Detection of Sleep using ANN on Wrist Worn Accelerometer Data and Deploying the Model on TinyML Device

Presented By:
Md. Ziaul Hasan – 1911001
Md. Taisirul Muktadi – 1911012
Asadul Islam Hamza - 1911023

TABLE OF CONTENT

1 Indroduction

2 Methodology

3 Result

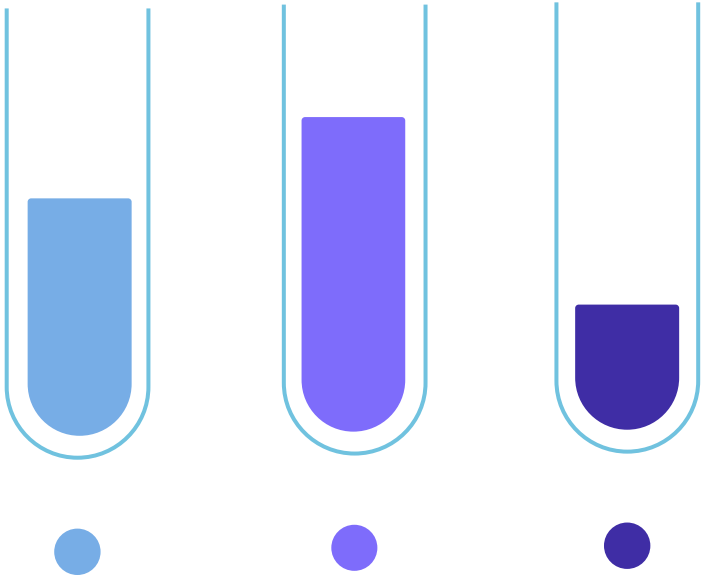
4 Future Work

Sleep is a critical aspect of human health

Sleep plays a crucial role in physical development, emotional regulation, memory consolidation, and overall cognitive functioning.

The inability to control and regulate one’s sleep patterns can lead to a variety of adverse consequences

If we can measure sleep we might control sleep.



Moderated Sleep

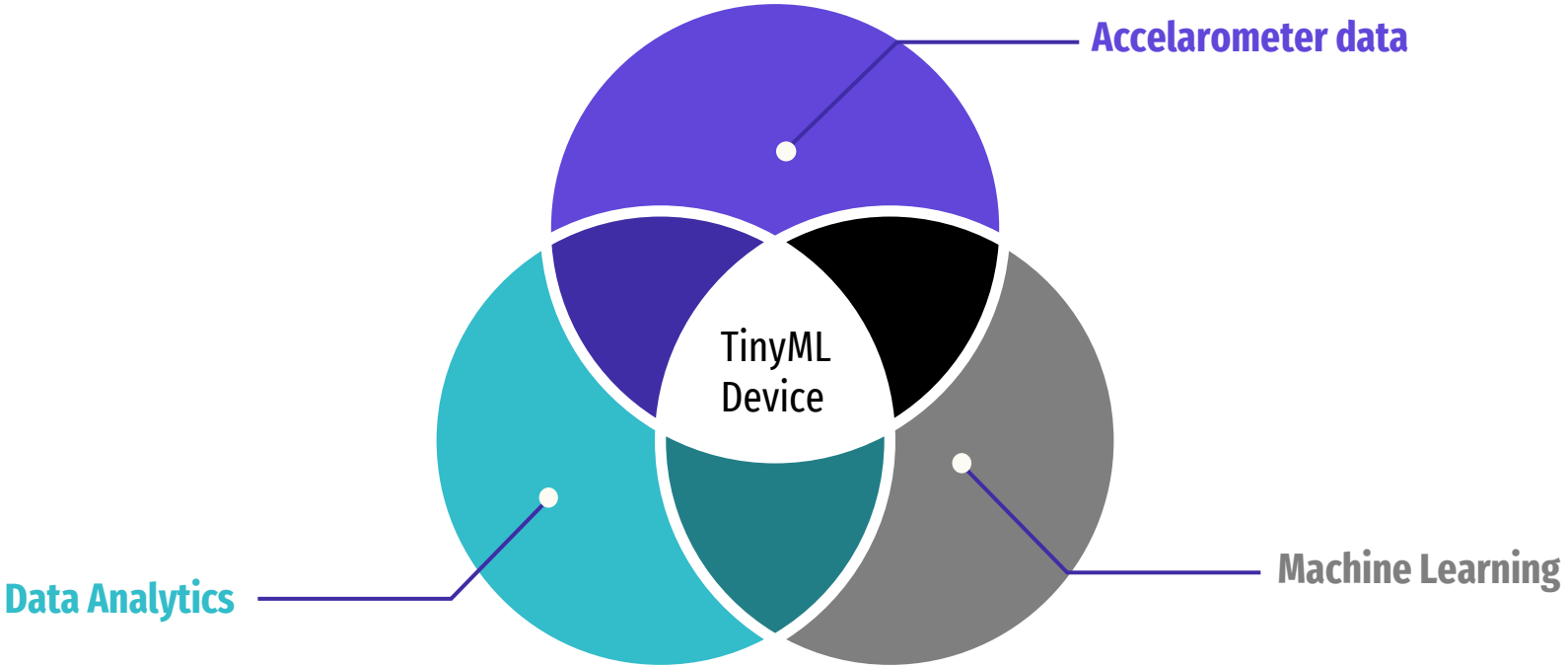
Deep Sleep

Light Sleep

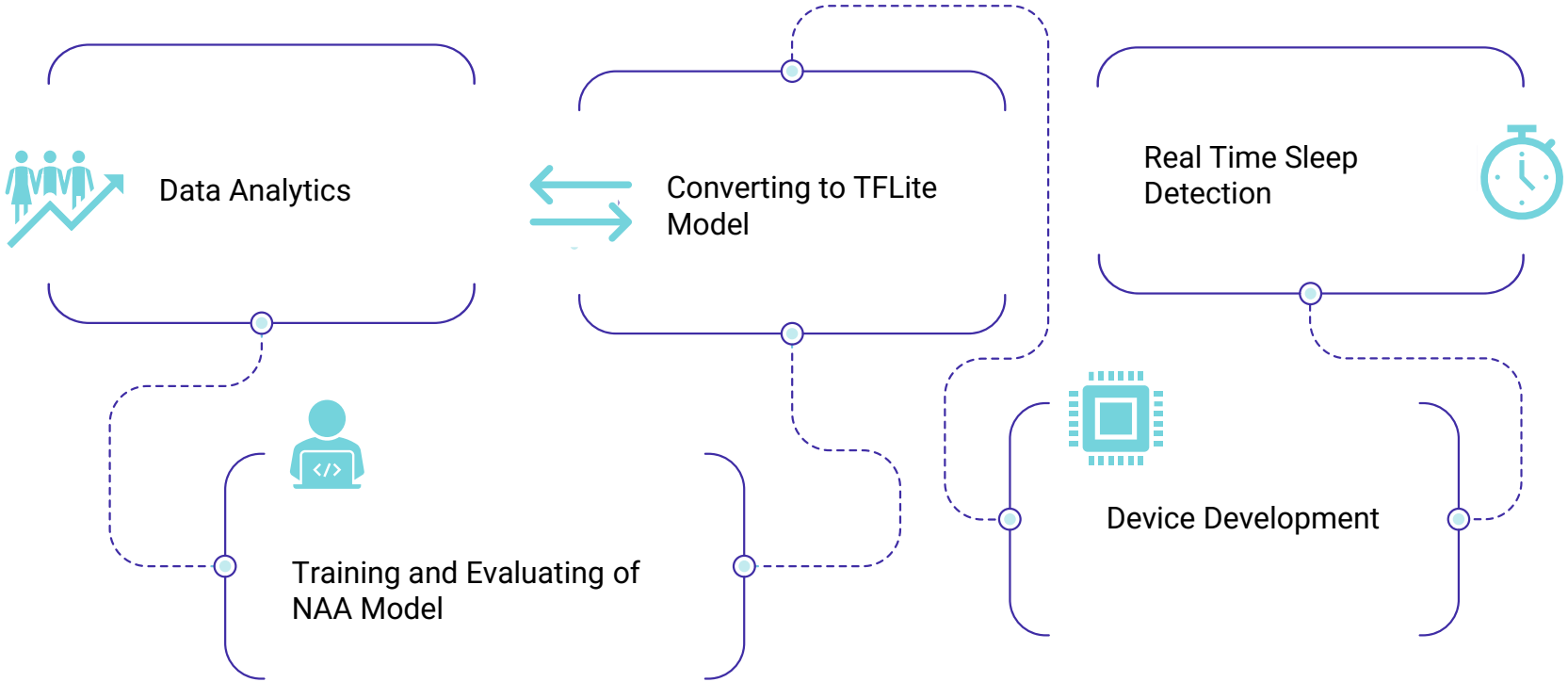
Polysomnography (PSG) is the gold standard tool for understanding physiological processes related to sleep.

But it is often cost-prohibitive, collected in clinical settings unfamiliar to participants, and requires trained technicians to operate and process data.

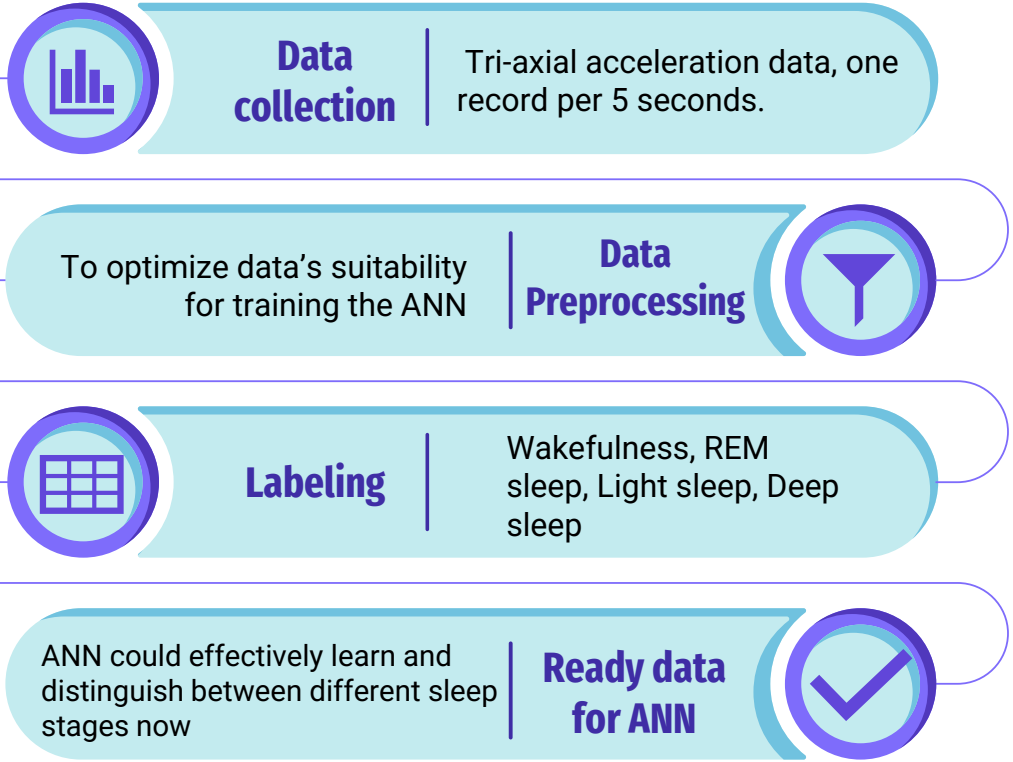
So we need something non-intrusive, easy to use, and affordable, which could accessible to a wide range of users.


Accelarometer data
TinyML
Device
Data Analytics
Machine Learning

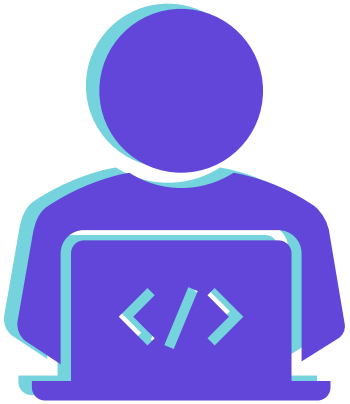
Methodology



Data Analytics



Artificial Nural Network (ANN)



- Architechture of ANN
- Training
- Evaluation
- To TFlite Model

TABLE I
MODEL ARCHITECTURE

Layer (type)	Output Shape	Param #
dense	(None, 10)	30
dense_1	(None, 20)	220
dense_2	(None, 10)	210
dense_3	(None, 2)	22
Total params		482 (1.88 KB)
Trainable params		482 (1.88 KB)
Non-trainable params		0 (0.00 Byte)

TABLE II
MODEL SIZES COMPARISON

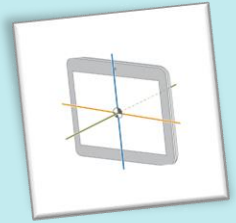
Model	Size
TensorFlow	4096 bytes
TensorFlow Lite	4424 bytes (reduced by -328 bytes)
TensorFlow Lite Quantized	3952 bytes (reduced by 472 bytes)

Device Development

Hardware Selection

Arduino Nano 33
BLE sense rev2

Accelerometer



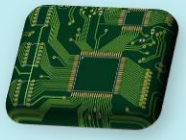
Inbuilt 9-axis
Inertial
Measurement
Unit (IMU)

Software Development

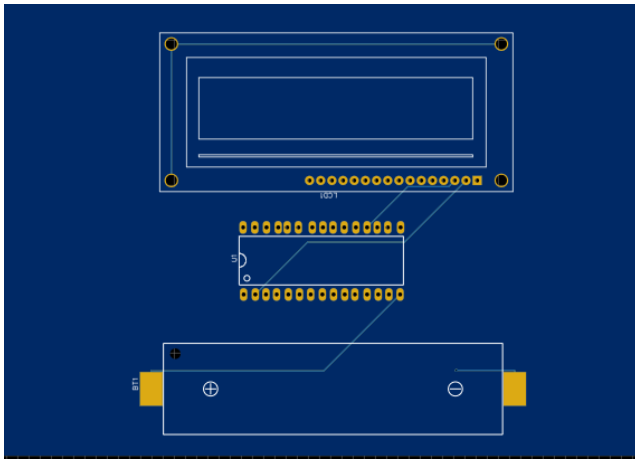
Arduino C++
in conjunction
with TensorFlow
Lite Micro

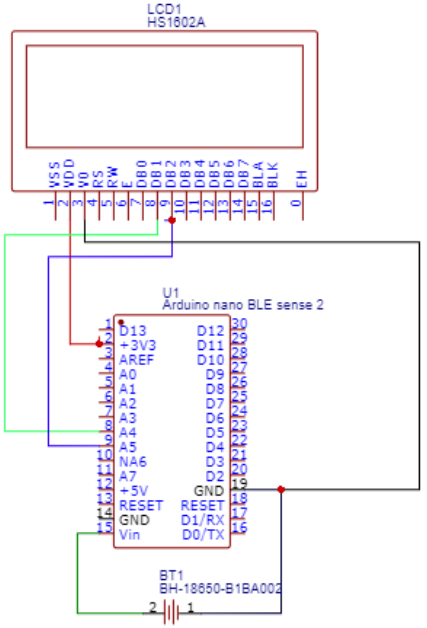
Circuit and PCB Design

Now it is suitable for a variety of applications, including those requiring machine learning inference.



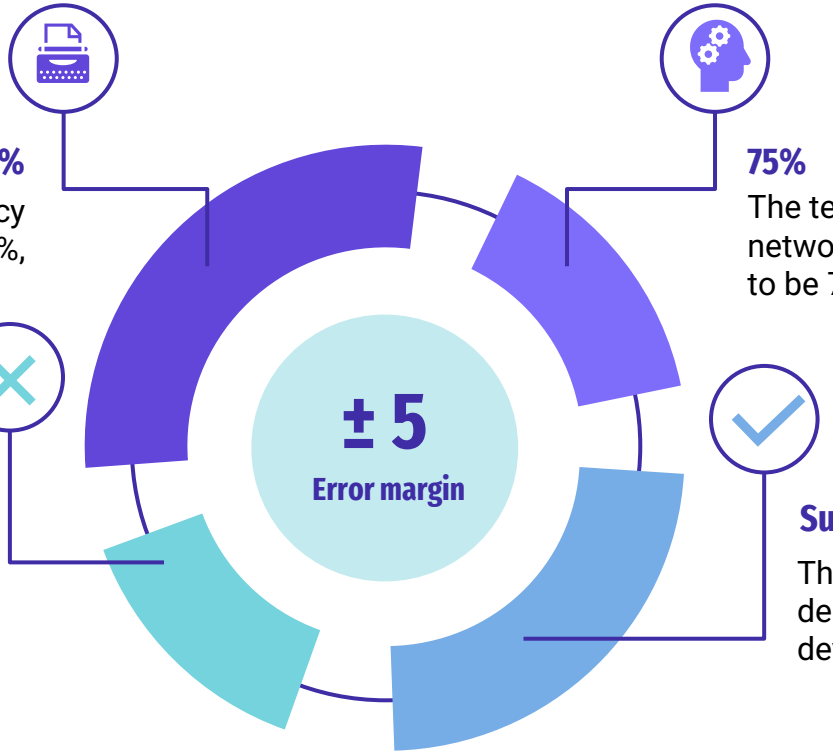
Circuit and PCB Diagram





Final Outlook

Result



73%

Validation accuracy of 73%,

75%

The test accuracy of the neural network model was found to be 75%

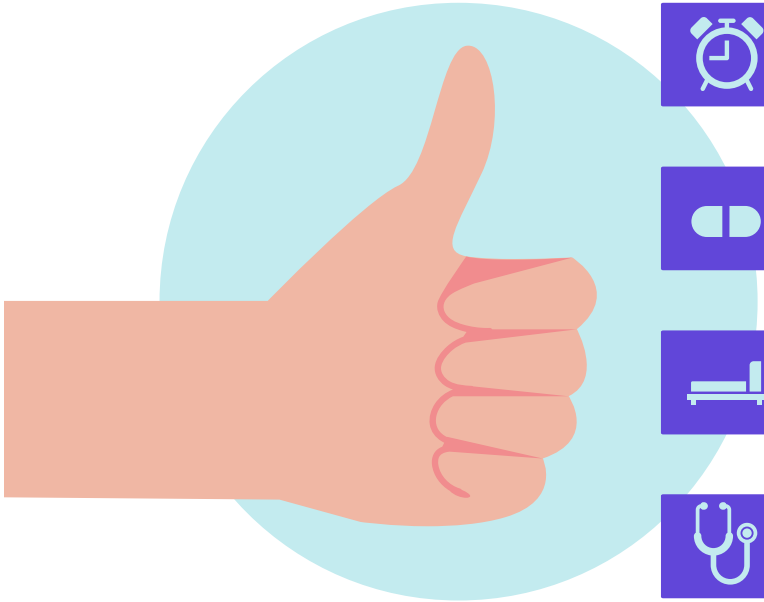
±5

Detecting sleep initiation with an error margin of ±5 minutes.

Successful CNN

The CNN model was successfully deployed on the TinyML device for real-time sleep detection

Future Work



- Controlled Sleep environment
- Personalised Feedback
- Sleep Supervised Learning
- Sleep monitoring for critical state patients

Thank you all

Open for Questions...