BA/MA Thesis: Deep Learning for Fetal Diaphragmatic Hernias Detection in US Images

Team:
Florian Recker, Shadi Albarqouni
Zentrum für Geburtshilfe und Frauenheilkunde, Klinik für Geburtshilfe und Pränatale Medizin
Albarqouni Lab., Klinik für Diagnostische und Interventionelle Radiologie

Abstract. Fetuses with diaphragmatic hernias face severe health and survival risks. Treatment and outcomes can be improved if this condition is detected early. Ultrasound measurement of the lung-to-head ratio (o/e LHR) is widely used in obstetric ultrasound procedures for the assessment of the observed to expected lung-to-head ratio. However, There is some difficulty when it comes to detecting diaphragmatic hernias with ultrasound imaging because of the overlap of tissues, the limited visibility, and the subjective interpretation of radiologists. This project aims to develop a deep learning-based model to detect fetal diaphragmatic hernias in ultrasound images. The model will be trained on a relatively large dataset of abdominal and head fetal ultrasound images with and without diaphragmatic hernias to identify diaphragmatic hernias' patterns and features.

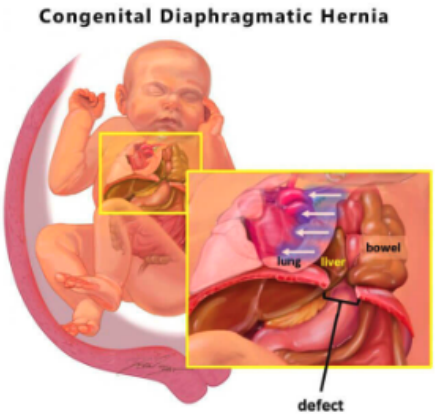

Image Source: [1]

Roadmap for the Praktikum and bachelor thesis:

1. Data collection (Nov): A relatively large dataset of 500 fetal ultrasound images, including those with (~200) and without (~300) diaphragmatic hernias, will be collected from our in-house database. This requires going through a list of patients and doing the following steps:
    a. Collect the right image view, e.g., head, lung, femur …etc. (Every single patient has multiple scans and views, and you are supposed to screen the images and store the right view)
    b. Annotate the measurements, e.g. head circumstance, lung size, and femur length, among others, and report them in an Excel sheet.

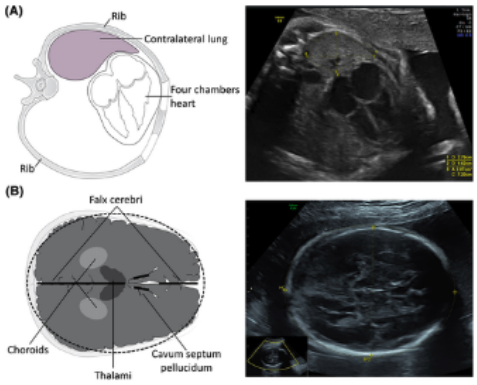

Image source: [3]

2. Data pre-processing (Dec. – Jan.): The collected images will be pre-processed to enhance the visibility of diaphragmatic hernias and reduce the impact of overlapping tissues. This involves running a few basic image processing algorithms, e.g., image filtering and inpainting methods.

3. Model development: (Feb.-Mar.) A deep learning-based model will be developed using convolutional neural networks (CNNs) to train the segmentation model and will be evaluated using various metrics, such as accuracy, sensitivity, and specificity.
4. Writing up the Bachelor thesis (Apr).

Expected Outcomes. The expected outcome of this project is a deep learning-based model that can accurately detect fetal diaphragmatic hernias in ultrasound imaging. The model will be validated using a large and diverse dataset of fetal ultrasound images and evaluated for its performance. The developed model has the potential to improve the accuracy and reliability of fetal diaphragmatic hernia detection, enabling prompt treatment and improved outcomes for affected fetuses.

Requirements:

- Background in Image Processing
- Sufficient knowledge of Python programming language and libraries (Scikit-learn)
- Sufficient knowledge of deep learning frameworks such as PyTorch.

References:

1. https://www.hopkinsmedicine.org/gynecology_obstetrics/specialty_areas/fetal_therapy/conditions-we-treat/congenital_diaphragmatic_hernia.html
2. Amodeo, Ilaria, et al. "A maChine and deep Learning Approach to predict pulmoNary hyperteNsIon in newbornS with congenital diaphragmatic Hernia (CLANNISH): Protocol for a retrospective study." *Plos one* 16.11 (2021): e0259724.
3. Russo, Francesca Maria, et al. "Proposal for standardized prenatal ultrasound assessment of the fetus with congenital diaphragmatic hernia by the European reference network on rare inherited and congenital anomalies (ERNICA)." *Prenatal diagnosis* 38.9 (2018): 629-637.