

Motivation

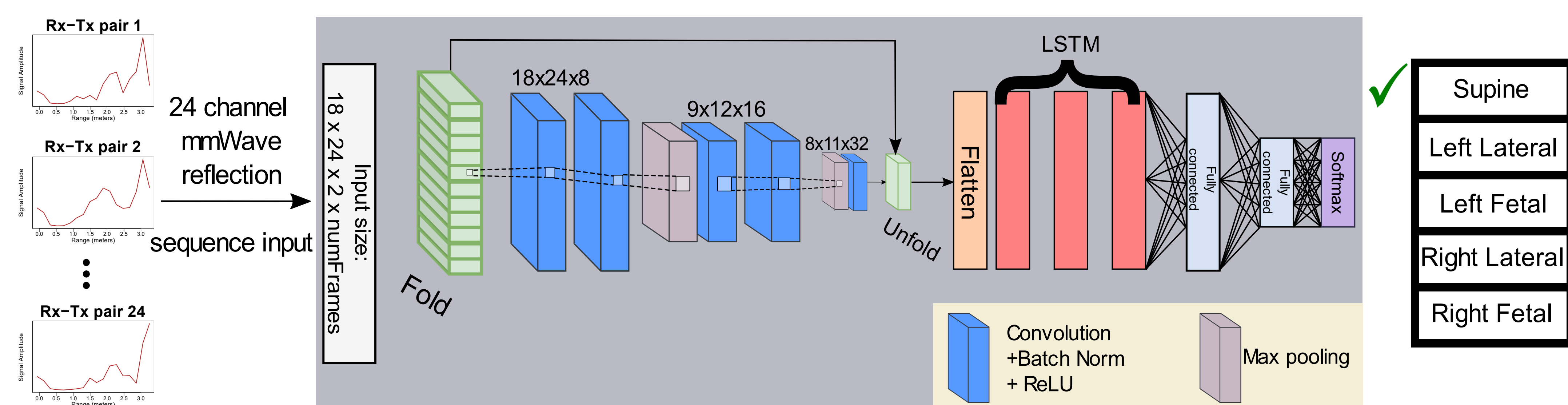
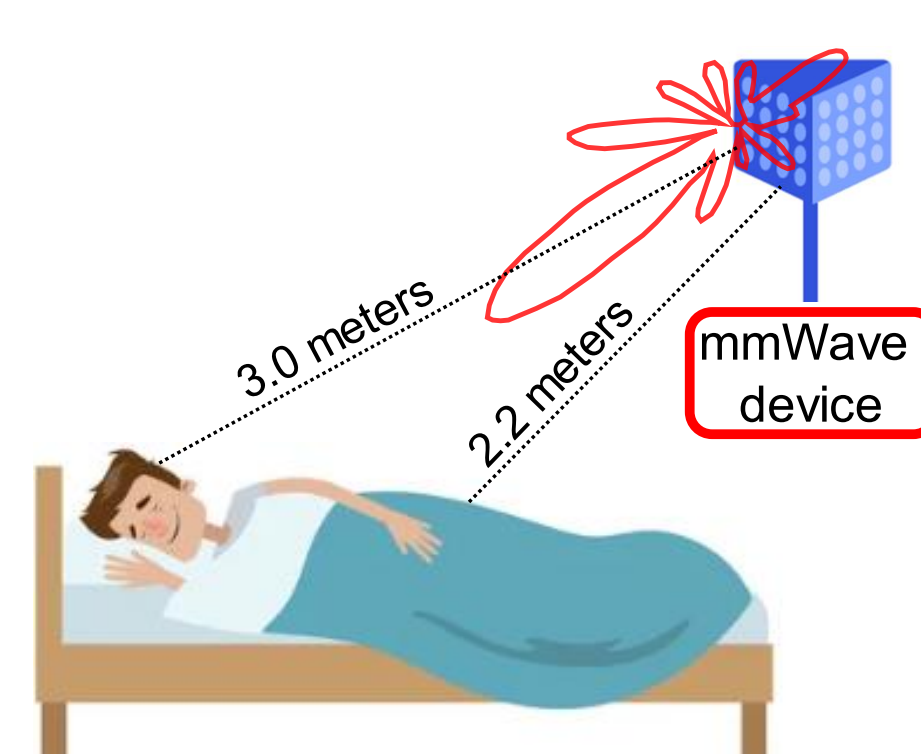
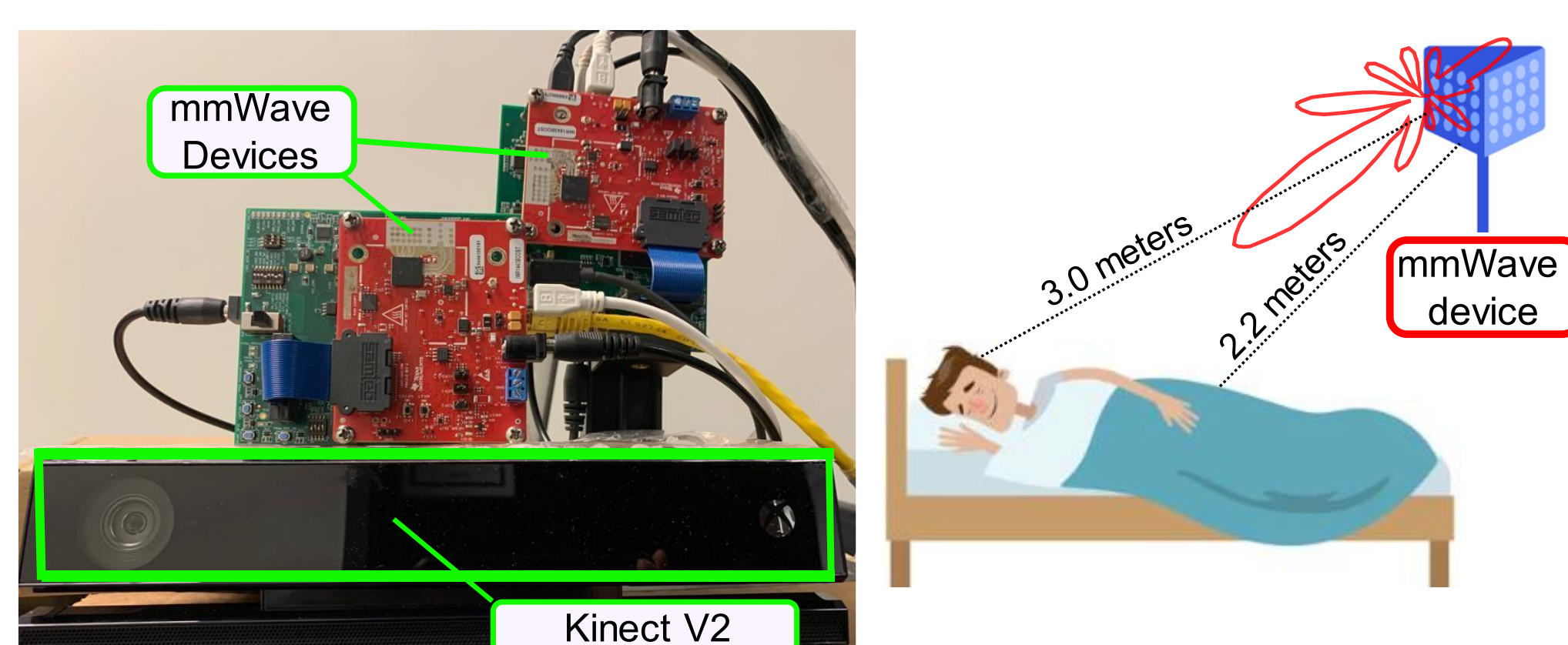
Motivation

- Certain sleep postures have been associated with negative health outcomes.
 - For example, the supine posture is linked with sleep apnea, which is a risk factor for cardiovascular complications such as strokes.
- Classification of sleep posture can give insights into improving sleep quality and preventing negative health outcomes.
- Cameras are privacy-invasive and require good lighting conditions with no occlusions, which is unlikely in a typical sleeping scenario.
- Wearable sensors or pressure mattresses may be uncomfortable during sleep.

System Design

Sleep Posture Classification

- Classification between 5 broad sleep posture categories.
- Two co-located mmWave devices collect signal reflections using the FMCW technique with a bandwidth of ~1.6 GHz at 77.8 GHz carrier frequency.
- Signal phase and amplitude are acquired using Fast Fourier Transform (FFT).
- A Convolutional Neural Network (CNN) with Long Short-Term Memory (LSTM) classifies the posture, taking the 24-channel reflection as input.



Objective and Intuition

Objective

- Classify different sleep postures using millimeter-wave (mmWave) wireless signals without requiring sensors on the user's body or bed.

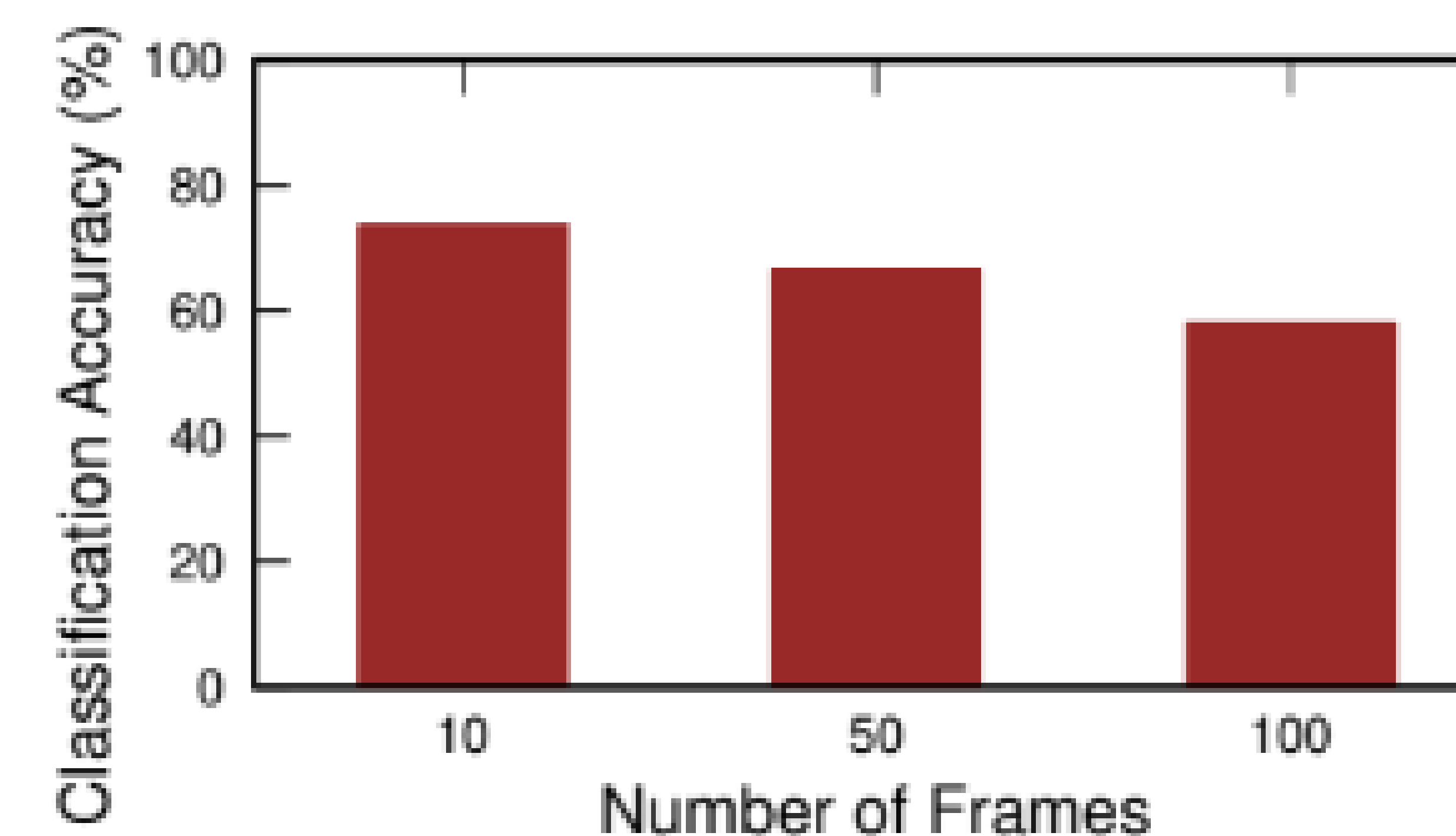
Intuition

- The small wavelength and high bandwidth of mmWave signals allow for more precise monitoring compared to other wireless approaches.
- Sleep postures produce distinct patterns in mmWave reflection signals.
 - The spatial and temporal information embedded within the reflected signals can be used directly for sleep posture recognition.

Results and Future Works

Results

- Classification network is trained and tested with a different number of consecutive frames of mmWave reflection signals.
 - Prediction accuracy of 73.45% with 10 frames.



Future Works

- Classify the postures of two persons simultaneously.
- Detect periods when a person changes their sleep posture in real-time.
- Deploy and evaluate in real-world at-home environments.