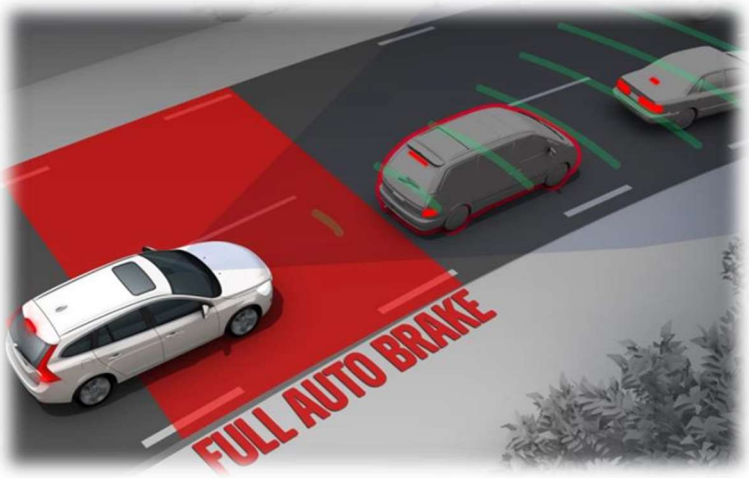

Image Copyright: Cars Guide (1)

Project
Automatic Braking Emergency Device (ABED)

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Concept of Operations

For the Practicum project, our team will design and deploy a device named the Automatic Braking Emergency Device (ABED). The Minimum Viable Product (MVP) has an ultrasonic sensor, a microcontroller attached to a vehicle. The ultrasonic sensor measures the distance of objects in front of it and applies a braking method to the vehicle, and thus the car safely stops before making contact with the object.

This product can be easily and inexpensively integrated into any moving object with a safely deployable binary braking mechanism. Once installed, it can apply the brake on a device automatically when there's an obstacle in front of it (e.g. robot vacuum, golf cart, go-kart, automated manufacturing…). We believe that companies and individuals can use this device to fulfill their needs related to automated driving, low-speed applications, and manufacturing environments.

Needs Statement

According to Reveal News (2), 8 out of every 100 Amazon distribution center workers were injured in 2019 due to close proximity to automated robot systems. A system is needed to intervene in vehicular electromotive action to prevent unwanted contact with environmental objects, including humans.

Objective

Our objective is to provide a cost-effective device that will integrate into the tens of thousands of electromotive vehicles worldwide to intervene in braking the vehicle when objects are at risk of being unintentionally struck. It will do this via a distance sensor and a microcontroller that can activate a braking method.

Market Analysis

Intended customers:

Our product can be a part of other larger systems that requires automatic low-speed braking in response to environmental feedback. Our potential customers would be automotive companies, automated manufacturing environments, low-speed electromotive vehicles, and toy manufacturers. For instance, a lot of companies have adapted using robots in their warehouses for transportation which would likely need our Automatic Braking Emergency Device in order for the robots to stop safely when approaching obstacles. This device could also detect a human entering a robot's path and could prevent

injury, making it attractive to a customer seeking to increase the safety in their manufacturing environment.

Competition:

There are a variety of systems that perform a similar function found in modern consumer vehicles. Tesla, Ford, Mazda, and Toyota have incorporated sonar distance sensors in bumpers of their current high-end lineup.

The ABED focuses less on providing a full autopilot solution, which is very complex and expensive and focuses more on one simple function – low speed, emergency braking. Taken as an example, Tesla's autopilot which is a suite of advanced driver-assistance system features, costs an additional $7,000 to add to your Tesla vehicle (3). This places it outside the range of most consumers.

Unique Features:

This device is widely applicable, since almost any system with safety measures could benefit from it, and performs reliably at low cost with off the shelf components. This device makes use of a common microprocessor and an easily attainable Ultrasonic sensor to implement an accurate braking system that has the potential to save companies several thousand times more than the cost of the device and its deployment/installation.

Price Point:

Given its simple components and intended use, the price point for the Automated Braking Emergency Device is approximately $20. This ballpark price point is for the cost of all board materials and peripherals, engineering overhead/programming implementation, and for appropriate profit margin.

Requirements

Our device **must** have the ability to detect a human sized object reliably. The device must detect the object far enough to stop the electromotive vehicle reliably in a safe distance from it. Once detected and appropriate, the device must respond to that reading by intervening to stop the vehicle before it makes contact with the object. It **Should** have a digital display with a readout of currently detected object distance. **May** feed this information back to an outside controller. (See below for design specification related requirements)

System Architecture

Figure 1: Level 0 Schematic

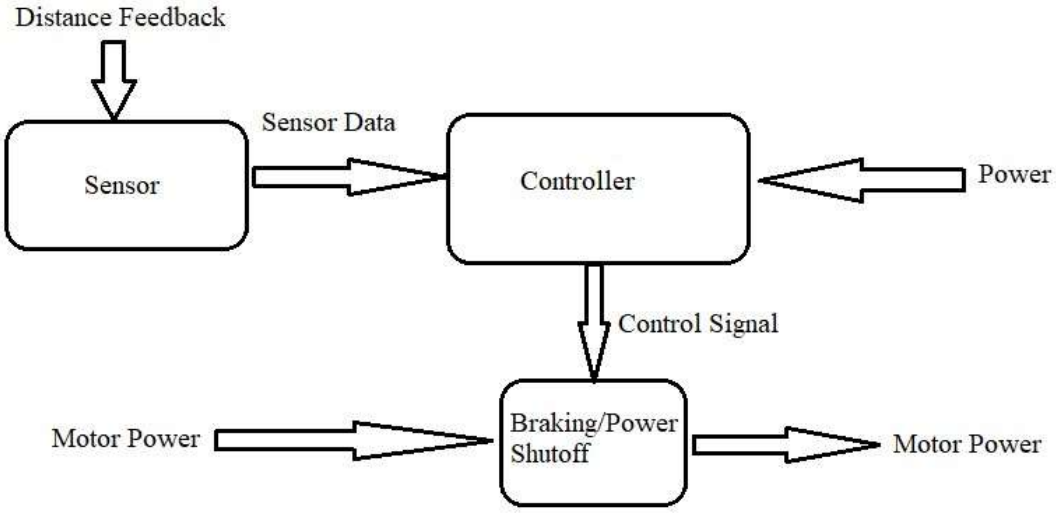

Figure 2: Level 1 Schematic

Design Specification

- Sensor:
  - Ultrasonic sensor HC-SR04
- Processor:
  - ATMega328p
- Actuator:
  - LCD1602
  - NPN PN2222 Transistor
- Power:
  - 3.3V on Provided by host system
- PCB board
  - Have ≥ 2 layers, with solder mask and at least a top-side silk screen.
  - Have an area between > 9 cm2 and < 900 cm2.
  - Have no linear dimension < 2 cm or > 30 cm
  - Have header pins connected to Processor to allow onboard programming

Citations

1. 23 October 2020 · Richard Berry, 22 October 2020 · Tom White, 8 October 2020 · Richard Berry, 7 October 2020 · Peter Anderson, 9 October 2020 · Richard Berry, 23 October 2020 · Andrew Chesterton, . . . 15 October 2020 · David Morley. (n.d.). What is Autonomous Emergency Braking or AEB? Retrieved October 25, 2020, from https://www.carsguide.com.au/car-advice/what-is-autonomous-emergency-braking-oraeb-51459
2. Merchant, B. (2020, September 30). Amazon Uses Automation to Hide a Disastrous Record of Workplace Injuries. Retrieved October 25, 2020, from https://onezero.medium.com/amazon-uses-automation-to-hide-a-disastrous-record-ofworkplace-injuries-4920797d9301
3. Elon Musk: Tesla raises cost of 'self-driving' cars. (2020, May 19). Retrieved October 25, 2020, from https://www.bbc.com/news/business-52703767

Revision

Revision 0.5: Initial document.

Revision 0.6: Added Needs Statement.

Revision 0.7: Updated Requirements.

Revision 0.9: Added Title Page to correspond to Rubric.

Revision 1.0: Submitted Document Revision
1.1: Typo fix.
Revision 1.2: Updated Schematic and Reqs.
Revision 1.3: Updated Design spec, rephrased sentences and Typo fix