University of Moratuwa
Faculty of Engineering
Department of Electronic & Telecommunication Engineering

EN 1190: Engineering Design Project

SLAP Innovators

SLAP Sonic ParkAssist

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1 Problem Description

1.1 Arriving at a Problem

In the realm of automotive safety, the issue of blind spots poses a significant concern. Despite the presence of mirrors, certain areas around a vehicle remain unseen, potentially leading to accidents involving pedestrians or objects. While parking cameras have been introduced to mitigate this risk, their efficacy in reducing accidents remains limited, with a mere 5% improvement. Conversely, integrating parking assist systems has shown a remarkable 42% reduction in parking-related incidents [1].

1.2 Arriving at a solution

Recognizing a gap in the market, particularly among older generation vehicles and newer cheaper vehicles lacking built-in proximity sensors, our solution aims to address this safety concern. Existing third-party proximity sensor options typically lack directional auditory feedback, presenting a challenge for drivers navigating parking and congested traffic situations. SLAP Sonic ParkAssist offers a tailored solution - an audio-feedback based parking assist system with directional audio, adaptable to vehicles without built-in proximity alarms.

Powered by the vehicle's battery, SLAP Sonic ParkAssist triggers a buzzer or siren when the vehicle nears a solid object. Four buzzers positioned at each corner of the vehicle activate upon detecting a barrier, intuitively guiding the driver away from potential hazards.

1.3 Justification

Conducting thorough market research, we discovered a prevalent need for parking assistance among respondents.

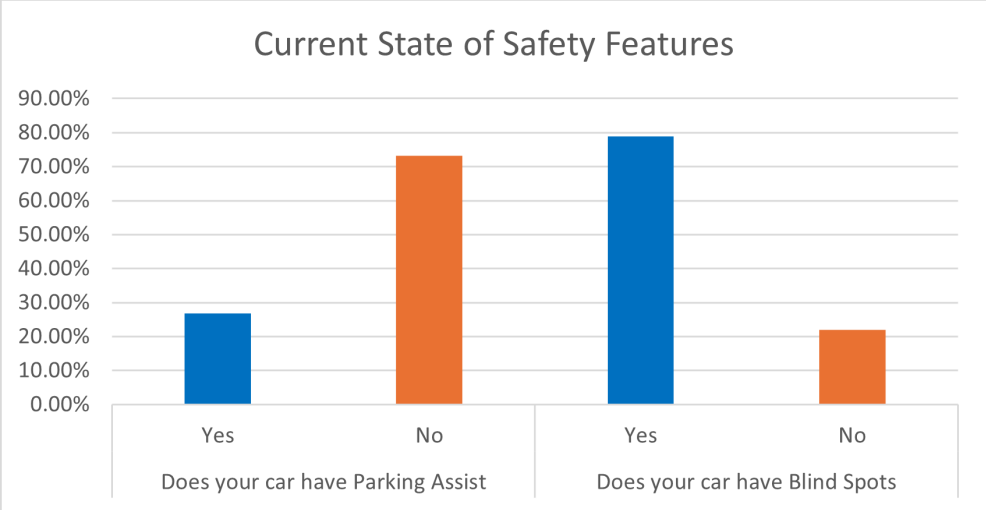


Figure 1: Current State of Safety Features

The survey overwhelmingly favored the implementation of parking assist systems for both parking and navigating congested traffic scenarios, irrespective of whether they had experienced accidents due to blind spots.

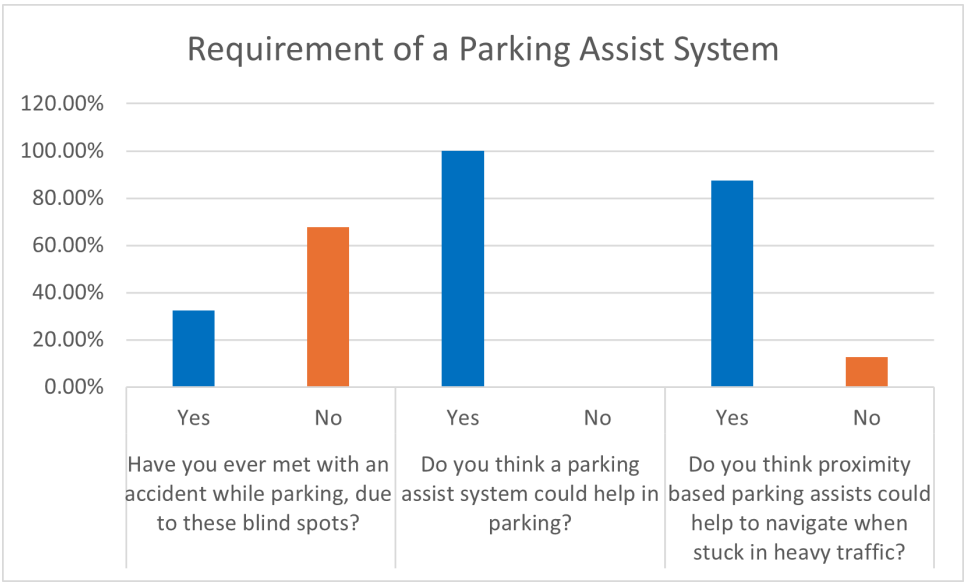


Figure 2: Market Availability

Our survey also revealed a clear preference for audio-feedback based systems, with a significant amount of respondents being willing to invest between Rs. 8,000 and Rs. 10,000.

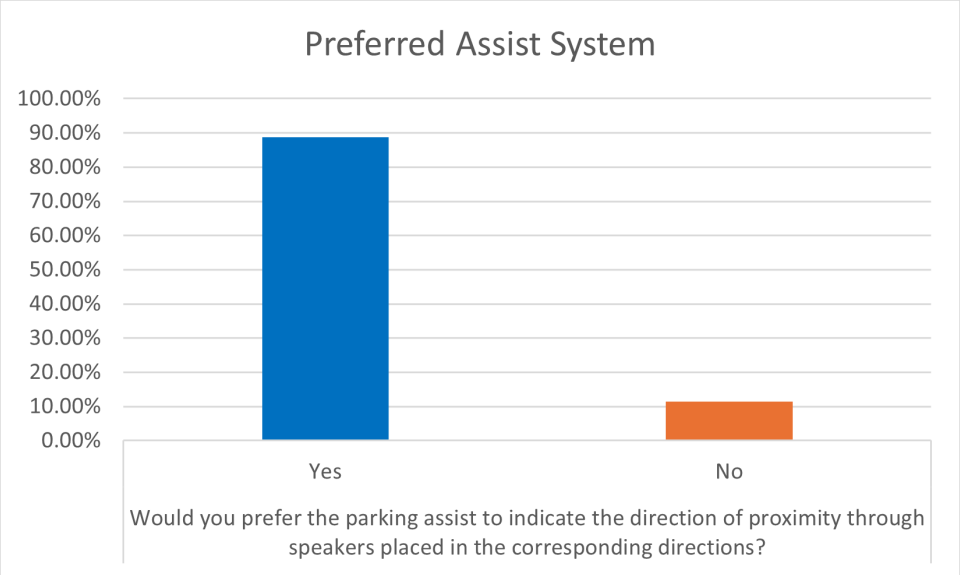


Figure 3: Market Preferences

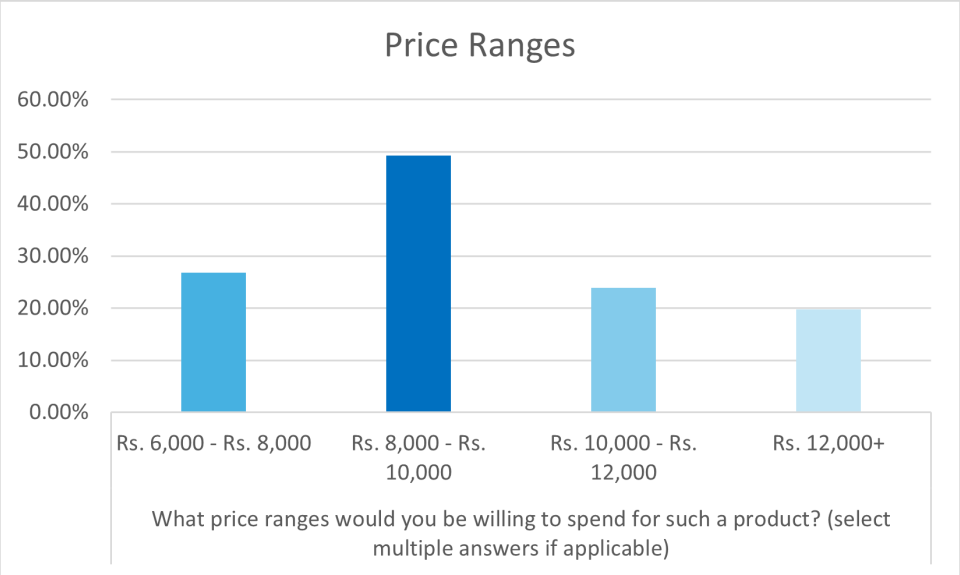


Figure 4: Price Ranges

In summary, the demand for our audio-feedback based parking assist system, along with the willingness of consumers to invest in such technology, highlights the tangible market potential for SLAP Sonic ParkAssist.

2 Feasibility

2.1 Technical Feasibility

The SLAP Sonic ParkAssist project is technically feasible, with all necessary resources successfully acquired and implemented. Our product utilizes an ATmega328P microcontroller, integrated with JSN-SR04T ultrasonic sensors, to provide precise parking assistance. The system is designed to enhance the parking experience by delivering accurate

distance measurements and alerts.

We designed the PCB using Altium and outsourced the manufacturing to JLCPCB, ensuring high-quality and reliable circuitry.

For the enclosure, we opted for a custom design using Solidworks. This enclosure was 3D printed using PLA filament, providing durability and a sleek appearance, with the services provided by Rysera.

All soldering and assembly were meticulously performed by us at the soldering room, ensuring robust connections and adherence to safety standards.

2.1.1 Hardware Feasibility and Justifications

We made sure to chose cost-effective, quality components for our products to ensure longevity and a low price point.

- Microcontroller: Atmega328p
- LM7805 Voltage Regulator for Power Supply (12V to 5V)
- Main PCB to interconnect modules and microcontroller
- JSN-SR04T Waterproof Ultrasonic Sensors
- JST XH-2.54mm connectors
- Active Buzzers

Justification for micro-controller

We decided to use the Atmega328p for our prototype as it has the exact number of inputs and outputs required for our project.

It also provides the required computing power to activate 8 sensors, calculate distances, and activate 4 buzzers simultaneously at a very high rate.

Further it is a fairly common, inexpensive, easily programmable component with an abundance of documentation online.

Justification for JSN-SR04T Ultrasonic Sensors

JSN-SR04T sensors are waterproof, making it suitable to attach to the exterior body of a vehicle. It has a large measuring angle of 75 degrees, which allows it to detect obstacles in a wide region. The module is separate from the sensor, allowing us to house all the modules within the enclosure. Measuring range, accuracy and ability of the sensor is on par with our performance requirements.

Justification for LM7805 Voltage Regulator

Provides stable, accurate voltage conversion without extreme heat dissipation.

2.1.2 Software Feasibility

The software requirement for programming the microcontroller is C++. Our primary goal was to develop a stable program that runs continuously without being affected by delays from each sensor module. To achieve this, we utilized a series of interrupts and rigorously tested and adjusted the software until it worked seamlessly with our sensor modules and met our performance requirements.

2.2 Economic Feasibility

We believe that SLAP Sonic ParkAssist has significant potential for success in the automotive market. Our product introduces unique features, such as four strategically placed buzzers at the corners of the car, providing drivers with precise directional alerts when obstacles are detected. This enhances the parking experience by giving more detailed feedback on potential obstacles around the vehicle, setting our product apart from standard parking assist systems.

Our market research indicates a strong demand for advanced parking assistance systems, particularly among drivers who value safety, convenience, and the latest automotive technologies. We have identified specific target markets, including tech-savvy individuals and safety-conscious drivers who are interested in investing in innovative solutions to enhance their driving experience.

Given the price point of Rs. 9,999, which aligns seamlessly with the market expectations, we are confident in the economic viability of the SLAP Sonic ParkAssist. We believe this pricing strategy positions the product for both profitability and success in the market.

3 Applications

- **Parking:** Our product eases the parking experience, alerting the driver of obstacles that may have gone unnoticed
- **Traffic Navigation:** Strategically placed sensors in the front of the car can ease navigation in heavily congested roads.

4 Product Architecture

The product architecture consists of the following subsystems:

- **Power Supply:** The 12V to 5V power step-down regulator provides power to all other subsystems.

- **Micro-controller:** Processes sensor outputs and decides which buzzers to activate and their beep frequencies.

- **Main PCB:** Interconnects all subsystems and modules with the Atmega328p.

- **Sensors:** JSN-SR04T Ultrasonic Sensors are used to measure distances to obstacles.

- **Buzzers:** Active buzzers used to alert the driver of obstacles.

The block diagram view of the product's architecture is shown below.

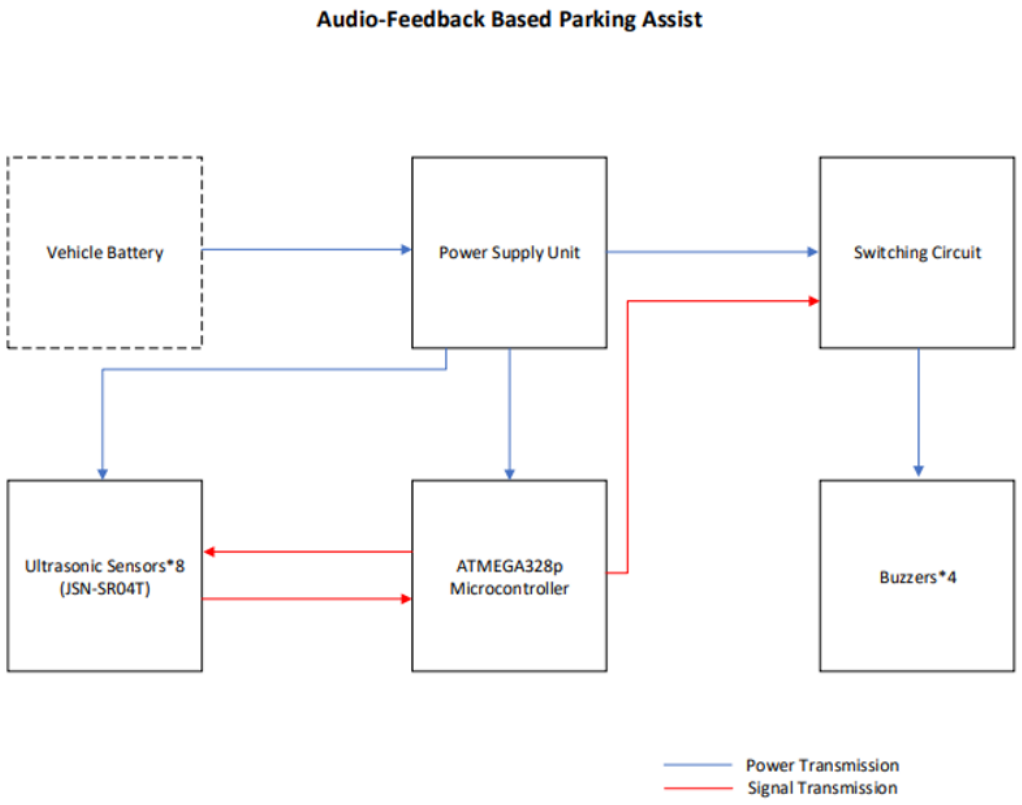


Figure 5: Block Diagram View

5 Enclosure Design

5.1 Initial Sketch

The initial sketch of the product enclosure is shown below.

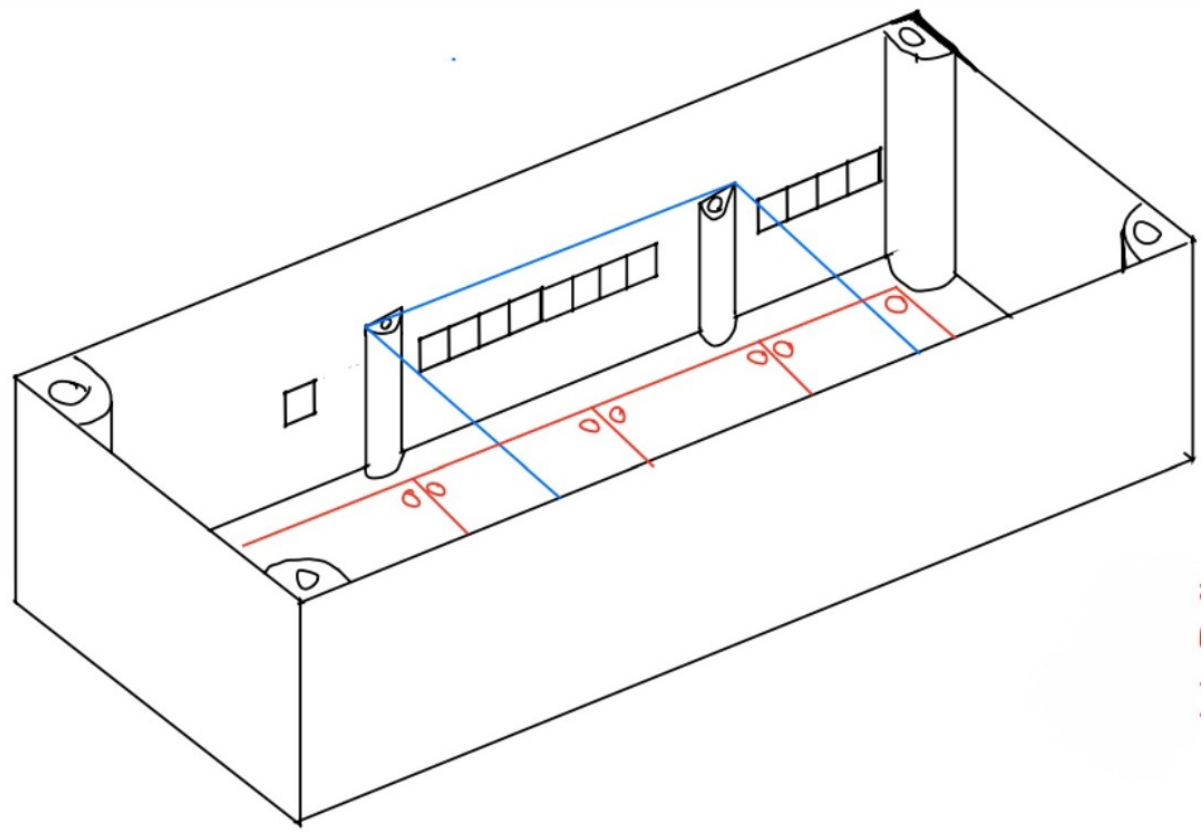


Figure 6: Enclosure: Initial Sketch

5.2 Final Sketch

The final sketch of the product enclosure is shown below.

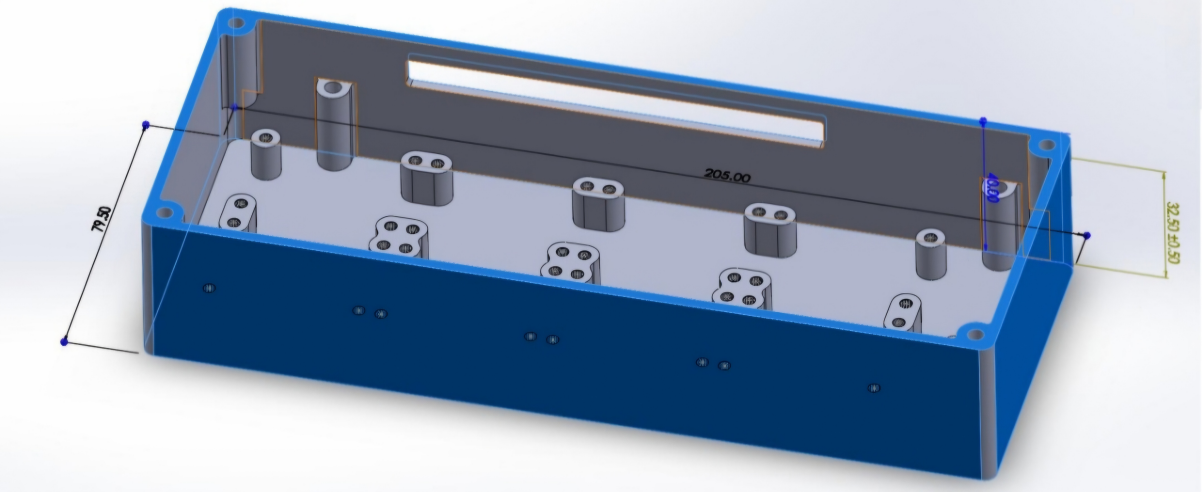


Figure 7: Enclosure: Final Design - External

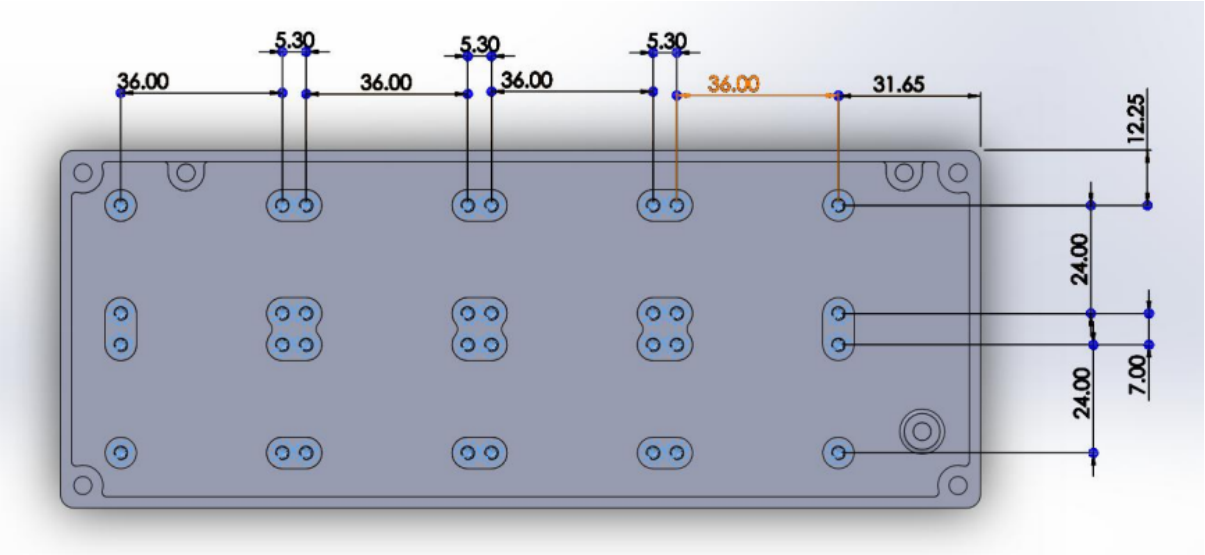


Figure 8: Enclosure: Final Design - Internal

6 PCB Design

The PCB design of our product is shown below.

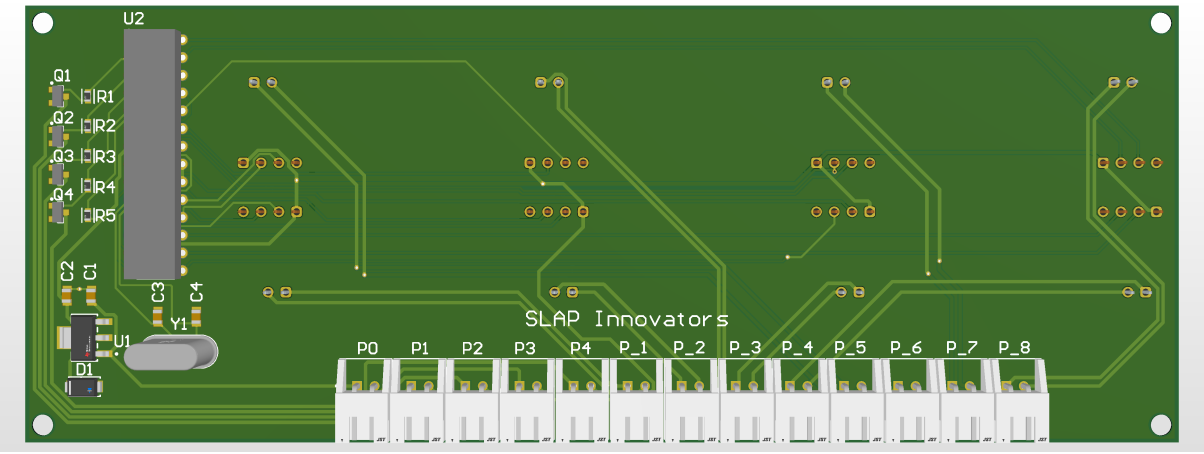


Figure 9: PCB: Top

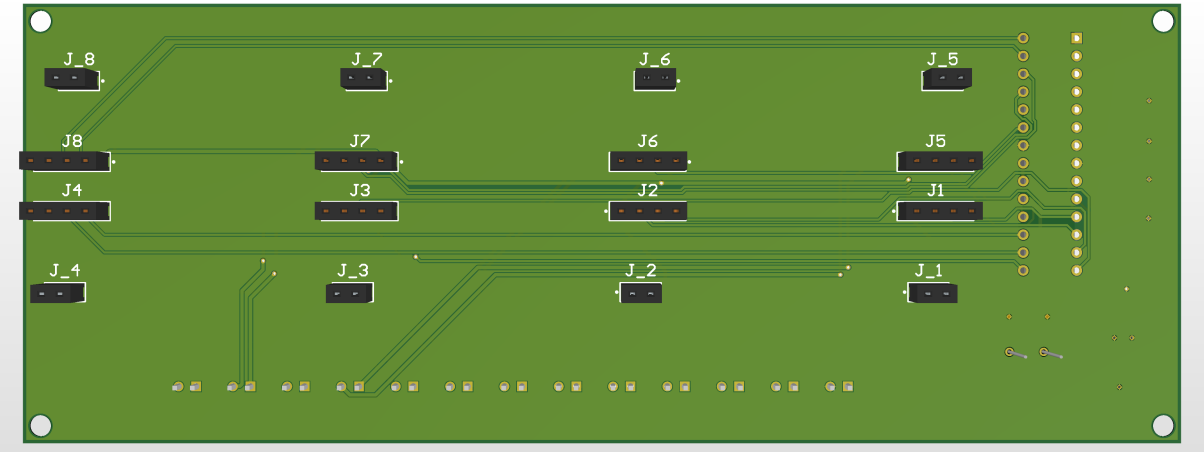


Figure 10: PCB: Bottom

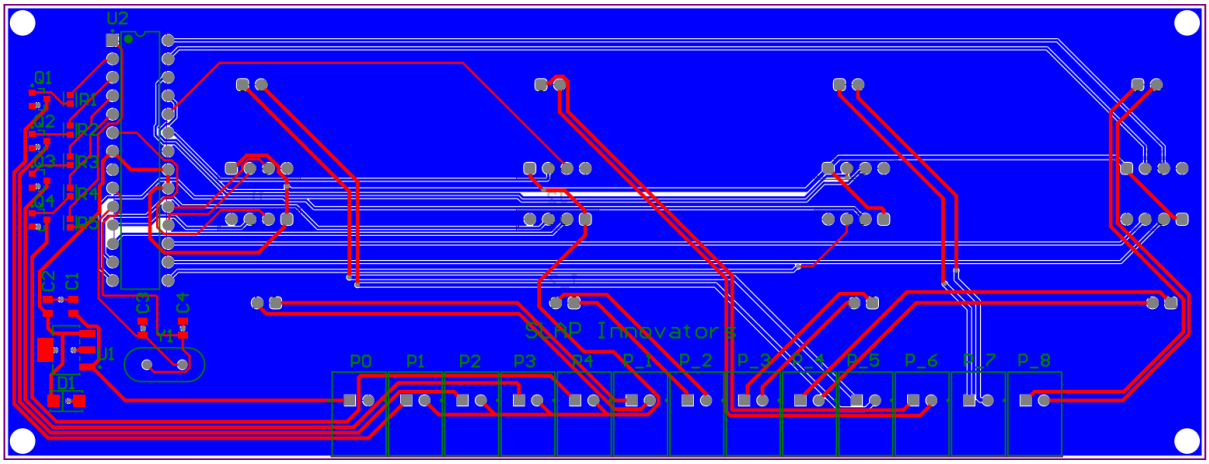


Figure 11: PCB: Schematic

7 Technical Specifications

7.1 Performance Specifications

- Rated Voltage : 12V
- Rated Current : 150mA
- Current Range : 35mA - 200mA
- Sensor Range : 20-80cm
- Sensor Accuracy : +/- 1 cm
- Ultrasonic Frequency : 40kHz

7.2 Power Consumption

- Power Supply : Reverse light power line/car battery
- Power Consumption : 1.8W

7.3 Dimensions

- Length : 205mm
- Width : 79.5mm
- Height : 34.5mm

7.4 Warranty

- 6 months warranty for manufacturing defects or faulty components.
- Warranty time can be increased after further testing.
- Repairs covered under warranty.

7.5 Main Features

- Directional Audio
- Beep frequency inversely proportional to distance
- Wide FOV
- Range of 20-80 cm

8 Final Product

Figure 12: Final Product

9 Future Modifications

9.1 PCB

Due to the absence of schematics, we were unable to integrate the sensor module with the main PCB. This limitation necessitated a larger PCB and enclosure, leading to increased costs. With further research, we anticipate being able to integrate all 8 modules directly onto the PCB, enabling us to design a more compact PCB and enclosure, ultimately reducing costs.

9.2 Enclosure

Currently, the enclosure is large to accommodate the 8 modules and connecting wires. Once we integrate the sensor modules directly into the PCB, we will be able to design a more compact enclosure.

To reduce production costs and enhance structural integrity, we plan to manufacture the final product using injection molding. We have chosen polycarbonate for this purpose due to the following favorable properties.

- Impact Resistance - Enclosure must be able to withstand bumps and vibrations on the road and impacts from items kept in the trunk.

- Thermal Resistance - Enclosure must be able to withstand the high temperature inside the vehicle when parked under the sun.
- Stability

To reduce the effects of vibrations and bumps, rubber bushes will be added to the mounting surfaces.

9.3 Micro-controller

Currently, we are using the Atmega328p microcontroller because it provides the precise number of pins we need. However, we plan to transition to an STM microcontroller once we have sufficient capital for the following reasons.

- Competitive pricing
- Better power management
- Higher processing speed
- Higher resolution timers

9.4 Buzzers

With increased revenue, we can develop custom buzzers that produce a less intrusive tone. Additionally, we can implement varied tones to distinguish between left and right directions more effectively.

10 Marketing, Sales, and After-Sale-Service Considerations

10.1 Market Analysis

Target Audience

SLAP Sonic ParkAssist is designed for drivers of older cars that don't have built-in parking assists, as well as those who own newer, more affordable vehicles without these features. Our target audience includes individuals looking to upgrade their parking capabilities without purchasing a new car. By offering an easy-to-install, effective parking assist solution, we aim to provide enhanced safety and convenience to a wide range of drivers.

Competitive Market

The competitive market for parking assist kits mainly consists of aftermarket products. The average price ranges from around Rs. 6,000 to Rs. 12,000. These solutions typically use either a display or a single buzzer or a combination of both. Displays can be

distracting, as they divert the driver's attention from the mirrors. Both single buzzers and displays only indicate the distance to the closest obstacle, lacking directional information.

Higher end products are produced by companies such as Bosche and Continental Automotive. However these solutions are priced at above Rs. 30,000, making them inaccessible to a majority of drivers.

In contrast, SLAP Sonic ParkAssist offers both distance and direction indicators, providing a more intuitive alert system that allows drivers to stay focused on their mirrors while navigating, at a reasonable price point of Rs. 9,999.

Quality control

The final product would go through quality control before being delivered to make sure it complies with the standards. This could entail evaluating the sensor detection ranges, examining the buzzer functionality, and the finish of the enclosure.

Testing and Updating

As a product that is developed around the user to cater their needs, we will be putting our best effort to continuously test and improve our hardware and software to enhance the user experience. Also testing would incorporate different types of vehicles to increase inclusiveness and accessibility of our products. We will also test our product in various weather and road conditions to ensure it's resistance to weather and bumps/vibrations.

Packaging and delivery

Once the product has passed quality control, it would be packaged and delivered to the customer. The packaging would be made out of recycled and hardened paper boxes. Bubble wrap padding will be included to keep the product inside the packaging safely. The sensors and buzzers will be packaged separately and labeled accordingly. A warranty card, an instruction manual, and drill bit will be included in the package as well.

Custom Features

Various colors of sensors to suit each vehicle type.

4 sensor and 8 sensor models to cover back or the front and back.

Toggle switch connected to power supply to have manual control over the operation of SLAP Sonic ParkAssist.

10.2 Marketing Strategy

Crowd Funding Campaigns

Empirically, it is a good move to seek capital through crowdfunding to scale the product. We can start a crowd funding campaign on "Kick Starter" to get the traction from

the local and international community.

Influencer Marketing

Find and interact with influential members of the public. Introduce our product to these members and use their reach to market our product.

Paid Advertising

Use paid advertising channels to specifically target the target audience, such as Google Ads or social media advertising.

Customer Reviews and Testimonials

Encourage satisfied customers to leave reviews and testimonials on our website or social media channels. This is very helpful in building our credibility as a user friendly device.

Affiliated Marketing

Marketing through our sales partners to their existing customers.

Marketing Team

After increasing our revenue from the first few batches, we can invest in a marketing team to further boost our product with detailed marketting plans to target specific audiences.

10.3 Sales Strategy

Direct Sales

We will launch a dedicated website for SLAP Sonic ParkAssist, featuring a secure payment gateway for online purchases. This platform will serve as our primary sales channel, allowing customers to buy our product conveniently. In the future, our website will also offer customization options for an additional fee, enabling users to tailor the product to their specific needs.

Demonstrations

Additionally, we will directly engage with drivers through automotive events, car clubs, and dealerships. By offering hands-on demonstrations, we aim to showcase the effectiveness of SLAP Sonic ParkAssist in real-world scenarios. If customers are satisfied with their experience, they will have the opportunity to purchase the product directly from us.

Partnerships

We will create bulk purchase contracts with car accessory stores to market and sell our product to their customers.

10.4 After-Sale-Service Considerations

Repair Services

We will offer in house repair services which are covered under warranty.

Installation Services

We will offer in store installation services and online videos for users/retailers to install the product themselves.

10.5 Recycling

Mechanical recycling for polycarbonate involves grinding the plastic into small flakes, which are then melted down and molded into new products. This process can be effective for recycling polycarbonate, as it maintains the material's integrity and quality. Additionally, some facilities employ chemical recycling methods for polycarbonate, where the plastic is broken down into its chemical components and reprocessed into new polycarbonate or other materials.

Currently, recycling printed circuit boards (PCBs) is challenging due to the complex mix of materials and the intricate processes required to separate and recover valuable components. However, as we increase revenue and scale up operations, we anticipate that advancements in recycling technologies and improved processes will make PCB recycling more feasible and efficient.

We plan to incentivize users to recycle by offering them a discount on future purchases if they return the enclosure to us at the end of it's lifetime.

10.6 Disposal

Since polycarbonate is not biodegradable, proper disposal is crucial to avoid environmental impact. Our product's instruction manual will provide detailed guidelines on how to dispose of the polycarbonate components, as well as the electronic circuits and sensors, in an environmentally responsible manner. This ensures that the materials are recycled or processed correctly, preventing them from ending up in landfills or polluting natural environments.

11 Task Allocation

The workload was fairly divided among all team members, and each person put in their best effort to achieve our goals.

Table 1: Task Allocation

Name	Task
Attanayake A.Y.	Circuit and PCB design, soldering and troubleshooting
De Zoysa A.S.I.	Enclosure design, market analysis, feasibility study and documentation
Goonetilleke P.	Sensor and buzzer research and microcontroller programming, testing and troubleshooting
Perera A.L.C.K	Enclosure design, overseeing budget, feasibility study and documentation

12 Project Budget

Following is the project budget for the initial prototype

Table 2: Cost Breakdown

Item	**Cost/Unit (Rs.)**	**Amount**	**Price (Rs.)**
ATMEGA328p	900	1	900
JSN SR04T	1750	8	14000
Components - eTusker	570	1	570
Connectors - Daraz.lk	712	2	1424
Components - Pitakotuwa	90	1	90
Components - Pitakotuwa	265	1	265
4 pin connectors - Tronic.lk	30	8	240
PCBs	393.41	5	1967.04
PCB Shipping	915.72	5	4578.60
Connectors - AliExpress	6.07	50	303.41
2 pin connectors	35	10	350
Enclosure	4150	1	4150
Wires	870	1	870
Total Price			**28,838.05**

13 Product Pricing

Cost estimation is done considering a batch of 100 units. Component costs are estimated to be reduced by 40% when bought for 1000 modules. Bulk pricing for micro controller and Sensors obtained from Digikey.

Table 3: Cost Breakdown and Pricing

Item	**Cost/Unit**	**Amount**	**Price (Rs.)**
ATMEGA328p	651.46	1000	651,460
JSN SR04T	325	8000	2,600,000
Components	2,520	1000	2,520,000
PCBs	140	1000	140,000
PCB Shipping	100	1000	100,000
Enclosure	1,200	1000	1,200,000
Hole Saw	680	1000	680000
Marketing and Sales(10%)	-	-	721,146
Profit (15%)	-	-	1,291,890.9
Total Price (1000 units)	-	-	**9,904,496.9**
Price per Unit	-	-	**9,904.5**

Therefore, the price per unit will be Rs. 9,999.

Typically, profit margins for consumer electronics range from 5% to 20%, with some high-end products achieving even higher margins.

In the case of SLAP Sonic ParkAssist, since it is a new product in the market, the profit margin can be higher initially to cover the research and development costs and generate revenue for future growth. As the product gains market acceptance and competition increases, the profit margin may need to be adjusted accordingly to remain competitive.

We have allocated 10% of the budget for marketing and sales expenses. However, we have not yet accounted for taxes, inventory costs, assembly costs, and personnel costs in our financial projections for the initial batch.

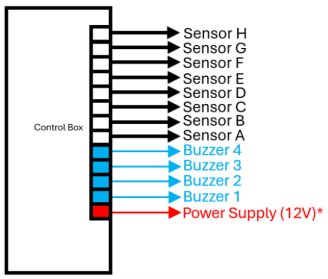
14 Datasheet

Parameter	Values
Rated Voltage	12V DC
Rated Current	150mA
Current Range	35mA - 200mA
Sensor Range	20-80 cm
Sensor Accuracy	± 1 cm
Ultrasonic Frequency	40 kHz
Dimensions	205 mm (L) x 79.5 mm (W) x 34.5 mm (H)
Operating/Storage Temperature	-20°C to 70°C
Power Consumption	1.8 Watts
Warranty	6 months for manufacturing defects and faulty components

15 User Manual

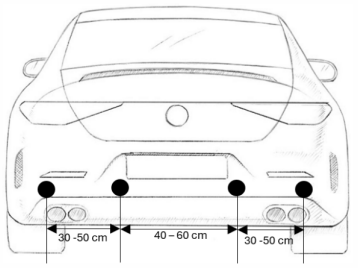
SLAP Sonic Park Assist

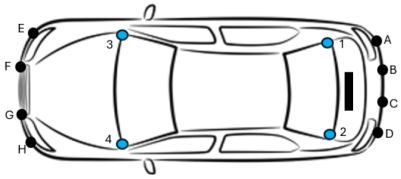
Installation Guide



*Power supply can be connected to
- Battery through toggle switch - Active when toggled
- Reverse lights - Active when reversing

USER MANUAL





- Sensors should be 40-70 cm above the ground
- Sensors should be spaced between 30 and 60 cm apart from each other.
- Before drilling bumper, ensure there is sufficient clearance (approx 25mm will be required)
- First, insert the wire into the hole and drag through till the sensor sits in the hole

Technical Details

Rated Voltage	12V
Operating Voltage	9-16V
Rated current	150 mA
Rated Power	1.8W
Operating Current	35-200mA
Detecting Range	20-80cm
Ultrasonic Frequency	40kHz

Warranty Details

- Warranty valid for 6 months from date of purchase
- Any indication of attempt to open control box will void warranty
- Any physical/water damage to control box will void warranty

Help us save the Planet!

- The control box is fully recyclable. Return control box to SLAP Innovators at end of lifetime for a discount on future purchases!

Disposal of Circuit Board

- Do Not Dispose of in Trash: This product contains electronic components and should not be discarded with household waste. (contains materials such as lead.)
- Recycle as e-Waste: Please recycle the circuit board at a designated electronic waste (e-waste) recycling facility.
- Environmental Impact: Improper disposal can harm the environment. Recycling recovers valuable materials and reduces pollution.
- Or simply return the PCB along with the control box!

SLAP Innovators

Figure 13: User Manual

16 References

References

[1] J. B. Cicchino, "Real-world effects of rear automatic braking and other backing assistance systems," *Journal of Safety Research*, vol. 68, pp. 41–47, 2019, ISSN: 0022-4375. DOI: https://doi.org/10.1016/j.jsr.2018.12.005. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S0022437518303451.