

# GPU based Deep Learning to Detect Asphyxia in Neonates

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## Abstract

Throughout the years, some countries have not seen any reduction in the death rate of neonates. Neonate refers to a baby within its first four weeks of life. Birth asphyxia is one of the three noteworthy reasons for neonatal deaths globally. A birth injury is demonstrative of some kind of mistake that changed an ordinary delivery into a traumatic ordeal for the newborn child (and mother). Perinatal asphyxia, or neonatal asphyxia, is a birth injury where a child doesn't inhale regularly before, during or after birth. Asphyxia is a condition that depicts a diminished or ceased level of oxygen, and the perinatal stage is the period before, during or immediately after birth. At the point when an infant has not been breathing appropriately, there is danger of cerebrum harm and acidosis (a condition when a lot of acid builds up in the blood) which may result in the death of the newborn child if undiscovered or analyzed late. Our project uses machine learning in building up a minimal effort symptomatic arrangement. This paper has composed a machine-based example framework that identifies designs in the voices of known suffocating babies (and typical newborn children) while crying. It then utilizes the created model to predict if the newborn is affected by asphyxia or not. An accuracy of 92% was achieved. It will serve as a valuable apparatus in diminishing death rate everywhere throughout the world if accuracy can be improved.

**Keywords:** Asphyxia, Cry, DIGITS, Machine Learning, Neural Network, Newborn

## 1. Introduction

Throughout the years, the death rate of neonates has reduced in a few nations but has stayed stagnant in countries like Africa and South East Asia. As indicated by the fourth Millennium Development Goal (MDG 4), it has been observed that about 41% of deaths of children under the age of five are among newly conceived children i.e. babies in their first 28 days of life (neonatal period)<sup>3</sup>. Birth asphyxia is one of the three noteworthy reasons for neonatal deaths globally amounting to around 23% of the aggregate deaths; the other two causes being diseases (36%) and pre-term (28%).

Asphyxia remains a dangerous infection threatening the mortality rate of newborns despite vital advances in medicine and related technology over the years. Asphyxia translates to "stopping of the pulse" in Greek. It is a birth

injury caused due to deficiency of respiratory gasses like carbon dioxide and oxygen which brings about hypoxemia and hypercapnia, joined by metabolic acidosis<sup>1</sup>. At the point when an infant has not been breathing normally, there is danger of cerebrum harm and acidosis (a condition when a lot of acid builds up in the blood) which may result in the death of the newborn child if undiscovered or analyzed late. Internationally, the death rate in less than five year old children reduced to 6.6 million in 2012 from 12.4 million in 1990<sup>2</sup>, demonstrating noteworthy advance at accomplishing the fourth Millennium Development Goal (MDG). Be that as it may, of late concern is the rising extent of newborn child deaths less than one month old (termed as neonates), which at present is a record of 4 million every year. The number of deaths of newborn children in developing nations suffering from this condition is quite large.

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Asphyxia implies absence of oxygen. Birth asphyxia happens when a child's cerebrum and different organs don't get enough oxygen before, during or directly after birth. This can happen unknowingly. Without oxygen, cells can't work as they usually do. Waste products (acids) develop in the cells and cause transitory or perpetual harm. There are various causes for this birth injury to occur. In some cases it's identified with a prolapsed umbilical cord (when the cord comes out before the child does), or it's identified with the umbilical cord being squeezed by one means or another. Now and again a child stops breathing due to Meconium Aspiration Syndrome, a circumstance in which the infant is pushed, defecates meconium, and inhales it in either before, during or soon after vaginal birth. In cases of premature delivery (before 37 weeks), the infant's lungs are immature bringing about the powerlessness to inhale by itself. The cause is typically identified as special conditions, and the perinatal asphyxia portrays the low level of oxygen the neonate is getting as an after-effect.

At its initial stages, medical determination which also includes blood tests is the only definitive method which can prove the presence of asphyxia. Physical examination and outwardly decisions cannot definitively determine this condition in newborns. Presence of skilled personnel in poor regions of society during childbirth is an extravagance. Due to lack of facilities, babies which are affected in these areas get identified as asphyxiated only when they develop irreversible, harmful effects or more terrible still, after the death of the affected newborn child. Our target in this venture was to not only devise an effective arrangement to predict the condition but also provide an economic method to do so, so that it can be used by all sections of the society. The proposed model composes a machine-based example framework that identifies designs in the voices of known suffocating babies (and typical newborn children) while crying. It then utilizes the created model to predict if the newborn is affected by asphyxia or is normal.

Among the works of utmost significance at addressing this issue are those of author in<sup>4</sup>. Using Neural Networks, they accentuated the significance of asphyxiated conditions in newborns and proceeded to build a framework to predict the same. "Crying in children is an essential correspondence work, which the mind represents straightforwardly. Various differences in the child's body are conveyed to the outside world through the child's cry" is what they concentrated on<sup>4</sup>. They used a database

(the Baby Chillanto Database) to build the framework, in which they gathered cry tests of ordinary, hard of hearing and suffocating children and made an example display by connecting programmed discourse acknowledgment methods. Their tests yielded up to 86% of grouping exactness.

Support Vector Machines (SVMs) are known for their scaling in issues related to speech recognition as well as for giving a decent out-of-test performance. With the expertise provided by<sup>4</sup> on this concept, Charles C Onu attempted to utilize SVMs for performance examination and to attain higher chances of correct predictions<sup>5</sup>. He made use of the Baby Chillanto Database which was obtained from the National Institute of Astrophysics and Optical Electronics, CONACYT, Mexico to build the framework. The database had 340 asphyxiated and 507 normal cry tests contained in it which was important for their examination (the cries were isolated by Reyes-Galaviz, Reyes-Garcia and Charles Onu in the proportion of 60:20:20 and used for preparing, checking against other results and checking if reasonable exactness is achieved, respectively).

A few flag handling stages were experienced when MATLAB was used for examination for every test sample. Highlights were split as coefficients of Mel Frequency Cepstrum (MFC) and were parameters utilized in the stage of learning. The Radial Basis Function Kernel (RBF) and the Polynomial Kernel are two unique sorts of Support Vector Machine Kernels which were utilized to perform investigations during learning along with LIBSVM<sup>6</sup>. Utilization of the Polynomial Kernel provided 88.85% exactness (by accurate characterization of 247 test samples, given a total of 278).

This project is based on the procedure used and results obtained by Reyes-Garcia, Reyes-Galaviz as well as Charles C Onu. The DIGITS software was used for constructing and training the neural network. Designing the best Deep Neural Network (DNN) for classifying images and detecting objects using real-time network behaviour visualization is done by the NVIDIA Deep Learning GPU Training System (DIGITS). The database used was the Baby Chillanto Database procured from the National Institute of Astrophysics and Optical Electronics, CONACYT, Mexico. The database had 340 asphyxiated and 1049 normal cry tests contained in it (isolated by Reyes-Galaviz, Reyes-Garcia and Charles Onu in the proportion of 60:20:20 and used for preparing, checking against other results and checking if reasonable exactness

is achieved, respectively). The software was configured based on the instructions provided on the author's website. The dataset was specified and the samples were partitioned as 75% for training and 25% for validation. An accuracy of 92% was obtained by using this process<sup>8</sup>.

## 2. Methodology

### 2.1 Create Database

Two datasets must be created, one for training and the other for validation. DIGITS allow creating the datasets, training and testing the model in various ways. It runs as a web application, which allows creation and deletion of datasets and is built using the Flask Python web framework<sup>7</sup>.

### 2.2 Partition Database

Partitioning of the data into the training and validation datasets is dependent on the user. AlexNet was used to train the model. DIGITS also supports other standard networks like LeNet-5 and GoogLeNet. None of these networks can solve particular issues in the most effective and optimum manner but they provide a decent beginning stage to create a custom network. Visualization tools are used to view the network graph. Various options are preloaded in DIGITS for transforming the data and achieving desired output optimistically like batch size, mean subtraction, etc<sup>7</sup>.

### 2.3 Train Neural Network

Training can be prematurely ended and restarted whenever the user desires. The validation metrics of exactness and loss can be seen graphically through upgraded real time JavaScript charts. An image or list of images can be provided to test the model at intermediate stages during training<sup>7</sup>.

### 2.4 Compare Results

The output obtained shows how likely it is that the sampled audio is representative of asphyxia or not. A visual representation of the various network layers is also shown. These results can be used while debugging. In the wake of preparing, the fundamental documents needed to deploy the model somewhere else can be downloaded as a file<sup>7</sup>.

## 3. Observation and Results

A batch size of 10 images was set.

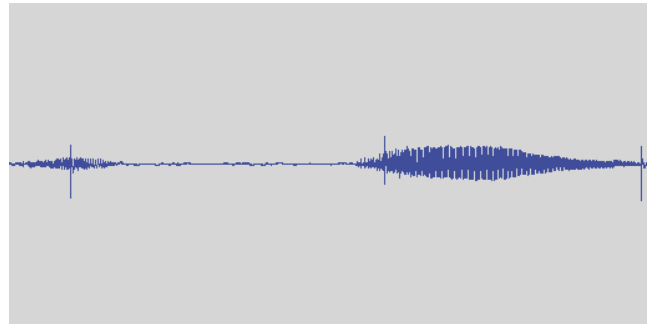


Figure 1. Asphyxiated sample.

An asphyxiated sample is shown in Figure 1. It can be observed that there are variations in the waveform and it is not consistent.



Figure 2. Normal sample.

In comparison to the waveform observed in Figure 1, waveform in Figure 2 is more consistent and illustrates a normal sample.

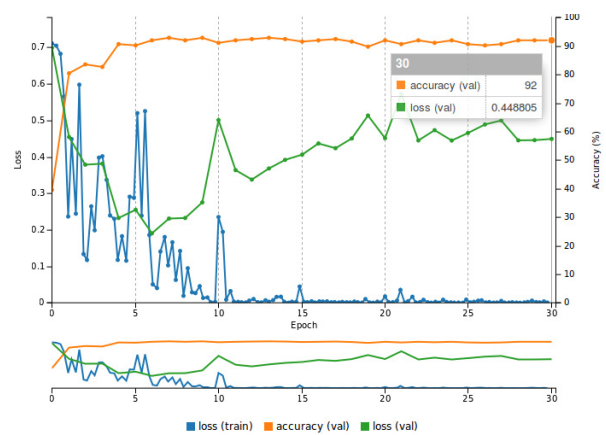


Figure 3. Accuracy of prediction.

It can be observed from Figure 3 that an accuracy of 92% has been obtained. Two losses (validation loss and training loss) have also been plotted. The error obtained after running validation dataset through the trained network is called validation loss. Error on the training dataset is called training loss.

From the graph, it can be seen that both losses drop as training progresses till a certain point. Over fitting is seen which basically means that the training error continues to drop because the network learns the data better but validation error begins to rise.

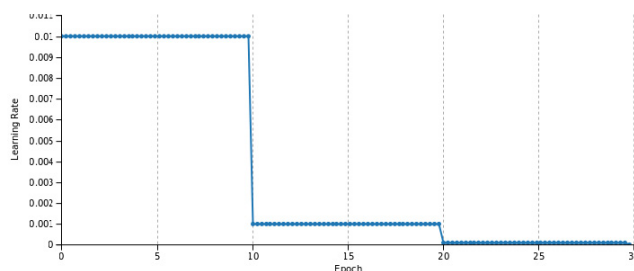


Figure 4. Learning rate.

From the Figure 4, it can be seen that till the 10<sup>th</sup> epoch, learning rate was 0.01 after which it was dropped by a factor of 10 as there was not much data to be processed after that. The learning rate is further dropped 10 fold after the 20th epoch as the network is being fine-tuned here.

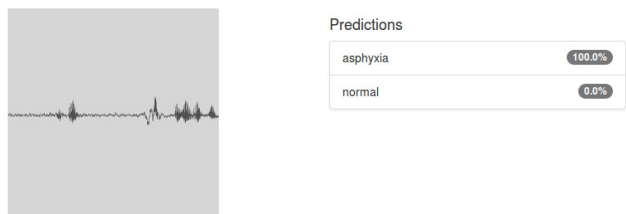


Figure 5. Providing input data manually for classification based on training.

Input data was given manually to see how well the model classifies it. A good success rate was obtained for the given inputs as seen from Figure 5.

## 4. Future Work

In future, the intention is to implement the system alongside professionals and work to further improve the system to the point where, asphyxia can be detected immediately using minimal equipment. Also, in order to work on real-time audio samples, normalisation must be done on the

fly to convert the audio into a form recognisable by the system.

## 5. Conclusion

The proposed method of using the DIGITS deep learning software to identify baby cries and guess the health condition of the baby depending on its cries generates correct results 92% of the time. Using these results doctors can effectively reduce the number of deaths by detecting asphyxia immediately after birth and taking the necessary preventive measures to save the baby and keep it healthy. This is a non-invasive method that does not require heavy investment, so developing societies can use it to their advantage.

## 6. Acknowledgement

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