Smart Baby Detection System

Kristopher Luo

Abstract

The purpose of this project is to create a Smart Baby Detection System that prevents parents from leaving their children in their car. I was first inspired to do this project when I saw many news reports on babies being left in cars and dying, and from then on, I felt the need to prevent these tragedies from occurring. This prototype consists of a camera, a switch, a Raspberry Pi module, a battery pack, and a 2" display. This project is a continuation of my last year's project, the Smart Baby Car seat. The previous prototype's primary sensor was a pressure sensor and used Bluetooth to communicate with the parent's mobile device. In this continuation, I will be utilizing a smart camera and a loud buzzer instead of the pressure sensor and the Bluetooth. This camera will be coded to recognize whether the baby is in the seat or not. The prototype was successful in passing all the expectations and ultimately could solve the problem.

Introduction

With increasing temperatures in warm places like Arizona, more and more infants are dying after being left in cars during the summer season. The design and development of a Smart Camera Detection System will prevent any further toddler deaths.

Machine learning is an application of Artificial Intelligence. Machine Learning enables a system to automatically learn and progress from experience without being explicitly programmed. The goal of machine learning is to understand the structure of data and fit that data into a model that can then be used to recognize correlations to the data. There are 2 methods of machine learning: supervised and unsupervised. I will be supervising the training of this model. A typical neural network is a group of algorithms that model the data using neurons for machine learning. The model will use 3 different sets: one with the baby in the car seat, one with the car seat but no baby, and one without the baby or the car seat.

The digital neural network is based off of the human brain. The main elements of biological neural networks are the neurons, electrochemical excitable cells that can receive signals or stimuli from other neurons via synapse connections. These neurons make up the human brain and allow humans to a higher level of thinking unknown by any other species. An organism could be analogical to this prototype as the brain is a neural network with neurons and the eyes are the camera module.

I will be using Tensorflow as the open source machine learning library. Tensorflow is an established neural network that is utilized for machine learning for many purposes. In my case, I will be using Tensorflow to recognize the presence of a baby through a camera module. Certain features including detail extractors will be utilized from the Tensorflow library. These features will ultimately take each frame from the live camera and extract/analyze the frame for the presence of the baby.

Methods

Design Criteria:

This prototype consists of a camera, a switch, a Raspberry Pi module, a battery pack, and a 2" display. The prototype is designed to sound an alert once the camera detects a baby. A stuffed animal is used to act as the baby and the prototype is tested to see if the camera is accurate and if the alert is sounded.

Design Constraints:

The Raspberry Pi is much more resource constrained than a computer, the machine learning library was utilized in a constrained environment. The project is powered by a rechargeable battery, and uses fragile sensors. The prototype was programmed using a Python coding platform on the Raspberry Pi.

Design Execution

Gather all materials. Replicate the circuit in the image. Plug in the ribbon cable into the camera slot of the Raspberry Pi. Plug in the other end of the cable into the camera module. Plug in the display into the pi. Connect the HDMI ports of the display and the pi. The prototype is ready to test!

Testing Procedures.

During the testing and experimental procedures, a stuffed animal was used instead of the baby. Turn on the Raspberry Pi. Open the Command Prompt at the top of the screen.Record 3 sets of data for baby at 5 seconds, 10 seconds, and 15 seconds (total of 9 sets of data). Repeat step 3 with no baby and no car seat. Train a model with the 5-seconds duration data sets collected for all the scenarios. Repeat step 5 with the 10- and 15-second duration sets. Run the models and record the correlation in 3 different scenarios: baby, no baby, and no car seat. Testing the models: Put the designated "baby" on the car seat and record data according to the test plan.

Results

1st Trial:

1. The prototype met expectations. (Prototype correctly identified each scenario)
2. The prototype did not meet expectations. (Bag was identified as a baby)
3. The prototype met expectations. (The alarm sounded)
4. The prototype met expectations. (Alert stayed on during the correct spans)

2nd Trial:

1. The prototype met expectations. (Prototype correctly identified each scenario)
2. The prototype met expectations. (Bag was identified as no baby)
3. The prototype met expectations. (The alarm sounded)
4. The prototype did not meet expectations. (Alert stayed on during the correct spans)

3rd Trial:

1. The prototype met expectations. (Prototype correctly identified each of the classes)
2. The prototype met expectations. (Camera did not misidentify objects as the baby)
3. The prototype met expectations. (The alarm was activated)
4. The prototype met expectations. (Alert stayed on during the correct spans)

4th Trial:

1. The prototype met expectations. (Prototype correctly identified each of the classes)
2. The prototype met expectations. (Camera did not misidentify objects as a baby)
3. The prototype met expectations. (The alarm was activated)
4. The prototype met expectations. (Alert stayed on and turned off correctly)

Discussion

This prototype met all test plan expectations. It was correctly identifying the presence of a baby 80% of the time. The prototype improved throughout the trials due to revisions including debugging the code and retraining the model. The first trial was conducted after the model was successfully trained. The main areas of revisions included adding the sound effects to the code and revising the code to accompany the limit switch. The main revisions made on the design of the prototype and hardware included using a much smaller display and making the prototype more compact.

For future research,

- The model trained in Raspberry Pi has limited accuracy. Creating and training models in a full resource environment like a desktop computer, would allow much more accurate models.
- I would like to add an infrared sensor to the prototype so that miscellaneous objects will always be ignored and that the alert will go off only when a baby is on the sensor.
- I could implement this prototype into my last year's project and create a full smart baby car seat
- This prototype could also be made into an actual baby smart seat and have compact and durable components.

References

EdjeElectronics. "EdjeElectronics/TensorFlow-Object-Detection-on-the-Raspberry-Pi." GitHub, 6 Nov. 2019, github.com/EdjeElectronics/TensorFlow-Object-Detection-on-the-Raspberry-Pi.

Howe, P. D., Marlon, J. R., Wang, X., & Leiserowitz, A. (2019). Public perceptions of the health risks of extreme heat across US states, counties, and neighborhoods. Proceedings of the National Academy of Sciences, 116(14), 6743–6748. doi: 10.1073/pnas.1813145116

Jones, Paul. Python: the Fundamentals of Python Programming. Createspace, 2016.

Puri, Munish, et al. Artificial Neural Network for Drug Design, Delivery, and Disposition. Elsevier Academic Press, 2016.

"Tutorials : TensorFlow Core." TensorFlow, www.tensorflow.org/tutorials/.

Vanos, J. K., Middel, A., Poletti, M. N., & Selover, N. J. (2018). Evaluating the impact of solar radiation on pediatric heat balance within enclosed, hot vehicles. Temperature, 5(3), 276–292. doi: 10.1080/23328940.2018.1468205

Willingham, AJ. "More than 36 Kids Die in Hot Cars Every Year and July Is Usually the Deadliest Month." CNN, Cable News Network, 20 July 2018, www.cnn.com/2018/07/03/health/hot-car-deaths-child-charts-graphs-trnd/index.html

Yegulalp, Serdar. "What Is TensorFlow? The Machine Learning Library Explained." InfoWorld, InfoWorld, 18 June 2019,www.infoworld.com/article/3278008/what-is-tensorflow-the-machine-learning-library-explained.html.

"Getting Started with the Camera Module." Projects.raspberrypi.org, projects.raspberrypi.org/en/projects/getting-started-with-picamera.

"GPIO." GPIO - Raspberry Pi Documentation, www.raspberrypi.org/documentation/usage/gpio/.