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Child Presence Detection and Alerting System in an Unmanned Car

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Abstract: Leaving a child unattended in an unmanned car has become a serious problem in the recent years. 14 per cent of parents say they have left their infants, toddlers or kindergarten-age children alone in a parked vehicle. For parents of children three and under, the percentage increases to 23 per cent. 11 per cent of parents say they have forgotten their child in a car. For those with children age 3 and under, it's nearly 1 in 4. The heat inside the car is not the only problem but also suffocation. The deaths happening from crashes are more than this, but this type of deaths can be avoided by simply reminding the parents about their unattended child in the car. This type of system can even be expanded to notify humans about their unattended pets in a car. The proposed project tries to reduce these types of deaths by alerting the owner using Raspberry PI 4 and a Bluetooth module if the child or the pet is left unattended. In the proposed work we are using voice detection to detect the child's cry using SVM model and Bluetooth condition of the parent's phone is checked to see if the parent is out of range. If Raspberry PI detects that the parent has left behind their child in the car then an alerting message is sent to parent's phone using a library in Python called Twilio.

Keywords: Support Vector Machine (SVM); Twilio; Bluetooth; Raspberry Pi; Python; Feature Extraction

I. INTRODUCTION

Given that people are progressively linked to their personal smart device in these days, it is worth investing in setting up a safety tool that could save a child's life. There are huge numbers of cases associated with the death of children who stay in a vehicle for long periods of time. A non-profit organization called Kids-n-cars announced that around 500 children died in the period 1998-2010 as they were left alone inside a parked car. When a car is switched off and parked, with its windows closed, even on the day of around 21°C, the temperature inside the vehicle rises rapidly. Because the child's thermoregulatory system is not well developed, the condition may result in hyperthermia or a heart stroke that may be fatal. Hence children are more likely than adults to have hyperthermia. Hyperthermia is an extreme condition in which the temperature of a person's body is beyond normal due to inadequate thermo-regulation. 10 per cent of child death is caused by a heart attack due to parents and caretaker negligence, according to US statistics. This is in the US alone, if we look at all the countries, then this kind of death is going to happen even more. Parents or caregivers distract themselves from their hectic lives and do not realize that their child may be challenged by death. They tend to position their child in the back of the car and may cause them to overlook the fact that their child is being carried. Perhaps they should go about their routine and leave their kids protected in shut-down window vehicles.

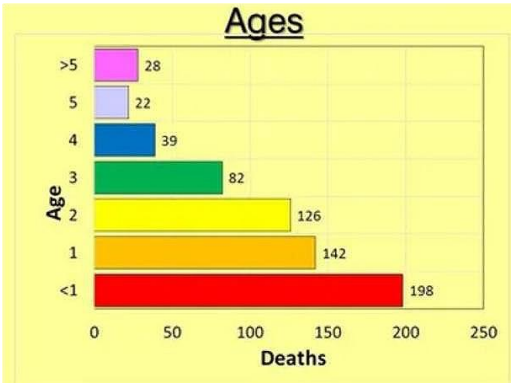

Fig 1. Vehicular heatstroke death of children of different age groups

The graph above displays the number of children who died in cars around the world from 1998 to 2016. This indicates the severity of the problem and the need to develop a system that will protect them. 2010 was the deadliest year in the history recorded, with 49 cases. In hottest southern states, several cases of hyperthermia occur. These type of casualties can be avoided by simply alerting the driver or the caretaker.

A. Machine learning

Machine Learning is a sub-area of Artificial Intelligence. It is the system's ability to find solutions to problems independently by identifying the patterns in databases. In order to allow software to generate solutions independently, people need to take prior action like the necessary algorithms and data must be fed in advance into the systems, and the respective analytical rules for pattern recognition in the data stock must be established. Once these two phases are completed, the Machine Learning system can carry out the following tasks:

- Draw conclusions based on data and findings.
- Estimation of the probability for desired results.
- Independently adapting to certain technologies.
- Unit optimization based on known trends.
- Identification, analysis and conclusion of relevant data.

Machine learning works much the same way as human learning. The system is enabled to "learn" through category of data and certain commands in order to recognize certain objects and differentiate between them.

B. Machine learning methods

- Supervised Machine Learning Algorithm [9]: This is a type of machine learning algorithm which uses labelled instances to find solution to a particular problem. This uses specific rules to learn from old instances or training set, which will then be used to classify or generalize new instances. One of the main examples for this type of ML algorithm is the SVM model.
- Unsupervised Machine Learning Algorithm [10]: When the training information is not either classified or labelled Unsupervised Machine Learning Algorithms are used. Unsupervised learning investigates how a system can conclude a function from data which is not labelled to define a hidden structure. The system does not really make out the correct output but explores the relevant information and can draw conclusions from the datasets to delineate hidden structures from the information that is unlabeled. The main algorithm used in unsupervised machine learning is clustering.
- Semi-supervised Machine Learning Algorithms [10] [12]: This has features of both supervised and unsupervised learning. The data set used to train the machine using semi supervised learning has both labelled as well as unlabeled sets. Most of the times the size of unlabeled data will be more when compared to labelled data. The accuracy got from this algorithm is significantly more when compared to supervised or unsupervised learning. This method is preferred when the data acquired requires experienced tools to train the machine.
- Reinforcement Machine Learning Algorithms [10]: This is a method of learning that interacts with its environment by generating actions and explores inaccuracies or benefits. The most important aspects of reinforcement learning are trial and error seeking, and delayed reward. This approach allows devices and software components to accurately evaluate the optimal behavior well within limited context to enhance its performance. A feedback called Reinforcement Signal is used to make the agent learn.

C. Support Vector Machine (SVM) Model [9][11]

Machine learning includes many models, one among them being Support Vector Machines. SVM carries out supervised learning tasks and interprets data using learning algorithms to analyze regression and classification. An SVM is a formally described discriminative classifier with a specific hyper plane. In other words, provided the labelled training data, the algorithm generates an ideal hyper plane in which new examples are categorized.

An SVM is a representation of the examples as space points, mapped in such a way as to distinguish the examples of different categories by a simple distance that is as wide as possible. Besides performing linear classification, SVMs can perform a nonlinear classification effectively, implicitly mapping their inputs into high-dimensional feature spaces.

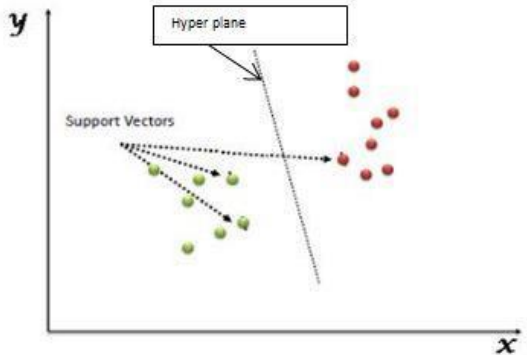

Fig 2. Classification using SVM model

II. LITERATURE SURVEY

A. Khamil, Khairun Nisa, et al [1] the method proposed in this paper consists of two parts, safety pad and keychain alert. Each of this part can be divided into hardware and software. A safety pad is kept under the seat which consists of three main components in the

safety pad which are the load sensor, Arduino UNO and Sheeld. The type of pressure sensor used in this system is TEM01052B. The signal gained by the sensor is processed using Arduino UNO and 1Sheeld acts as an interpreter between the UNO and the smartphone when the baby is placed on the seat, the voltage changes where Arduino will forward the information to 1Sheeld and give notification to the phone indicating that the baby is inside the car, they have used keychain as an backup alerting system when the parent is not carrying a smartphone. The 1Sheeld used in the system acts as a connection between the UNO and the smartphone via Bluetooth.

B. Anchala Baid, et al [2] this paper focuses on developing a child presence detection system. Integrated with ARM 7 Microprocessor, LPC2148 Microcontroller, GSM module, Buzzer and different sensors such as LM35 Temperature sensor, Child presence sensor, and Sound sensor. When the ignition button is turned off, a child presence sensor which is placed under the child's seat detects the presence of the child. This sensor gathers the information and sends it to the microcontroller, using GSM module the message is sent to the parents and driver. LM35 sensor is used to keep the track of temperature, if the temperature exceeds the threshold level a notification is sent to parents saying it's an emergency and the temperature sensing range is between -40° to +110° Celsius. Sound sensor is used to recognize the child's moaning voice as child suffocates inside the car due to insufficient oxygen. LCD is used to display accurate information. GSM modem/module communicates with the microcontroller using serial communication. Modem is interfaced to the microcontroller using MAX232 serial driver. They use C programming and MDK- ARM Keil µVision IDE to interface with the hardware. When there's some connection trouble, the program displays an 'ERROR' message else it displays 'OK' command showing perfect interface between hardware and software. It provides high security to the vehicle. The drawback of this system is that it is a low range circuit and it cannot be implemented in critical conditions.

C. Atul Samant, et al [3] this solution uses a device consisting of a PIC microcontroller which takes three inputs namely Child Presence Detector, Temperature Sensor and Ignition Switch. The child presence detector is used to recognize the presence of a child through crying voice of a child. It can even be used with a Weight sensor. The temperature sensor give output as high if the temperature exceeds the threshold (above 35°). LM35 or LM35C is used for improved accuracy. An inbuilt ADC in the PIC microcontroller converts the readings of the sensor into digital values. The state of the ignition switch also acts as an input. If the ignition switch is OFF then the input of the microcontroller is high. Logical AND is performed on all the three inputs and if all three inputs are HIGH, the warning system sends an alert. The Warning system first generates an alarm using a buzzer. If there is no response for the alarm, the microcontroller will initiate a call by sending a signal to the connected GSM module to the SIM number saved in the SIM of GSM module. To implement this LabVIEW Software and a DAQ devices are used.

D. Siew Wen Chin, et al [4] this paper deals with the development of a speech recognition system using radial basis function neural network (RBF NN) and continuous wavelet transform (CWT) using voice activity detection (VAD) algorithm. Mel frequency cepstral coefficients (MFCC) is used to analyse input speech signal by forming fixed size window for analysis. The RBF NN is used by RBF-CWT algorithm to detect speech/ non speech signal within the windowed signal. When the non-speech or vice versa fusion took place, the CWT energy transition coefficient is calculated to localize the final Start / End speech synchronization Punctures. Rather than classifying the speech signal via the MFCC at the level of the frame that easily catches lots of unnecessary noise against standard VAD with binary Classifier, RBF NN suggested, with the aid of CWT analyses MFCC transformation at the window level offers greater noise-signal protection. The Modelling tests indicate progress in speech accuracy detection and overall ASR levels particularly under noisy conditions compared to the normal VAD with the Zero-crossing distance, short-term energy and binary signal Classifier.

III. EXISTING SYSTEM

The existing system uses the ARM7 Microcontroller for the process part and a GSM modem for sending message. A child detector sensor is placed inside the seat to detect the presence of a child. This system also uses ignition monitor to confirm the presence of the driver in the car, it also uses a temperature sensor to track the current temperature inside a car. The GSM modem alerts the parent or the driver as soon as a child is left in the car which is detected using the child detector sensor placed in the seat and the car is found to be turned off. This might result in false positive when the ignition is off, but the driver is still with the child. To reduce this type of false positive an external factor like Bluetooth has to be considered to check if the driver is still with the child. Another case of not getting the right result is when the child is not placed in the right seat.

IV. PROPOSED SYSTEM

The proposed system detects the presence of the child in the car by classifying the crying noise made by the child in times of discomfort. This detection is done using a machine learning model known as SVM model, which can be used for both classification and regression type of problems. In the proposed system to check if the parent or the driver is in the car, the Bluetooth of the Raspberry Pi is

checked. Bluetooth of parent's phone will be connected to Bluetooth of Raspberry Pi. The Raspberry Pi will be placed inside the car, when the parent is out of range the Bluetooth gets disconnected from Raspberry Pi. This indicates that the parent is not near the car. During this time if the child's cry is detected in the car, it means the child is left alone in the car. If this happens then an alerting message is sent to parent's phone using an online application called Twilio.

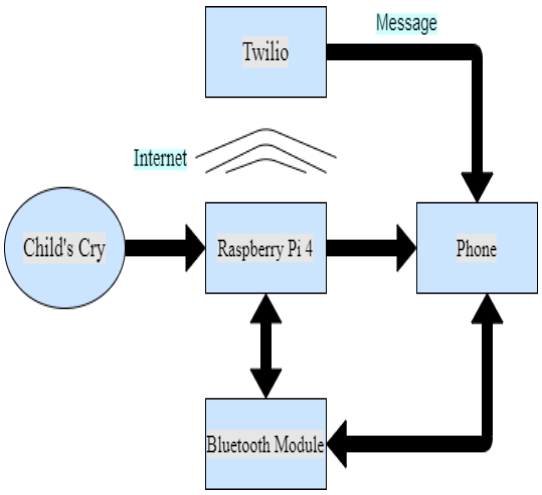

Fig 3. Block Diagram

In the proposed system a Support Vector Machine model is first trained using different features of audio sets. The first step in model training is extracting features from the audio sets using LibROSA module in python. LibROSA is used to carry out computation on audio sets in python. Feature extracted from the audio sets are Zero Crossing Rate, Mel Frequency Cepstral Coefficients (MFCC), Root Mean Square (RMS), Spectral Roll-off, Spectral Centroid, Spectral Bandwidth. These features are extracted into a numpy array which then will be used to train and test the model. The audio to be classified is taken as input to Raspberry Pi that is Child's cry is fed into the Raspberry Pi and exact same features as above mentioned are extracted from this audio and is compared with the trained model to classify if the audio loaded is child's cry or not. If the model predicts that predicts that the audio is a baby cry, then the Bluetooth of Raspberry Pi will be checked to see if it is in connected condition. If the Raspberry Pi's Bluetooth module is still in connected condition then that means the parent is still in range. If this is the case then no message will be sent even if the Child's cry is detected as the parent is still with the child. If the parent is out of range then the Bluetooth module will be in disconnected condition, if the child's cry is detected at this time then an alerting message will be sent to the parent's number since they are out of range and the baby is crying in the car.

V. EXPERIMENTAL RESULTS

The features were successfully extracted to train and test the model and an accuracy of 96.52% was achieved on the test data. The train and test set sizes were 344 and 115 respectively. For this size of test set the accuracy, recall, precision and f1 scores were 96.5217%, 96.8682%, 96.6325% and 96.6991% respectively.

```
2020-05-12 03:01:07 PM - INFO -
Calling TrainClassifier
2020-05-12 03:01:07 PM - INFO -
Splitting train and test set. Test set
size: 0.25%
2020-05-12 03:01:07 PM - INFO - Train
set size: 344. Test set size: 115
2020-05-12 03:01:07 PM - INFO -
Training model...
2020-05-12 03:02:03 PM - INFO - Time
taken: 56.04176833199995
2020-05-12 03:02:03 PM - INFO -
{'accuracy': 0.9652173913043478,
'recall': 0.9686819172113289,
'precision': 0.9663254310344828, 'f1':
0.9669913419913421}
2020-05-12 03:02:03 PM - INFO - Saving
model...

Tab Width: 8    Ln 6, Col 65    INS
```

Fig 4. Model Creation

Fig. 4 represents the creation of model using the features extracted from the audio sets to train and test the model for its accuracy, recall, precision and f1 score.

```
2020-05-12 03:09:01 PM - INFO -
Reading silence.wav_35.wav
2020-05-12 03:09:01 PM - INFO - Time
taken for reading file:
0.004172270000026401
2020-05-12 03:09:01 PM - INFO -
Starting feature engineering
2020-05-12 03:09:02 PM - INFO - Time
taken for feature engineering:
0.534762240000191
2020-05-12 03:09:02 PM - INFO -
Predicting...
2020-05-12 03:09:02 PM - INFO - Time
taken for prediction:
0.003080335000049672. Is it a baby
cry?? 0
2020-05-12 03:09:02 PM - INFO - Saving
prediction...
2020-05-12 03:09:02 PM - INFO -
Saved! /home/srinidhi/Desktop/output/
prediction/prediction.txt

Tab Width: 8    Ln 8, Col 88    INS
```

Fig 5. Negative result (not a child's cry)

Fig. 5 represents that the audio loaded is not a baby cry (child cry). This is predicted by the using the previously trained model.

Fig 6. Positive result (child's cry)

Fig. 6 represents that the audio loaded is a child's cry, after finding that the audio is a child's cry Bluetooth is checked to see if it in the connected condition.

When the child's cry was detected and Bluetooth was disconnected from Raspberry Pi, an alerting message was sent 100% of the times as shown in Fig. 7.

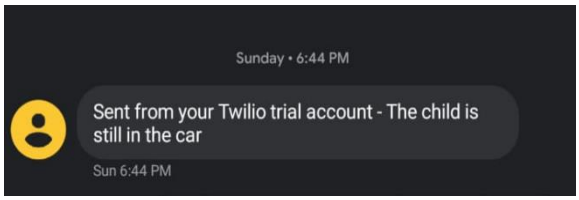

Fig 7. Message received on parent's phone

The message in the above figure is received by the parent when the child's cry is detected in the car by Raspberry Pi and the Bluetooth of Raspberry Pi is disconnected from parent's phone. The Bluetooth condition indicates that the parent is out of range and the child is left behind in the car.

VI. CONCLUSION

Child left behind in the car was successfully detected by the SVM model and the Bluetooth's unique address was checked to see if the parent is out of range, if the parent was out of range and the child's cry was detected an alerting message was successfully sent to parent's phone using Twilio. Since this uses machine learning technique, it is more accurate and is more reliable.

VII. FUTURE SCOPE

The European New Car Assessment Programme (Euro NCAP) has mandated the Child Detection and Alerting System in cars, the proposed system can be used to implement the mandate. The proposed project can be further more extended to detect the sounds made by animals to detect the pets left behind in the car.

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