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Baby Car Seat Unfastened Alert with Voice

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Abstract
The “Baby Car Seat Unfastened Alert with Voice” project aims to enhance child safety by alerting parents when their child unbuckles the seat belt. This innovative system addresses a critical safety concern, as unfastened seat belts can put children at significant risk during travel. The system consists of several key components. A reed switch sensor is installed within the seat belt buckle to detect when it is unfastened. Additionally, a force-sensing resistor is placed beneath the seat to determine whether a child is present. To ensure that parents are promptly informed, a voice alert system is included. At the heart of this project is the Arduino Uno, which serves as the main controller. It facilitates communication between the various components, including the reed switch sensor, force-sensing resistor, and an LCD display that provides real-time information about the seat's status. When the seat belt is unfastened, the system triggers a voice alert, effectively notifying parents of the project aims to provide an additional layer of safety for children, offering peace of mind to parents during travel.
Keywords: Arduino Uno, Baby Car Seat, Voice Alert, Unfastened Alert System, Reed Switch Sensor, Force Sensing Resistor

Introduction-Safety Concern with the Baby Car Seat

The primary purpose of this project is to develop a Baby Car Seat with an unfastened alert system with voice. This innovative design aims to assist parents by providing a voice alert when the seat belt of the baby car seat is unfastened, addressing a critical safety concern that can place a child at high risk.

The study on this topic has been done due to safety of children during vehicle travel is a paramount concern for parents and caregivers. Traditional baby car seats, while designed to protect infants and toddlers, often have limitations that can compromise their effectiveness. One significant issue is the risk associated with unfastened seat belts. When a child is able to unbuckle their seat belt, it exposes them to severe dangers, including the potential for injury during sudden stops or accidents.

Despite the presence of safety features, many parents may not be aware when their child has unbuckled their seat belt, especially if they are focused on driving or distracted by other factors. This lack of awareness can lead to critical delays in response time, increasing the risk of harm to the child.

Additionally, existing car seat systems may not provide real-time feedback to parents regarding the status of the seat belt or the presence of the child in the seat. This gap in safety monitoring highlights the need for an innovative solution that can effectively alert parents when their child unbuckles their seat belt, thereby enhancing overall child safety during travel.

The "Baby Car Seat with Unfastened Alert with Voice" project aims to address these safety concerns by integrating advanced technology to create a reliable alert system that not only detects when a seat belt is unfastened but also ensures that parents are promptly informed, providing an essential layer of protection for children in vehicles.

The “Baby Car Seat with Unfastened Alert with Voice” project is a commendable initiative aimed at enhancing child safety in vehicles. By integrating a reed switch sensor within the seat belt buckle, the system can effectively detect when a child unbuckles their seat belt. The addition of a force-sensing resistor under the seat ensures that the system only activates when a child is present, preventing false alerts.

The use of an Arduino Uno as the main controller for this system is a smart choice, as it allows for seamless communication between the various components, including the sensors and the LCD display. The real-time information provided by the LCD helps parents monitor the status of the seat belt, while the voice alert system ensures that they are immediately notified if the seat belt is unfastened.

Baby Car Seat with unfastened Alert with Voice addresses a critical safety concern for the baby during the travel but also offers peace of mind to parents, knowing that they will be alerted with voice if their child attempts to unbuckle their seat belt during travel. Overall, it represents a significant step forward in child safety technology in vehicles.
In the summary the objectives of this study have been successfully achieved:

1. **Detection System**: The circuit for detecting an unfastened seat belt using an Arduino Uno has been developed and implemented effectively.
2. **Alarm System**: An alarm system that utilizes a voice alert to notify parents when the baby unfastens the seat belt has also been created and tested successfully.
3. **Sensor Integration**: The final objective, which involved producing a baby car seat with an unfastened alert system incorporating a reed switch sensor, force sensing resistor, LCD monitor and speaker, has been accomplished.

Literature Review
The first journal on secure systems in cars was proposed by S. Sharmiladevi, M. Kasiselvanathan, and Dr. S. P. Vimal. Their work addresses critical safety features, including an anti-pinch window system, drowsiness detection, alcohol detection, and seat belt sensors. This integrated safety system utilizes a Raspberry Pi ARM 11 as the microcontroller, paired

with various sensors designed to reduce the incidence of injuries in vehicles. One of the key components of their approach is a video acquisition system that activates when drowsiness is detected. This system uses facial recognition technology to monitor the driver's alertness levels. If drowsiness is detected, it triggers a buzzer, serving as an immediate warning to the driver. By combining these innovative technologies, the proposed system aims to enhance overall vehicle safety and mitigate the risks associated with driver fatigue and negligence. This proactive approach can significantly reduce the likelihood of accidents, making roads safer for everyone.

The paper presented by Priyal Sheth and Dr. Amarish Badgujar introduces a "Driver Assistive Safety System" (DASS) designed to enhance vehicle safety. This innovative system employs various methods, including alarms, visual indicators, speed control, and ignition interlocking, to ensure that drivers wear seat belts while operating their vehicles. The alarm system alerts drivers if their seat belts are not fastened, while visual cues on the dashboard serve as reminders of safety precautions. Additionally, the speed control feature limits the vehicle's speed if the seat belt is not worn, encouraging compliance with safety regulations. Ignition interlocking prevents the vehicle from starting unless the seat belt is secured. The accompanying flow chart illustrates how these components work together to promote safe driving practices. Ultimately, the DASS aims to reduce accidents and enhance overall driver safety by integrating advanced technology into vehicle operation shows in Figure 1.

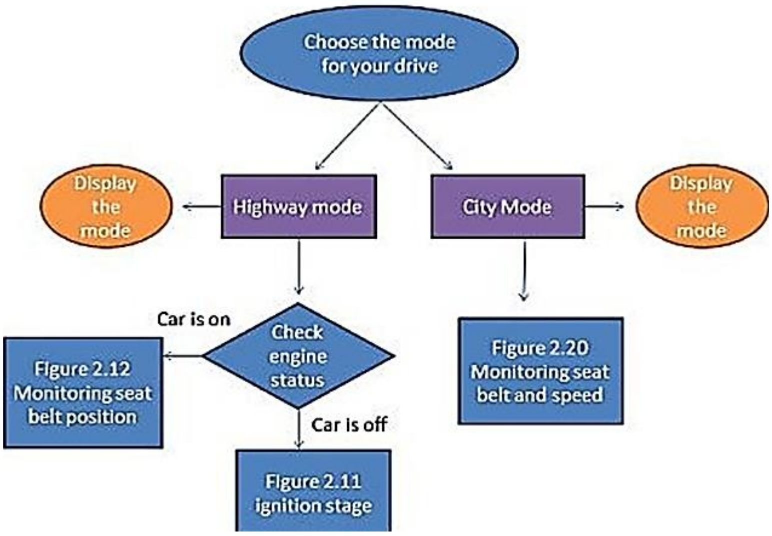

Figure. 1: Flow chart of the process of Driver Assistive Safety System

In additional to this issue, paper presented by Jason Davis, discusses a warning system aimed at enhancing child safety in vehicles. This system is specifically designed for child car safety seats and incorporates a seat belt buckle mechanism that detects the presence of a child. It also monitors the temperature within the vehicle, transmitting this information to a portable receiver device. If a child is detected, alerts are activated to inform the driver of the child's safety status. In additional, the process of alerting the driver, highlighting the integration of the seat belt insert and key fob to ensure that the presence of a child is effectively communicated. Overall, this warning system seeks to provide an additional layer of safety for children traveling in vehicles.

Article presented by Khairun Niza Khamli, describes a designed system consisting of two main components: a safety pad and a keychain alarm device. This system is activated through a warning alarm to enhance safety measures. It has proven to be an effective technological advancement and has been integrated with smartphone functionality for improved accessibility. Overall, this system aims to provide an efficient solution for alerting users to potential safety issues.

The final journal, presented by Akhil Mohan C, Hanna G. Elizabeth, Navya P. C, and Bagyaveereswaran V., proposes a new system that monitors both vehicle speed and seat belt usage . A key feature of this system is the "Ladies' One Button Help" (LOBH), designed for emergency assistance. This innovative system aims to reduce accidents caused by excessive speeding by ensuring drivers adhere to permitted vehicle speeds and comply with safety regulations. As illustrated in Figure 2, the system utilizes an Arduino Uno as its microcontroller, enabling effective real-time monitoring and alerting functions. Overall, this proposed system enhances driver safety and responsiveness in emergencies.

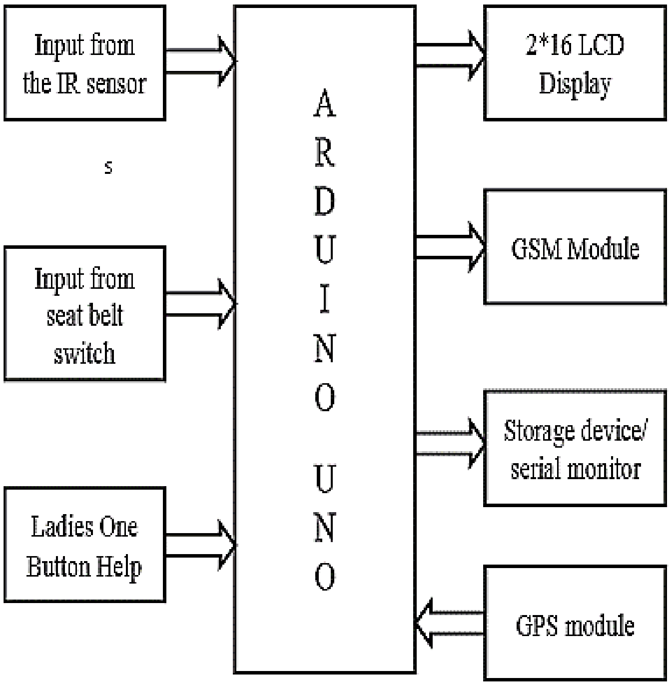

Figure 2: The Block diagram of proposed system

Research Methodology

The system for the "Development of Baby Car Seat with Unfastened Alert" addresses a significant safety concern by providing alerts when a child is unbuckled in the car seat. The research conducted has effectively identified and resolved the problem, reinforcing existing theories through additional observations and findings. The literature review served as a crucial guide in gathering data and information for the project, enabling a thorough analysis of the features of various components used. Each component was carefully selected and compared to similar alternatives to ensure the best fit for the project's requirements.

System Design

The circuit design for the project is based on a block diagram, which visually represents the system's main components and their functions. As shown in Figure 3, the block diagram illustrates how the hardware mechanisms and software interact within the system. In this design, the Arduino Uno serves as the main controller, responsible for managing all input and output activities. The system incorporates a reed switch sensor and a force-sensing resistor as input devices, while a speaker and an LCD display function as output devices. This configuration allows for effective monitoring and alerting, ensuring enhanced safety for children in car seats.

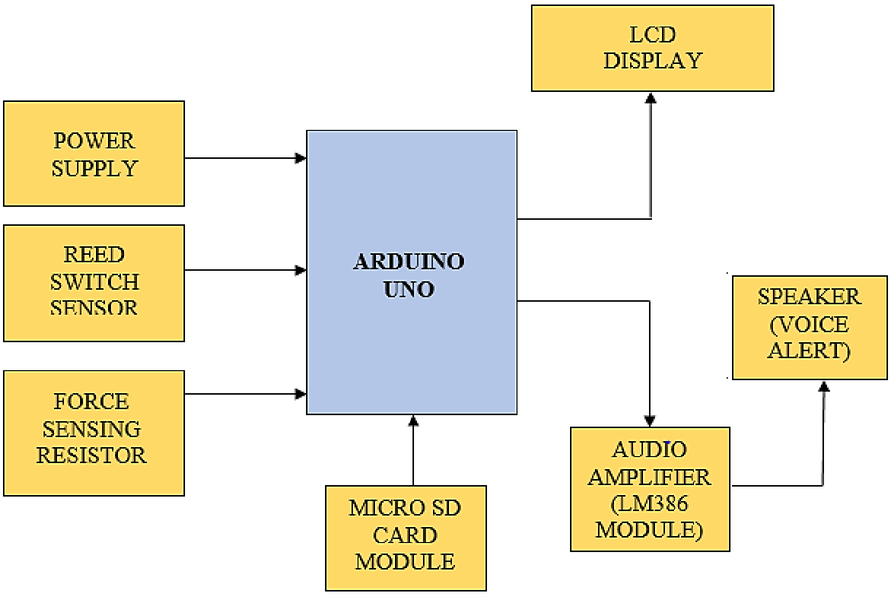

Figure 3 :The Block Diagram of Block Diagram of Development of Baby Car Seat with Unfastened Alert

System Flow Chart

This project is also designed based on a flow chart, which visually represents the workflow and processes involved. A flow chart provides a step-by-step approach to solving tasks within the project, making it easier to understand the sequence of actions required. As depicted in Figure 4, the flow chart outlines the steps for the "Development of Baby Car Seat with Unfastened Alert," detailing how the system activates a voice alert from the speaker when the seat belt is unfastened. This systematic approach ensures clarity in the operational process, enhancing the effectiveness of the safety features implemented in the design.

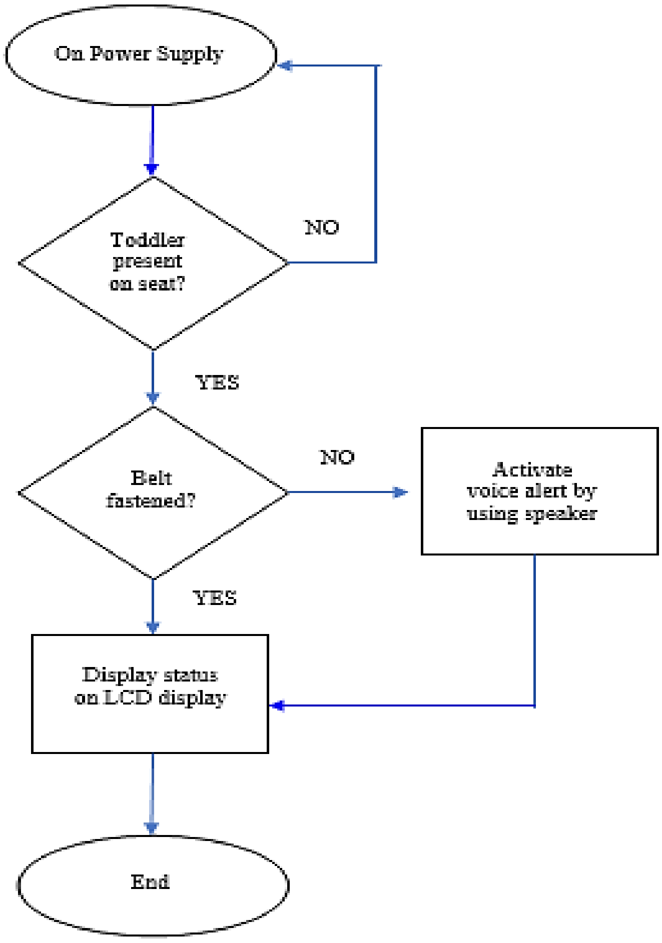

Figure 4: Flow chart of Baby Car Seat with Unfastened Alert

Circuit Design

Both circuits contributing to the system were constructed prior to the installation of the hardware and the prototype. Each circuit was built to complete its specific tasks, and once finalized, they were integrated into a single device. The design of these circuits is based on references from related papers, ensuring alignment with proven methodologies. Figure 5 illustrates the circuit for the " Baby Car Seat with Unfastened Alert," showcasing how the individual components work together to enhance the functionality and safety of the system. This careful integration underscores the project's commitment to effective design and implementation.

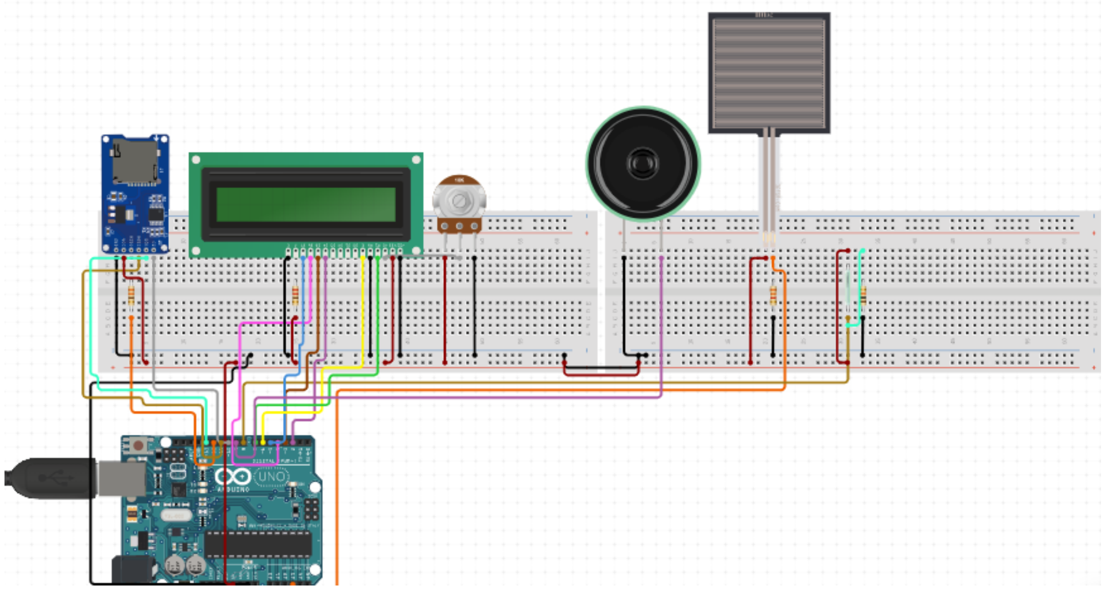

Figure. 5 Circuit of system

Results

System Prototype

The "Baby Car Seat with Unfastened Alert" is implemented with several key components, including an Arduino UNO, a reed switch sensor, a force sensing resistor, and a speaker. To ensure stability and control throughout the system, resistors and switches are also incorporated. The prototype system is depicted from the front and side views in Figure 6, while Figure 7 provides a back view showcasing the circuit layout.

In this design, the reed switch sensor is mounted inside the seat belt buckle of the baby car seat to detect a magnet attached to the seat belt buckles tongue. The system determines the seat belt's status based on the sensor's detection: when the reed switch sensor detects the magnet, the seat belt is considered fastened; conversely, if the sensor does not detect the magnet, it indicates that the seat belt is unfastened. This mechanism is crucial for ensuring the safety of the child in the car seat.

Fig. 6 Front and side view of prototype

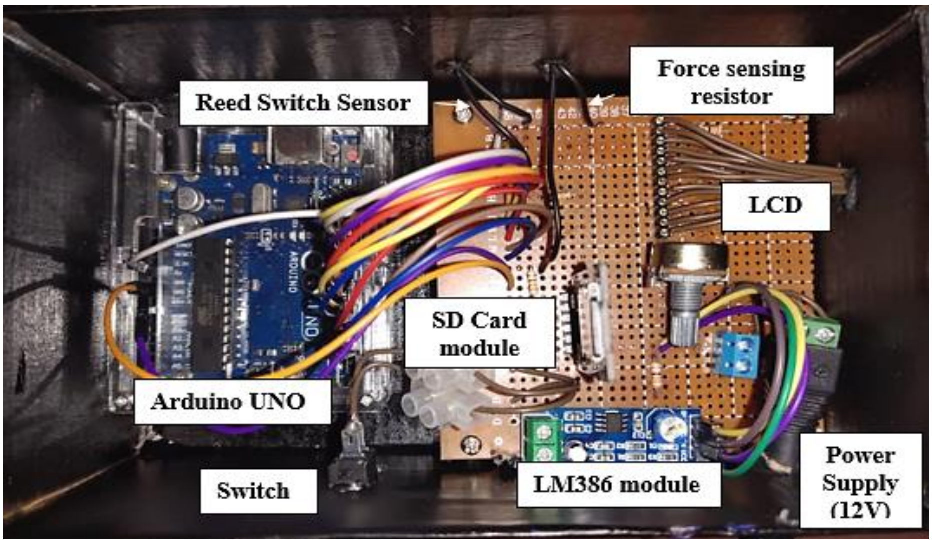

Figure 7 : Front and side view of prototype

Project Testing

The system has successfully been tested and developed into a working prototype. Upon powering on the project, the LCD displays the name of the system at start up, while the speaker generates a welcome message: "Welcome to baby car seat system," as shown in Figure 8. Once a baby is seated and the seat belt is fastened, accompanied by the voice message: "The seat belt is fastened. Your baby is safe."

Conversely, if the baby is seated but the seat belt is unfastened, the LCD displays the relevant status as depicted in Figure 9. In this case, the system activates a warning alarm and voice alert, with the speaker announcing: "Alert! The belt is unfastened!" This functionality ensures that caregivers are promptly informed of the child's safety status, enhancing the overall effectiveness of the safety system.

Figure 8 left: LCD shows at start up, right- ,LCD shows status when the seat belt is fastened

Fig.9 LCD shows status when the seat belt is unfastened

Time of Detection vs. Number of Tests

In this section, the analysis of the time taken to attain a voice alert at various positions is presented. The data has been collected for three different distances: 1.5 cm, 2.0 cm, and 2.5 cm. The outcomes of this analysis are summarized in Tables 1

Table 1
Time Take for Voice Alert at 1.5, 2.0 and 2.5 cm of Distance Position

Number of Test	Time of detection for 1.5cm	Time of detection for 2.0cm	Time of detection for 2.5 cm (s)
1	1.41	1.43	1.36
2	1.49	1.52	1.42
3	1.47	1.50	1.34
4	1.56	1.36	1.33
5	1.43	1.33	1.38
6	1.38	1.45	1.41
7	1.48	1.50	1.45
8	1.50	1.36	1.45
9	1.46	1.45	1.46
10	1.43	1.47	1.43

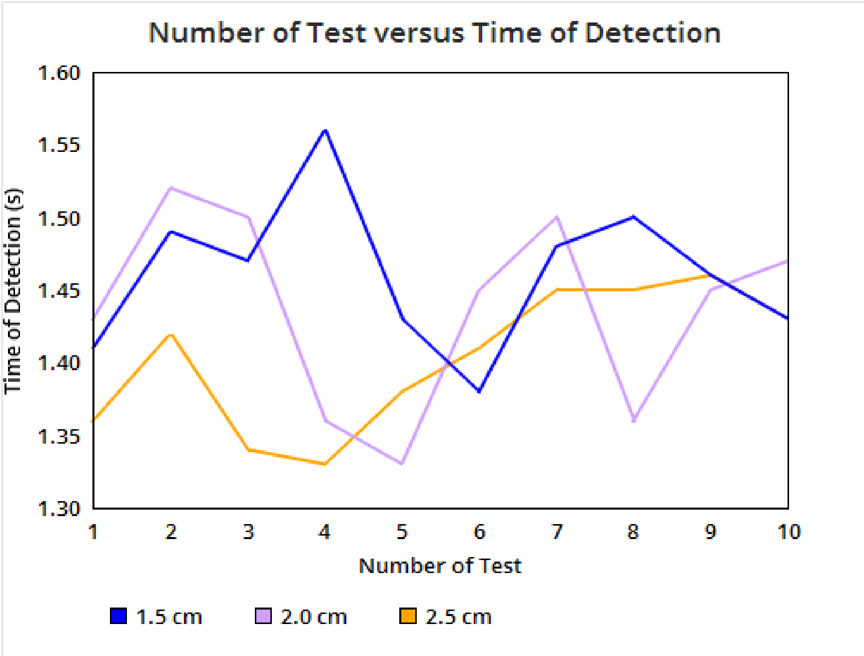

Figure 10: Graph of number of test versus time of detection

Figure 10 illustrates the relationship between the number of tests conducted and the time of detection for voice alerts at a position of 1.5 cm. The data were recorded over 10 trials for each position. From this analysis, it was observed that the time taken to attain a voice alert remained stable, with a range of 1.33 seconds to 1.56 seconds across the three positions tested (1.5 cm, 2.0 cm, and 2.5 cm). This stability suggests consistent performance in the system's response time across varying distances.

Detection Sensitivity Analysis

In addition to the time of detection, this project also analysed the detection sensitivity of the system using two types of sensors: the reed switch sensor and the force sensing resistor (FSR)shows in Table 2 and Table 3.

The performance of each sensor was evaluated based on its ability to detect the voice alert under various conditions. This analysis provides insight into how effectively each sensor responds to stimuli, which is crucial for optimizing the system's overall functionality.

By comparing the detection sensitivity of the reed switch sensor and the force sensing resistor, we can identify strengths and weaknesses in their performance, guiding future improvements and applications in similar projects.

Table 2

Distance position (cm) versus Detection rate of magnet (%)

Position (cm)	**Detection rate of magnet (%)**
0.2	100
0.4	100
0.6	100
0.8	100
1.0	90
1.2	90
1.4	90
1.6	0
1.8	0
2.0	0

Table 3

Mass(Kg) versus detection rate of pressure (%)

Mass (kg)	**Detection rate of pressure (%)**
0.5	0
1.0	60
1.5	90
2.0	90
2.5	100
3.0	100
3.5	100
4.0	100
4.5	100

Detection Rate of Reed Switch Sensor

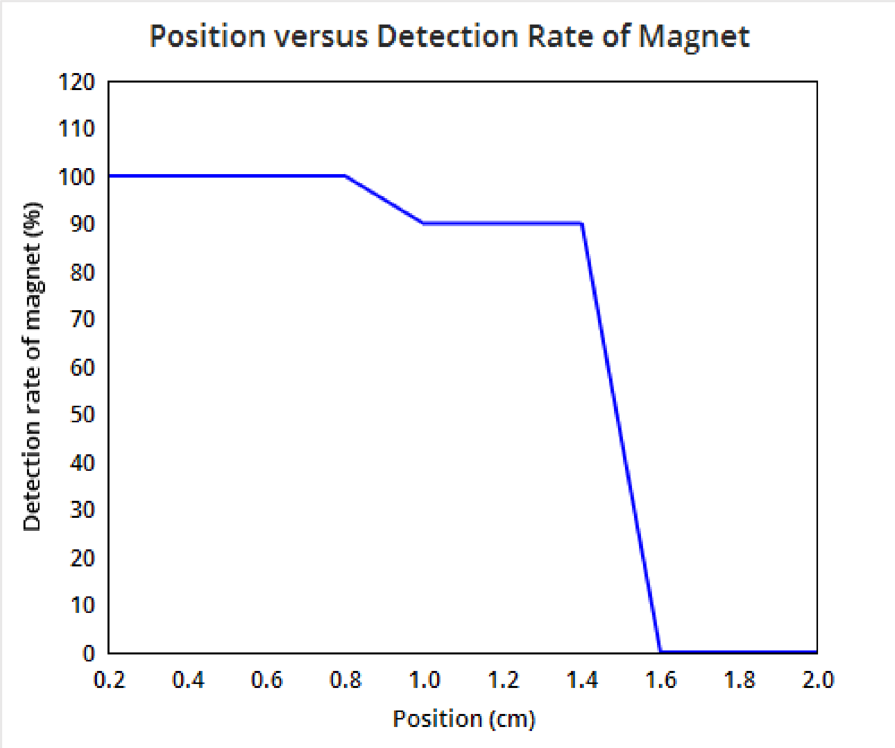

Figure 11: Detection Rate of Reed Switch Sensor

Figure 11 illustrates the detection rate of the magnet on the tongue of the seat belt buckle for the reed switch sensor. The analysis indicates that the detection rate decreases as the distance increases. Notably, the detection rate reaches 0% at approximately 1.6 cm.

This finding suggests that the effective range for the reed switch sensor to attain a voice alert when the seat belt is unfastened is limited to around 1.6 cm. Beyond this distance, the sensor fails to detect the presence of the magnet, highlighting a critical consideration for system design and placement.

Detection Rate of Force Sensing Resistor

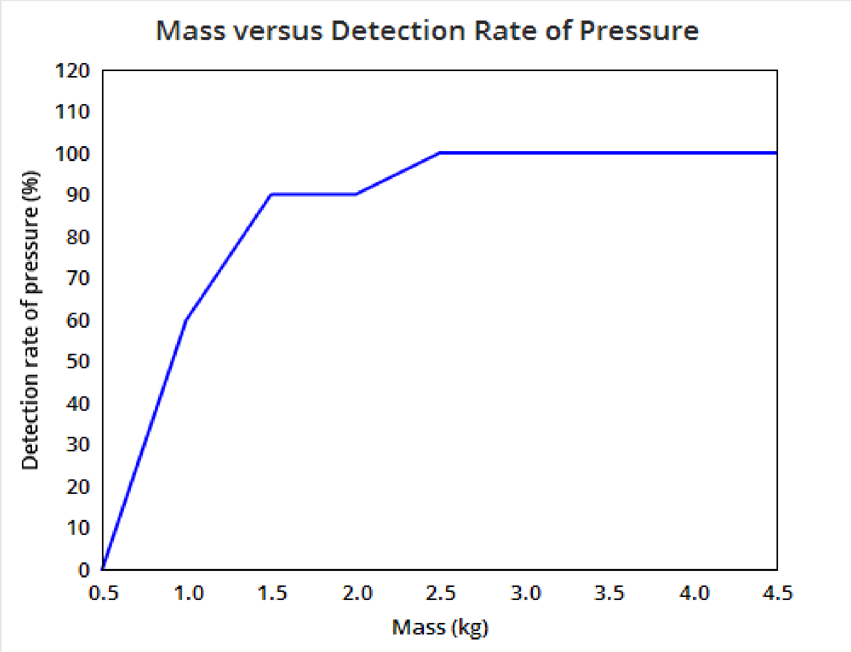

Figure 12: Detection Rate of Force Sensing Resistor

Figure 12 illustrates the detection rate of pressure on the force sensing resistor (FSR). The results indicate that the detection rate increases with the applied mass. Notably, the detection rate reaches 100% at approximately 2.5 kg.
This finding suggests that a minimum mass of around 2.5 kg is required for the force sensing resistor to function effectively and attain a voice alert. Below this threshold, the sensor may not provide reliable detection, which is an important consideration for ensuring consistent performance in the system.

Conclusions

This project design implements a Baby Car Seat Unfastened Alert with Voice system, leveraging advanced sensor technology to enhance child safety during travel. The system utilizes an Arduino Uno microcontroller as the central processing unit to monitor the status of the seat belt. The detection mechanism employs a combination of a reed switch sensor and a force sensing resistor (FSR) to accurately assess whether the seat belt is fastened securely. Upon detecting an unfastened condition, the system triggers a voice alert through a connected speaker, providing immediate notification to the caregiver.

The development process included rigorous testing and data analysis to ensure the reliability and responsiveness of the alert system. The integration of the sensors and the alarm system was optimized for minimal response time, with the FSR calibrated to require a minimum mass of approximately 2.5 kg for reliable activation. Additionally, the reed switch sensor was evaluated for its effective detection range, confirming that the system can maintain functionality up to 1.6 cm.

Overall, this project successfully demonstrates the potential of electronic safety solutions in child car seats, with the ability to provide timely alerts that significantly mitigate risks associated with unfastened seat belts. The data collected throughout the project validates the system's stability and effectiveness, ensuring compliance with safety standards and enhancing parental peace of mind during travel.

Acknowledgement
I would like to express my sincere gratitude to all those who contributed to the success of the "Baby Car with Unfastened Alert with Voice" project.

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