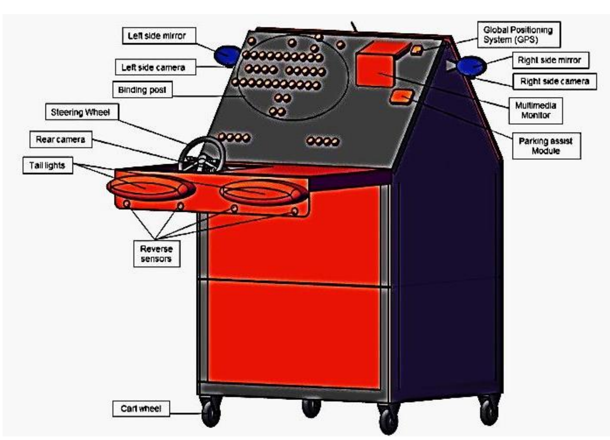

Figure 2. Rear isometric view

Figures 1 and 2 above show the front and rear isometric view of the prototype respectively. In figure 1, the front isometric are compose of the following parts; storage cabinet, front camera, park light, horn, headlight, signal light right, wiper blade, tool board and signal light left, while the rear isometric view are compose of the following parts; cart wheel, reverse sensors, tail lights, rear camera, steering wheel, binding post, left side camera, left side mirror, global positioning system (GPS), right side mirror, right side camera, multimedia monitor, and parking assist module.

2.2 Supplies and Materials

The supplies and materials used for making the simulator are available in the cities. Supplies are parts and components attached to the construction of the project. While materials are the consumables used in the production of the trainer model, Table 1 shows the materials and equipment and their prices for the device.

Table 1: Supplies / Materials and their operational function

Materials/Supplies	**Number of items**	**Functions** The material/supply was used for
Camera	1 pc.	seeing the surroundings of the trainer model/vehicle.
Steering wheel	1 pc.	controlling the lighting system's on/off switch
Multimedia monitor	1 pc.	viewing 360-degree captions of the camera as well as infotainment.
Parking assist control module	1 pc.	detecting the distance between the vehicle and the barrier.
Global positioning system	1 pc.	monitoring the location of the trainer model/vehicle.
Battery	1 pc.	supplying power to all electrical components of the trainer model.
Built-in charger	1 pc.	charging the battery without any delay in operation.
Push start ignition switch	1 pc.	switching of the entire system.
PVC Poly wood	6 pcs.	designing of the trainer model.
Voltmeter	1 pc.	measuring voltage present in the circuit.
Wiring harness	5 meters	harnessing the circuit
Binding post	80 pcs.	attaching and detaching electrical wires in the circuit.
Cart wheel	4 pcs.	Carrying the trainer model easily from one place to another.
Angle bar	5 pcs.	framing of the trainer model.
Welding rod	5 kg.	assembling the body and connecting metal to make trainer model
Cutting disc	8 pcs.	cutting metals
Ply-board	2 pcs.	framing and for tool compartment casing

Tools and equipment. Tools and equipment are the instruments that are used during the fabrication of the device. Below is the list of tools and equipment together with their respective functions.

Table 2: Tools /equipment and their operational functions

Tools/Equipment	Specification	Number of items	Functions
Welding machine	JB Kawasaki, Japan	1 pc.	welding the metal frame of the device.
Angle grinder	Makita, Japan	1 pc.	refinishing the metal surface of the frame.
Hand drill	Makita, Japan	1 pc.	creating a hole in the circuit board of the device.
Hack saw blade	Stanley, USA	1 pc.	cutting metal and ply-board
Wrenches	Stanley, USA	1 pc.	tightening bolts and nuts.
Test bulb	No brand	1 pc.	testing and current supply load.
Screw	Stanley, USA	1 pc.	tightening screws in the device.

2.3 Fabrication

In the fabrication of an Autotronics Simulation Model for a Car Lighting System, an assembled metal frame baseline body is horizontally positioned with a belt in a cabinet inside the frame. All the working parts are visible: headlight, park light, brake light, signal light, horn, wiper, steering wheel, car lighting, 360° camera with monitor, park assist sensor, and audio system. To be driven around by the learner/s, a steel frame is to serve as a base where the circuit board is supposed to be located above. The platform is made of steel angle bars with a 3/16" x 2" diameter as a frame structure, with 3/16" x 1" angle bars for the support of the structure. The door cabinet is made of marine plywood 3/4" x 4' x 8', with a plywood board 3/16" x 4' x 8' as a stand for the tool board of the device, and the metal frame body on the rear side is visible. The components used are durable and affordable materials in the local market.

3. RESULTS AND DISCUSSION

As shown in different figures below, the marine plyboard frame with an angle bar at the back is equipped with car lighting, a 360° camera and park assist sensor system, a frame as a base, a circuit board assembly, and a metal wheel for easy moving anywhere into the laboratory room. The prototype of the instructional simulation device. As shown, the board will be equipped with a lamp as an output device, switches input devices, a wire harness to connect to the circuit board, a metering gauge, a banana jack, an RCA connector, and wiring circuits. The circuit board will be mounted facing parallel and at the average level of the learner. The device is invaded with a self-charging gadget and onboard wi-fi internet inside the storage cabinet.

Figure 3 shows the instructional model's back left side perspective. The metal frame will be supplied with a steering wheel for the headlight, signal light, park light, and warning switches, as illustrated. The trainer type comes with a cartwheel for simple movement within the laboratory. The circuit board for the automobile electrical system will be positioned on the device's back left side, with the frame parallel to the learner's average level.

Figure 3: Rear view of the prototype

In this device, the rear circuit board has various circuit connectors for the electrical components, each with its fuse to safeguard the system connected to the front side load. In addition, the 360-degree camera, head monitor, global positioning system, park assist sensor system, and voltmeter were all incorporated into the circuit board's backside. The system's key components are the steering wheel and several switches, such as a rotary switch, wiper switch, and push start ignition switch.

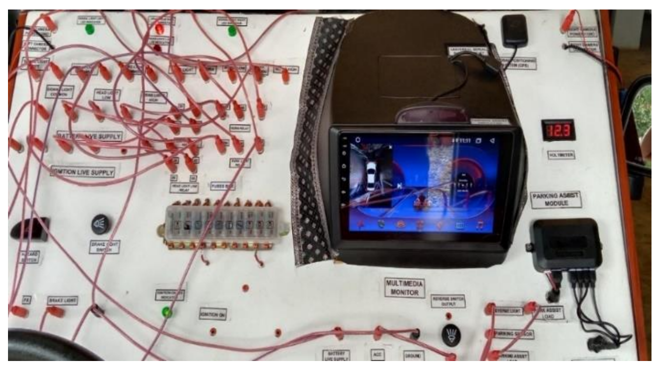

Figure 4: Rear Circuit Board Components

Figure 5: Rear metal frame assembly

The technicians and practitioners could view the real operation of the different components in the rear electrical load assembly, such as the park light, signal light, hazard light, tail light, reverse light, and brake light. The banana jack and rear camera connection are mounted to the back of the metal frame. The four peace's black park assist sensor is mounted to the plyboard beneath the light park assembly. Moreover, the tool board on the rear right side of the simulator was purposely installed for the tools to be placed during hands-on and troubleshooting activities.

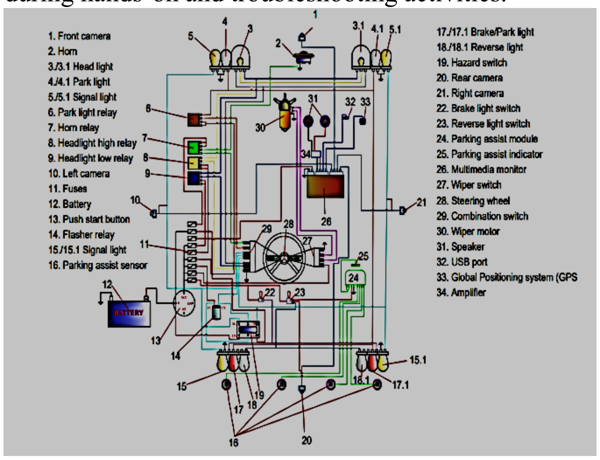

Figure 6: Schematic diagram of the electrical system

In figure 6, there are twelve distinct circuits in the electrical simulation: (e.g., headlight, park light, signal light, hazard, horn, reverse light, brake light, tail light, voltmeter, wiper, 360 degrees camera, a and park assist sensor circuit). The electrical power and control system must run parallel to the electrical components and provide dependable user or learner safety. This is achieved by meticulous circuit design, careful selection, precise electrical component setup, and highly experienced specialists constructing this device.

Left Isometric **Right Isometric**

Figure 7: Finished Product

This device is equipped with a car lighting system, a 360-degree camera, and a parking assist sensor. This device was already a push start bottom that compliments the modern technology in the vehicle. The advantage of this device is that the learners can see the direction of the circuit and wires. As seen in the panel board, it is composed of different connections like fuses, relays, switches, positive supplies, multimedia monitor, GPS, USB port, and parking assist sensor module. We also have here combination switch attached to the steering wheel that controls all the lights in this device. With the use of a diagram, the learners can easily simulate the circuit connection. For 360 cameras, there are certain connections for the students to perform. The monitor, displays the front view, back view, left side view, and right-side view, as well as the birds eye view and cornering. It is also connected to the signal light if you switch to the different direction, the monitors will display.

4. CONCLUSIONS

The autotronics simulation model for car lighting system (ASMCLS) was successfully designed, developed, and fabricated to be use for instruction specially for the automotive students, technicians, and practitioners. Through this development of the trainer model, they will improve their knowledge and skills as part of their professional development and it will boost their self-confidence. Moreover, this development of innovation helps the learners to upgrade their knowledge and skills to adopt the modern technology of the vehicle, it also it also addressed the need for new technology training equipment in the automotive industry. All the components of this device are safe and reliable and the materials used can be purchase in the local market.

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