RETINAL LESION DETECTION AND SEGMENTATION IN FUNDUS IMAGESUSING MACHINE LEARNING

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***Abstract** - Preterm newborns are prone to late-onset sepsis, leading to a high risk of mortality. Video-based analysis of motion is a promising non-invasive approach because the behavior of the newborn is related to his physiological state. But it is needed to analyze only images where the newborn is solely present in incubator. In this context, we propose a method for video-based detection of newborn presence. We use deep transfer learning: bottleneck features are extracted from a pre- trained deep neural network and then a classifier is trained with these features on our database. Moreover, we propose a strategy that allows to take advantage of temporal consistency. On a database of 11 newborns with 56 days of video recordings, the results show a balanced accuracy of 80%.*

Key Words: deep transfer learning,pretained deep neutral learning, embedded, Arduino software .

1. INTRODUCTION

During the first weeks of their life, preterm newborns, *i.e.* newborns born before a gestational age of 37 weeks, are hospitalized in neonatology service and require a particular attention. Indeed, prematurity implies a high risk of mortality, mostly due to late-onset sepsis and respiratory failure. The diagnosis of late-onset sepsis is currently relying on the observation of vital physiological signals and blood culture, which might be a slow process. So, the development of a monitoring system which could automatically give information to the healthcare workers is of great interest. This is an active field of research at the interface between medicine and computer science. The existing works on automatic sepsis detection are based on the analysis of physiological signals. Video- based motion analysis has already been used in several clinical contexts involving newborns. But to the best of our knowledge, there is no work on video-based automatic sepsis detection.

This approach would have the advantage to be fully non-invasive and contact-less, which limits the sepsis risk and enable long-term monitoring. However, video- based automatic estimation of newborn motion faces several challenges related to real-life acqui- sition conditions encountered when considering recordings of several days or weeks. During the stay of the preterm newborn in the neonatalogy unit, it happens many times that nurses handle the newborn inside the incubator.

During these periods, adults are present in the framing, which leads to irrelevant motion with regards to our final aim. Moreover, the newborn is regularly taken out of the incubator in order to change the bedding or to have a skin-to-skin contact with the parents, which leads to irrelevant absence of motion. These periods when adults are present or when the preterm newborn is absent must not be included in the motion analysis. In the context of long-term monitoring, it is of primary importance to be able to automatically detect the periods of interest.

This work is part of the Digi-NewB project, whose aim is to develop a monitoring system of preterm newborns, with a focus on late-onset sepsis detection. In this paper, we propose a video-based method to detect automatically the periods when the newborn is solely present in the incubator. We use transfer learning from a deep neural network in order to label images with three classes: “adult present”, “newborn absent” and “newborn present”. Bottleneck features are extracted from a pre-trained deep neural network and are used to train a classifier.

Then we propose a strategy of decision intervals fusion in order to take advantage of temporal consistency. So, the objective of this paper is to find the most appropriate neural network for transfer learning and decision intervals fusion.

The remaining of this paper is organized as follows. First, we introduce the related work. Second, we describe our method for automatic detection of preterm newborn. Then we report the results of our experiments. Lastly we conclude the paper.

1.1 EXISTING SYSTEM

In existing system, premature baby health monitoring is done manually. Full time monitoring is not done. More chance of loss of life. Newborns born before a gestational age of 37 weeks, are hospitalized in neonatology service and require a particular attention. Indeed, prematurity implies a high risk of mortality, mostly due to late-onset sepsis and respiratory failure. The diagnosis of late-onset sepsis is currently relying on the observation of vital physiological signals and blood culture, which might be a slow process. The existing works on automatic sepsis detection are based on the analysis of physiological signals [2]. Video-based motion analysis has already been used in several clinical contexts involving newborns [3]. But to the best of our knowledge, there is no work on video-based automatic sepsis detection. This approach would have the advantage to be fully non-invasive and contact-less, which limits the sepsis risk and enable long-term monitoring.

1.2 PROPOSED SYSTEM

In the context of newborn motion estimation, video-based detection of adults has been proposed in . It relies on the fact that adult's motion comes from the outside of the image. The arrival and the departure of the adult are estimated by analyzing the change of motion in the image edge.

A similar method has been proposed in for infant presence detection in the context of sleep assessment. A region of interest (ROI) is set around the infant and motion is estimated both inside and outside the ROI. A set of temporal rules based on both motion estimates are designed in order to decide whether the infant is in or out of the bed.

These two methods have been tested for newborns or infants in a cradle. In our application context, newborns are in incubator. In real-life acquisition, the newborn may create motion in the image edge, leading to false detection when using the above methods. Moreover, experience shows that it can happen very often if the camera is not perfectly placed in the incubator. So this kind of method is not viable for a long- term monitoring ofnewborns in incubator.

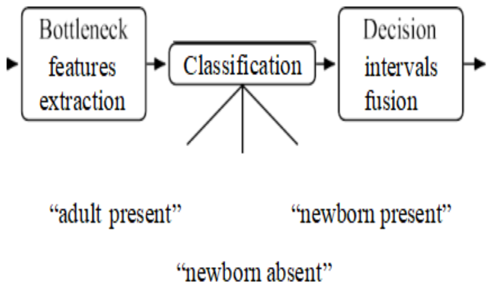


Fig. 1. Overview of the video-based detection of newborn presence

When the database has a lot of variety but the number of images is not large enough to train a neural network from scratch, a possible way is to perform deep transfer learning. This allows to benefit from the ability to generalize of a deep neural network without having to train a network from scratch.

Transfer learning methods aim at transferring the knowledge from a source domain to a target domain. In the case of deep learning, a neural network is pre-trained in the source domain. Then, the output layer performing classification is replaced by another classifier that is trained in the target domain.

2. SCOPE OF THE PROJECT

Full time monitoring is done automatically.

Less chance of loss of life.

In this Proposed system Arduino microcontroller is used as heart of the system, we use the heartbeat sensor to monitor the heart beat or pulse rate of the baby, Temperature Sensor is used to monitor the temperature inside the incubator and outside the incubator (surrounding temperature), Gas sensor is used to detect the any harmful gas that may damage the baby health. It automatically maintains the incubator temperature using light. Any Abnormal Condition and any values that are being monitored went beyond threshold, automatically alarm will be issued using buzzer, sending Message through GSM to Parents, and doctors. All the information is sent to IOT webpage.

3. LITERATURE SURVEY

3.1. Design and test of an incubator analyzer", gamze tilbe şen, mehmet yüksekkaya, 2018, IEEE.

In this paper, Incubators are cabins that provide the environment with necessary conditions for premature or newborn babies, and they are designed to allow monitoring and care of the baby. The incubator analyzer is the analyzer that shows the performance of the incubator. Knowing how close the values of a medical device are to the actual values is very important in the treatment process. To ensure the accuracy of medical devices, tests and controls are required. As a result of periodic tests and controls, it is possible to reduce the risks by preventing incorrect measurements. If the temperature, humidity and oxygen sensors of the incubators are measured incorrectly, the baby's life would be threatened. This study aims to determine the design requirements of a single incubator analyzer that measures heat, oxygen and humidity in the incubator and to design an analyzer. The general design of the incubator analyzer consists of a battery circuit, a microcontroller, a liquid crystal display (LCD) screen, five temperature sensors, a humidity sensor and an oxygen sensor. Incubator standards of our country and EU has been reviewed according to the design. In addition, within the scope of the project, the sensors in accordance with the standards have been researched and determined, but due to their high its cost, alternative sensors are preferred. By that the design of the analyzer can be a model for the actual device. Proper firmware is programmed for temperature, oxygen and humidity sensors, and data from those sensors are processed and displayed on an LCD screen. Also, a suitable case is designed by computer aided programs. The analyzer is tested in incubators and functioned properly. With this project, it is determined that a cost effective incubator analyzer can be designed and with more sensitive sensors proper standards can be achieved. This project can be a model for incubator analyzer design.

3.2"intelligent baby incubator", megha koli, purvi ladge, bhavpriya prasad, ronak boria, prof. Nazahat j. Balur, 2018, IEEE.

In today's world where temperature is an important part of our environment. Any variations in the temperature can affect all the living organism and also some semiconductor materials. Our project is to provide a control on the changes in temperature for certain applications such as baby incubator. Worldwide incubator is used for the infants to improve the survival of babies by providing them warm environment and reducing the heat loss from the baby's body. Basically, incubator is the standard method used worldwide. In this we are using Arduino, temperature sensor for monitoring or controlling the temperature of the baby's body. The constant temperature of 36.5- 37.2° C is required by the baby as it is required by the baby as in mother's womb.

3.3 "Multisensors system for real time detection of length, weight, and heartbeat of premature baby in the incubator", sri purwiyanti, sri ratna sulistiyanti, fx. Arinto setyawan, 2018, IEEE.

Premature babies inserted into the incubator will always be monitored progressively, especially the heart rate, body length, and body weight. The aims of this research are to design and to create an incubator that can detect the abnormalities of baby's heartbeat through the baby's fingers in continuous and real time by using pulse sensor.

The incubator also able to measured baby's length and weight automatically by using ultrasonic sensor and load-cell sensor, respectively. output of all sensors will be processed and calibrated by Arduino Microcontroller,then the results will be displayed on the liquid crystal display (LCD). The systems also able to allow some notifications if any abnormalities have been occur. As a result, the heartbeat detector has a precision of ± 95% when compared to a reference heartbeat detector. The system also can measure the length and weight of the infant with the measurement results are closer to the reference instrument, which the average error is not more than 5%. The results are most likely is a good preliminary result in order to build a smart incubator.

3.4."Temperature monitored IOT based smart incubator", ashish.B, IEEE, 2017.

Baby neonatal Incubator is a closed apparatus for providing a controlled environment in all the possible ways for the immense care of premature babies. Majority of premature babies are born between 32 to 37 weeks of gestation period and die due to lack of simple essential care such as warmth. Until recently, most of the developing countries turned a blind eye to premature babies leading to their demise. This research work provides a cost-worthy design of an embedded device for real time monitoring of newborn babies in the incubator. It permits early detection of potential life-threatening events and maintains a safe environment for the infant. Many of the existing medical technological companies (such as small and medium) may not adopt the best existing technologies as its maintenance might not be cost effective. On the other hand, the bigger medical firms which have adopted them are cost effective and common man cannot afford the same. So, the main objective of this research is to overcome the drawbacks and provide eco-friendly service to all the common people.

3.5."Advanced portable preterm baby incubator", m. Shaib, m. Rashid, l. Hamawy, m. Arnout, 2017, IEEE.

Nearly 20 million premature and Low Birth Weight infants are born each year in developing countries, 4 million die within their first month. These deaths occur due to the unavailability or unreliability of traditional incubators. Moreover, although Telemedicine is helpful in rural areas, the shortage of healthcare providers have made it inaccessible in both basic healthcare. Thereby, traditional preterm baby and low-birth weight incubators and therapeutic techniques lack Telemedicine communication and feedback. The aim of our project is to develop an advanced portable and wireless-base incubator. We tend to provide an affordable, feasible, patient friendly and reliable premature baby incubator especially in low-income countries.

The project focuses on the premature babies in the third trimester of pregnancy. The design is based on Wi-Fi and infrared technologies that measure the essential parameters that must be controlled for preemies. These parameters include the heart rate, oxygen level in the blood and temperature. Results showed the advanced design building blocks. The response of the generated power-voltage proves that the power can be regulated by the voltage. The thermal isolation can decrease the thermal lose and increase the time needed to drop temperature 6 times. In the room temperature of premature infant, 20 C and 45 C, the resistance decreases from 12.69 kilo Ohms to 4.82 kilo Ohms. The voltage and the temperature were inversely proportional. The heaters were efficient when tested on water. One of the major advantages of the device is that it surpasses existing techniques. As a future prospect more electronic components needs to be tested and features needs to be extracted. In the sense that it selects the threshold value dynamically irrespective of the large variations in retinal fundus images from varying databases.

4. BLOCK DIAGRAM

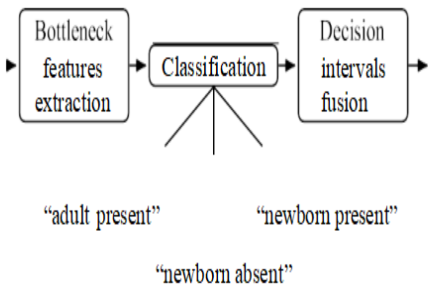


Fig. 1. Overview of the video-based detection of newborn presence

Overview

The problem that we consider is a classification of images in a video stream within thefollowing classes:

1 ("adult present"): both newborn and adult are present,

2 ("newborn absent"): newborn is absent, regardless of adult's presence,

3 ("newborn present"): newborn is present and adult is absent.

First we extract bottleneck features for the images in the video. Then, we perform a classification of the images into the three classes, which gives a sequence of decisions. Finally, we adopt a strategy of decision intervals fusion in order to remove short peaks of detection that we assume to be irrelevant.

Bottleneck features extraction

Bottleneck features are extracted from a deep neural net- work that has already been trained for a specific classification problem. The training dataset has usually a huge number of samples, which leads to a model with a good ability to generalize.

Fig. 2 illustrates bottleneck features extraction. First, the image must be pre-processed according to the input layer of the pre-trained network. Then the pre-processed imagepasses through the network but stops before the output layer, which is usually a fully-connected layer performing the classification. Thus, we obtain the most high-level features of the pretrained network and they are ready to be used for another classification problem.

Input	Hidden	Hidden	Output
Layer	Layer 1	Layer N	Layer

Fig. 2. Illustration of bottleneck features extraction

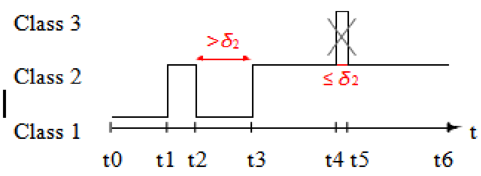


Fig. 3. Illustration of decision intervals fusion for class 2

Classification

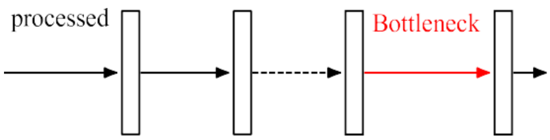
We consider two classifiers in our experiments: a support vector machine (SVM) and a small neural network.

The small neural network consists of one fully-connected layer with rectified linear unit (RELU) as activationfunction, followed by another fully-connected layer with softmax as activation function. The second layer performs the classifi- cation. Droupout regularization is applied before this layer in order to prevent overfitting.

Decision intervals fusion

The classifier gives a sequence of decisions for a video. Let *i* be a class. We call "interval of class *i*" a sub-sequence where all the decisions are equal to class *i*. If the duration of the temporal interval that separates two successive intervals of class *i* is less than a threshold δ_i, then the latter are fused by changing the decisions of the separating interval to class

i. This process is done sequentially with a different threshold for each class.



5. RESULT

In this section we report the results of our experiments. First, we focus on the selection of the pre-trained network and of the classifier with performances evaluated on still images. Then we report the results for the whole process on videos. Experiments are conducted with scikit-learn and keras with tensorflow backend.

This study has received ethics approval from the Ouest IV Ethics Committee (reference number 34/16) and one of the parents of each newborn gave its signed agreement to take partto the study. The databases were acquired in the context of the Digi-NewB project. Data were collected in six different hospitals in neonatalogy services and there were no constraints during acquisition apart from camera placement. As a consequence there is a wide variety of background and lightning. In order to acquire images of good quality while being the least disturbing for the healthcare workers, the camera is placed inside the incubator at the foot of the newborn, so the image view is narrow.

Fig. 4. Example images of the class “adult present

Fig.5.Example images of the class “newborn absent”

VI: CONCLUSION

In this paper, we introduced our method of video-based detection of newborn presence in incubator. The goal was to classify images in a video into the classes “adult present”, “newborn absent” and “newborn present”. It relies on deep transfer learning by using bottleneck features of a pre-trained deep neural network. We proposed a decision intervals fusion on the classifier output in order to take advantage of temporal consistency. This allows to increase the balanced accuracy and improves the generalization on the test set. The results are satisfying as we get a balanced accuracy of more than 80% on videos. Further work could include the fusion of two binary classifiers, each one specializing in either newborn detection or adult detection, or the use of classifiers and networks taking into account temporal information. It is worth noting that the proposed method is a fundamental step for automatic late- onset sepsis detection based on motion analysis, but also for the evaluation of preterm newborn maturation. These two main objectives will also be part ofour future works.

REFERENCES

1) Long, E. van der Sanden, Y. Prevoo, L. ten Hoor, S. den Boer,J. Gelissen, R. Otte, and E. Zwartkruis-Pelgrim, “An efficient heuristic method for infant in/out of bed detection using video-derived motion estimates,” Biomedical Physics & Engineering Express, vol. 4, no. 3, p. 035035, 2018. E. Rezende, G. Ruppert, T. Carvalho, A. Theophilo, Ramos, And P. de Geus, “Malicious software classifica Tion using VGG16 deep neural network’s bottleneck features,” in Information Technology-New Generations. Springer, 2018, pp. 51–59.

2) K. D. Fairchild, “Predictive monitoring for early detection of sepsis in neonatal ICU patients,” Current Opinion in Pediat rics,vol. 25, no. 2, pp. 172–179, 2013.

3) Stanculescu, C. K. Williams, and Y. Freer, “Autoregressive hidden markov models for the early detection of neonatal sepsis,” IEEE Journal of Biomedical and Health Informatics, vol. 18, no. 5, pp. 1560–1570, 2013.

4) S. Cabon, F. Por e´e, A. Simon, O. Rosec, P. Pladys, and G. Carrault, “Video and audio processing in paediatrics: a review,” Physiological Measurement, vol. 40, no. 2,p. 02TR02, 2019.