University of Peradeniya

The Application of Non-Invasive Accelerometric Based Systems for Fetal Movement Monitoring

Post Graduate students
Praditha M. Alwis (DEE Peradeniya)
Isuru P. Thilakasiri (DEE Peradeniya)
S. N. Liyanage (CE Peradeniya)
Rahal T. Nanayakkara (CalTech, US)

Former Students
Upekha Delay (Cornell. US)
Thoshara Nawarathne (Calgary, Canada)
Sajan Dissanayake (Dialog Axiata, SL)
Samitha Gunarathne (Oulu, Finland)
Thanushi Withanage (Maryland, US)

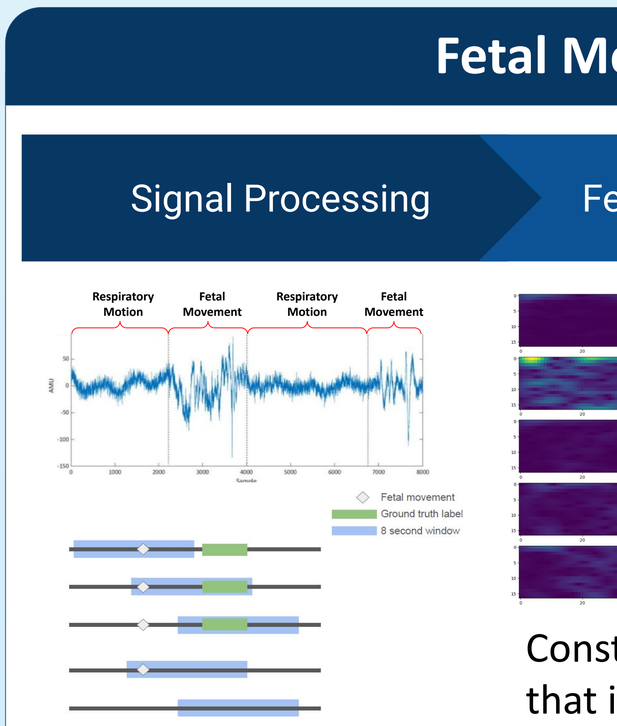
Staff Members
R. I. Godaliyadda (DEE Peradeniya)
B. P. Ekanayake (DEE Peradeniya)
Chathura Rathnayake (Dep. of Obstetrics and Gynaecology)
Janaka Wijayakulasooriya ((DEE Peradeniya)

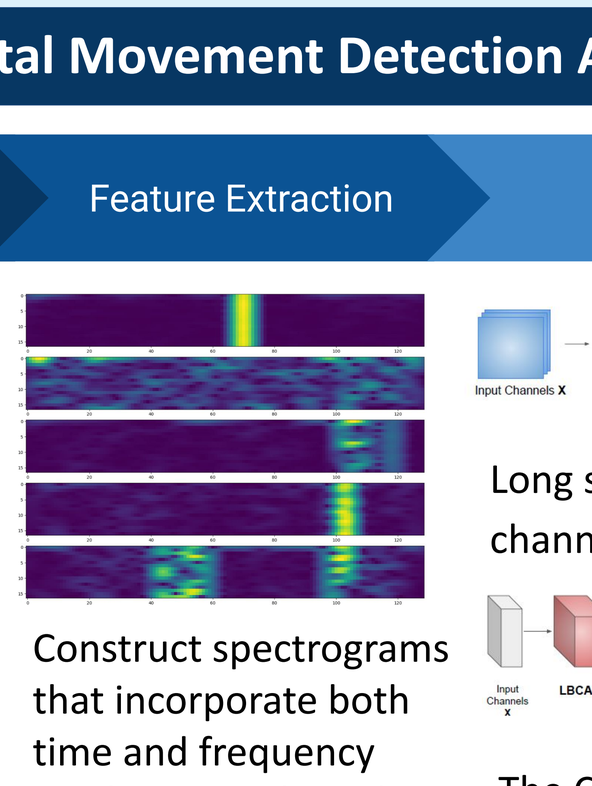
Motivation: In Sri Lanka, the World Health Organization reports nearly 1,900 in-utero deaths after 28 weeks of gestation and about 5,800 annual births with defects. Monitoring fetal movements is essential for assessing fetal health and reducing adverse outcomes. Although methods like Ultrasound and Cardiotocography scans exist, they are limited to clinical settings, costly, invasive, and require specialized expertise, making continuous monitoring impractical.

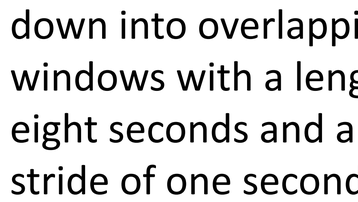
Outcome: A non-invasive, lightweight, and low-cost **wearable device** capable of recording signals from the mother's abdomen. Complemented by an AI algorithm designed to **detect fetal kick counts**, enables continuous monitoring outside clinical settings, providing expectant mothers with a reliable tool to ensure the well-being of their unborn child.

Wearable Device

The wearable multi-sensory device featured 4 MPU6050 modules, each with a 3-axis accelerometer and 3-axis gyroscope. Data were transmitted to a central microcontroller via the serial peripheral interface for processing and storage.





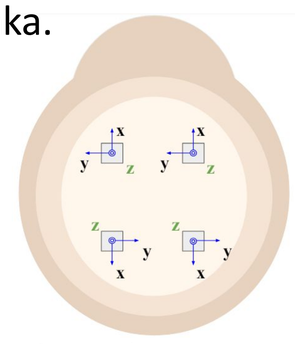


Artifacts such as coughs, positional changes, and laughs can also be recorded to distinguish fetal movements.

Acquired Dataset

Recordings were collected from 44 pregnant mothers who were inpatients at the Professorial Unit of the Gynecology Ward, Teaching Hospital, Peradeniya, Sri Lanka.

- **30 Ward readings** - Recordings with mothers' perception ground truths
- **14 Ultrasound readings** - Recordings with Ultrasound observations as the ground truth.



Sensor placement on mother's abdomen

The dataset is publicly available at https://doi.org/10.7910/DVN/QHFHYC

HARVARD Dataverse
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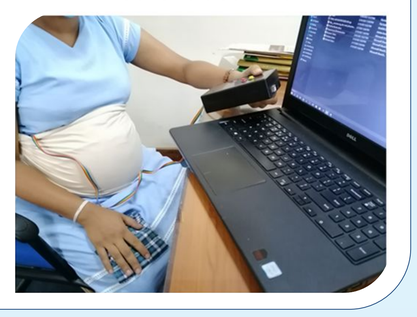
A Multi-Sensory Inertial Measurement Unit Dataset for Fetal Condition Monitoring

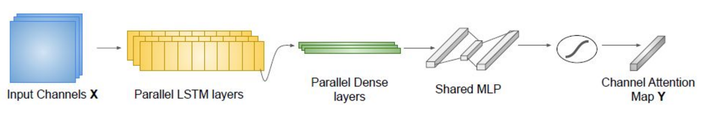


Fetal Movement Detection Algorithm

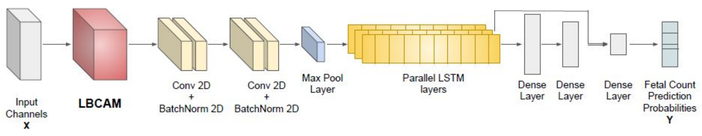
Signal Processing → Feature Extraction → Fetal kick detection

Dataset was broken down into overlapping windows with a length of eight seconds and a stride of one second.

Construct spectrograms that incorporate both time and frequency attributes, making them effective for use in deep learning by considering temporal significance.



Long short-term memory based channel attention mechanism.



The CNN + LSTM fusion model for fetal kick enabling efficient feature extraction from spectrograms and accurate temporal analysis of fetal movements.

Results

Predict the occurrence of fetal kicks with accuracies:

Ward readings: **88%**
Ultrasound readings: **68%**

Application of an LSTM-Based Channel Attention and Classification Mechanism in Fetal Movement Monitoring
SIGNAL PROCESSING AND ANALYSIS
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L.B.I.P. Thilakasiri ; D.M.P.M. Alwis ; R.T. Nanayakkara ; G.M.R.I. Godaliyadda ; M.P.B. Ekan...

Contact details
Name : R. Godaliyadda
Tel. No.: +94777709035
Email : roshang@eng.pdn.ac.lk

Multidisciplinary AI Research Centre (MARC)
University Research Council
University of Peradeniya
Peradeniya, 20400, Sri Lanka