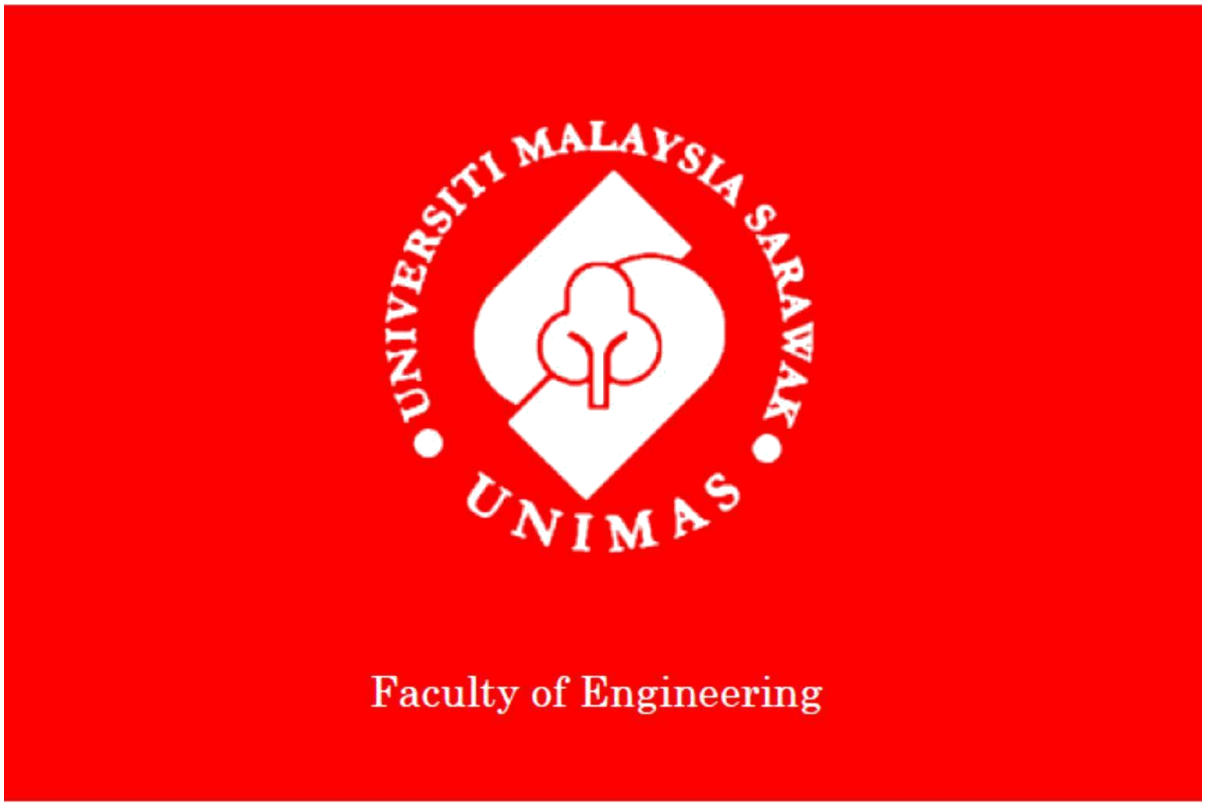

DEVELOPMENT OF A CHILD DETECTION SYSTEM WITH ARTIFICIAL INTELLIGENCE (AI) USING OBJECT DETECTION METHOD

Lai Suk Na

Bachelor of Engineering with Honours

(Mechanical and Manufacturing Engineering)

2018

FACULTY OF ENGINEERING

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(Project Supervisor)

Date

DEVELOPMENT OF A CHILD DETECTION SYSTEM WITH ARTIFICIAL INTELLIGENCE (AI) USING OBJECT DETECTION METHOD

LAI SUK NA

A dissertation submitted in partial fulfillment
of the requirement for the degree of
Bachelor of Engineering with Honours
(Mechanical and Manufacturing Engineering)

Faculty of Engineering
Universiti Malaysia Sarawak

2018

To my beloved family and friends.

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ABSTRACT

The issue of children dying due to vehicular heatstroke has raised the public attention. The failure of current vehicular occupant detection devices to identify correctly the occupant as a child had triggered the idea of developing a child detection system using Artificial Intelligence (AI) technology. The usage of Convolutional Neural Network (CNN) had been recognised as an effective way to perform image classification. However, this approach required a significant number of images as training data and substantial time for model training in order to achieve desired results in accuracy. Due to the limitation of abundant dataset, transfer learning was used to accomplish the task. Modern convolutional object detector, SSD Mobilenet v1 trained on Microsoft Common Objects in Context (MS COCO) dataset was used as a starting point of the training process. MS COCO dataset that consisted of a total of 328k images were divided into 91 different categories including dog, person, kite and so on. The trained model was then retrained to classify adults and children instead of persons. At the end of the training, a real-time child detection system was established. The system was able to give different responses to the detection of a child and adult. The responses comprised of visual and audio outputs. Upon detection, a bounding box was drawn on a child or an adult face as visual output. At the same time, the system would trigger the speaker to speak out the statement “child is detected” for successful child detection whereas adult detection would result in the statement of “adult is detected”. Theoretically, the detection system could achieve an overall precision of 0.969. However, the experimental results obtained was able to match up to a precision of 0.883 that resulted in a small error of 8.88%.

ABSTRAK

Isu kanak-kanak maut dalam kenderaan kerana strok haba telah menimbulkan perhatian orang ramai. Kegagalan alat pengesan di pasaran untuk mengenal pasti kehadiran penumpang kenderaan adalah anak dengan tepat telah mencetuskan idea untuk membangunkan sistem pengesanan kanak-kanak menggunakan teknologi Kecerdasan Buatan (AI). Penggunaan rangkaian neural konvolusi (CNN) telah diakui sebagai cara yang berkesan untuk melakukan klasifikasi imej. Walau bagaimanapun, pendekatan ini memerlukan imej yang banyak sebagai data latihan dan masa yang panjang untuk latihan supaya dapat mencapai ketepatan yang dikehendaki. Oleh sebab batasan dataset yang banyak, pembelajaran pemindahan digunakan untuk menyelesaikan tugas. Pengesan objek konvolusi moden, SSD Mobilenet v1 yang dilatih dalam dataset Microsoft Common Objects Context (MS COCO) digunakan sebagai titik permulaan proses latihan. Dataset MS COCO mengandungi sejumlah 328 ribu imej dibahagikan kepada 91 kategori yang berbeza termasuk anjing, orang, layang-layang dan sebagainya. Model ini dilatih untuk mengklasifikasikan dewasa dan kanak-kanak yang pada asalnya mengenali kanak-kanak dan orang dewasa sebagai orang. Pada akhir latihan, sistem pengesanan masa nyata ditubuhkan. Sistem memberi respons yang berbeza kepada kanak-kanak dan orang dewasa. Maklum balas terdiri daripada output visual dan audio. Secara teorinya, sistem pengesanan dapat mencapai ketepatan keseluruhan 0.969 sedangkan hasil eksperimen memberikan ketepatan 0.883, memberikan kesilapan sebanyak 8.88%.

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LIST OF ABBREVIATIONS

AI	-	Artifiial Intelligence
ML	-	Machine Learning
DL	-	Deep Learning
ANN	-	Artificial Neural Network
DNN	-	Deep Neural Network
CNN	-	Convolutional Neural Network
RNN	-	Recurrent Neural Network
IDLE	-	Integrated Development Learning Environment
XML	-	Extensible Markup Language
HTML	-	Hyper Text Markup Language
WAV	-	Waveform Audio
CSV	-	Comma Separated File

CHAPTER 1

INTRODUCTION

1.1 General Background

Heatstroke is defined as a situation whereby the body lost the ability to cool itself due to prolonged exposure to high temperatures (Mayo Clinic, 2017). The symptoms of heatstroke include high body temperature, normally achieved a temperature of 40^{o}C or higher, nausea, vomiting, rapid breathing, racing heart rate, headache and so on. There are children dying from heatstroke each year after being left unattended in vehicles. According to McLaren (2005), although under a relatively cool ambient temperature, the majority rise in temperature of a parked vehicle occurs at the first 15 to 30 minutes. According to Kidsandcars (2017), the probability of children suffer from heatstroke in cars is much higher than that of adults. Core body temperature of children rises more rapidly under high temperature due to their greater body surface area to mass ratio as compared to adults. A child can get overheat at around 3 to 5 times faster than an adult. Statistics show that there is a total of 700 child fatalities due to vehicular heatstroke since 1998 in the United States and 87% of them were aged under 3 years old. Figure 1.1 shows the circumstances of child vehicular heatstroke (Null, 2017).

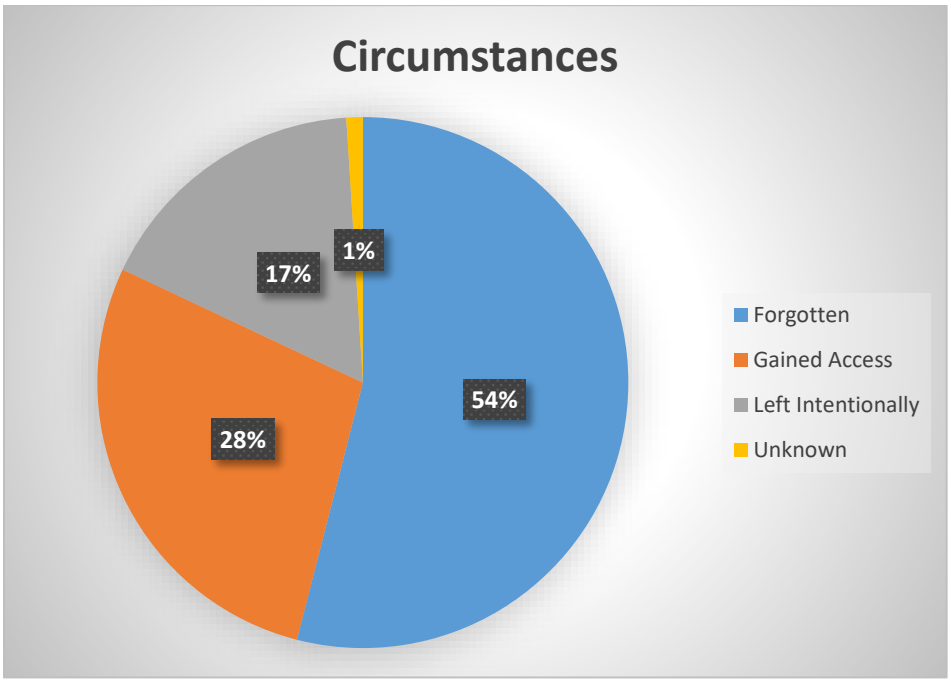

Figure 1.1: Circumstances of Child Vehicular Heatstroke Death in the United States (1998 – 2016)

The issue of children dying of vehicular heatstroke has raised the attention of the public and lead to the invention of various types of devices to help remind drivers or caregivers. The typical product currently available in the market includes Sense-A-Life, a device that utilized pressure sensor to detect the presence of a child, and immediately alert driver that has left a child in the car through a mobile application and speakers. It is designed with simple installation and easy transfer between vehicles.

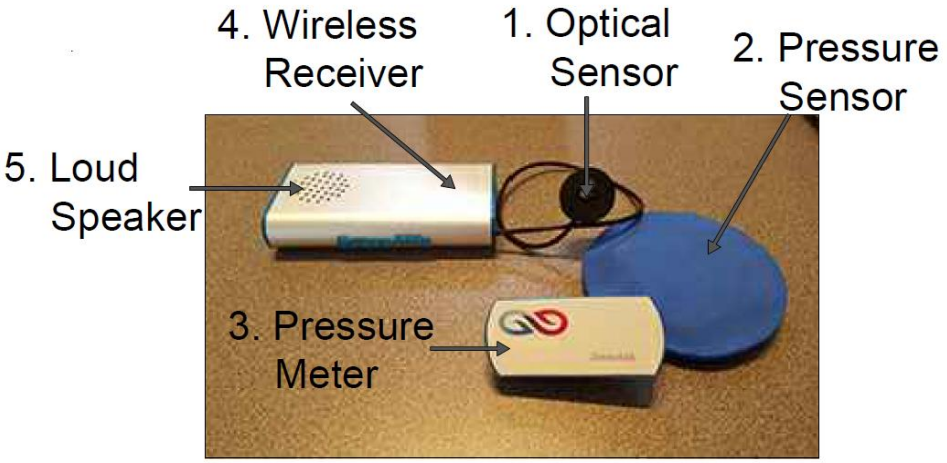

Figure 1.2: Sense-A-Life Vehicular Occupant Detection System (Adapted from Schlosser, 2016)

However, there are weaknesses in this invention. The usage of the pressure sensor cannot differentiate whether the force applied to it is a human or a load. This will cause the occurrence of false signal generation. Besides, it is designed to be installed in a baby car seat. It cannot detect the presence of a child who gained access to the car on their own. Another invention is developed by Hyundai Motor named rear occupant alert system. The system implemented ultrasonic sensor to detect motion of child in the rear seats after driver leaves the vehicle and activate triggering system including horns sound, light flash and send text message to the driver. The system can work effectively even the child is not put in the baby seat (Newswire, 2017).

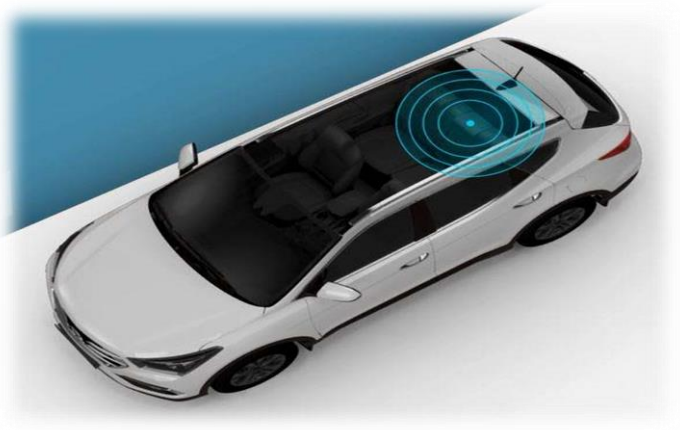

Figure 1.3: Hyundai Rear Occupant Alert System (Adapted from Muller, 2017)

However, the system cannot generate the signal if the child is sleeping or not move. In addition, the system will generate a signal to any motion regardless of whether the vehicular occupant is an adult or a child. This reduces the reliability of the system.

Current products in the market generally comprised of sensors to sense temperature and vehicular occupant detection as well as triggering system. Weaknesses of these products are the ability to detect correctly whether there is a vehicular occupant present in the car and whether he or she is a child or an adult. As such, a study should be done to develop a child detection system which can accurately detect the presence of a child in a car. Application of Artificial Intelligence (AI) technology in image recognition system is the reason for the idea of developing a child detection system to achieve the objectives of this research.

Table 1.1: Comparison between the Advantages and Disadvantages of Current Vehicular Occupant Detection Systems in the Market

	Advantages	Disadvantages
Sense-A-Life	• Ease to install	• Pressure sensor cannot differentiate between a child and a load • The region of detection is limited in the baby car seat only
Hyundai Rear Occupant Alert System	• Detection is not limited to the baby car seat only	• Cannot differentiate the occupant is an adult or a child • Fail to sense the occupant if there is no motion detected

1.2 Problem Statement

The problem encountered currently is the available sensors in the market cannot differentiate accurately the vehicle occupant is an adult or a child. The sensor can detect the presence of vehicular occupant and generate signal to alert car owner. However, the system cannot determine whether the occupant is a child or adult. This will increase the frequency of false signal generation.

The inaccurate sensor such as pressure sensor will activate triggering system to any load applied on it, generating the false signal to users, thus reducing the reliability of the detection system.

On the other hand, problem to be faced in this project is the qualities of input which will affect the accuracy of results. This problem may occur due to motion of children. Other factor such as brightness, distance and angle from the camera to the target would affect the performance of the system as well.

1.3 Objectives

The objectives of this study are:

- To provide a framework for the development of a child detection system with AI using object detection method.
- To establish an image recognition system that can detect the presence of a child.
- To develop a child detection system that is able to reduce the frequency of false signal generation.

1.4 Scope of research

This research focuses on developing an alternative way to detect vehicular occupant instead of using sensors available in the market. The system established will response to the presence of child only. This research will help to study the workability in using image recognition to differentiate a child against an adult. There are several challenges that may not be solved by using image recognition. Firstly, training an image recognition system requires a large amount of images as training data. Besides, training an image recognition model required the useage of Graphics Processing Unit (GPU) in order to speed up the process and obtain a more accurate retrained model.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Artificial Intelligence

The field of Artificial Intelligence (AI) was coined by John McCarthy and two senior scientists: Claude Shannon and Nathan Rochester in 1956 at a conference, Dartmouth Conference, the first conference devoted to the subject (Buchanan, 2006). They proposed that every aspect of learning or any other feature of intelligence can be precisely described, and a machine can be made to simulate it. According to Luger (2009), artificial intelligence (AI) is the science to enable the machine to accomplish the thing that requires intelligence. It promotes the use of a computer to do reasoning. AI can refer to anything from a computer programme playing a game to pattern recognition, image recognition as well as text and speech recognition by utilizing AI technology. The field of AI reached its major advance in the year of 1980, with the emergence of Machine Learning (ML), an approach to achieve AI (Dietterich & Michalski, 1983). Machine learning works on the principle of using algorithms to learn from examples. The machine is trained to learn from a large amount of data by itself, without explicitly programmed. However, conventional machine learning techniques were limited in their ability to process natural data in their raw form (Luppescu & Romero, n.d.). The weakness had led to the blossom of Deep Learning (DL) in the 2000's. DL is a set of methods that allow a machine to be fed with raw data and automatically discover the representations needed for detection and classification (Lecun, Bengio, & Hinton, 2015). DL architectures comprised of multiple processing layers to extract a useful representation of data. For example, in image processing, raw images are fed into the learning model. Initial layer extract edge detection, the second layer detects the motif, the third layer may assemble motifs into larger combinations that correspond to parts of familiar objects, and

subsequent layers would detect objects as combinations of these parts. In short, AI is any techniques that enable computers to replicate human intelligence. ML is the subset of AI involving the field of study that gives computers the ability to learn without explicitly programmed. Improvement of ML leads to DL, which allow a model to learn the representations of data with multiple levels of abstraction. Figure 2.1 shows the relationship between AI, ML, and DL.

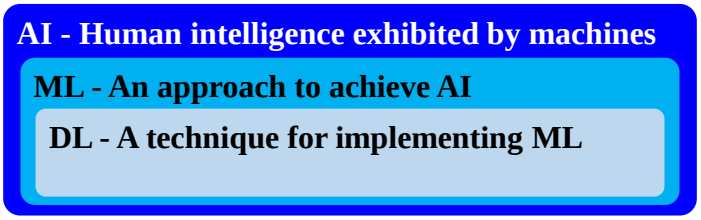

Figure 2.1: Relationship between AI, ML, and DL

2.2 Machine Learning

According to Negnevitsky (2002), machine learning consists of adaptive mechanisms that enable the computer to learn from experiences or data exposed to it. The knowledge is improved by keeping making adjustment and correction on the error signal generated. The most famous machine learning mechanism include artificial neural networks and genetic algorithms. Machine learning is a field of study that focuses on computer systems that can learn from data. These systems are called models. Models can learn to perform a specific task by analysing lots of examples for a particular problem.

There are three modes to conduct machine learning, including supervised learning unsupervised learning and reinforcement learning.

2.2.1 Supervised Learning

A machine learning process whereby the model is to predict the provided output or target variables. In other words, all the target variables are labelled. Classification and regression are examples of the supervised learning problem, which the output variables are either categorical or numeric. Under supervised learning, machine learning can further be divided into classification task and regression task.