

The background of the slide is a photograph of the Iowa State University campus, featuring the Old Capitol building with its prominent dome on the left and various other university buildings and trees in the background. The entire image is covered with a semi-transparent red overlay.

IOWA STATE UNIVERSITY

**COM S 672 Advanced Topics in Computational Intelligence - Research
Project Presentation**



Estimation of Knee Adduction Moment Using Wearable Sensor with AI and possible adversarial example

Yu-Pin Liang (Jasmine)

IOWA STATE UNIVERSITY

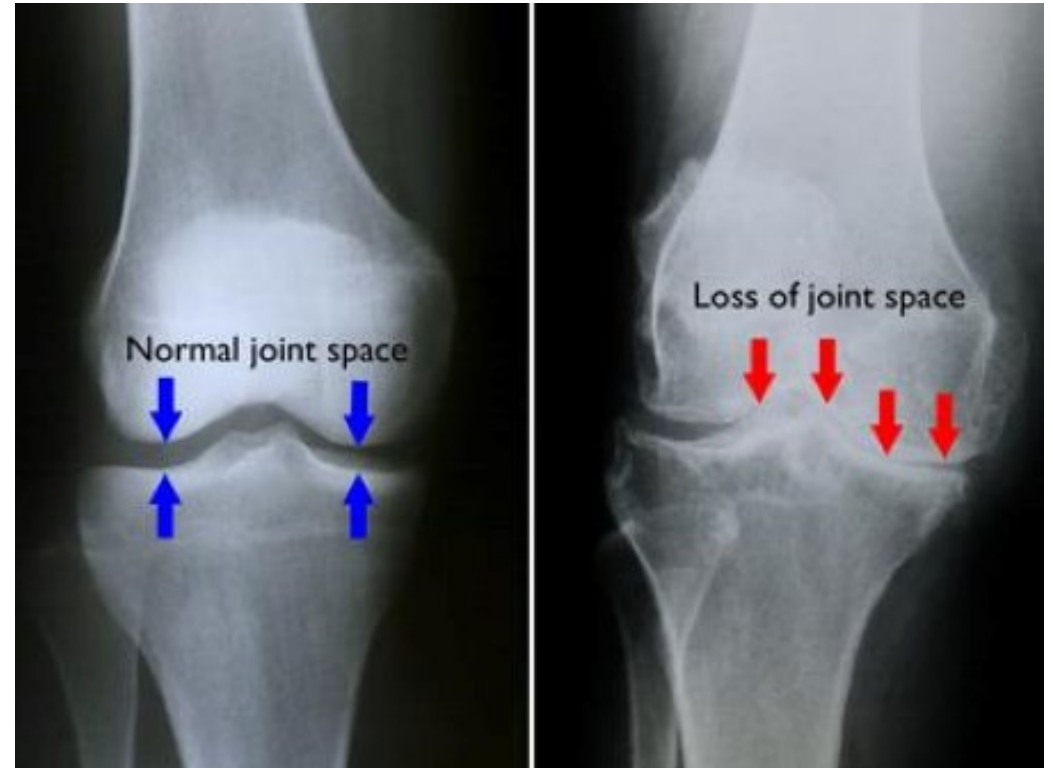
The background of the slide is a photograph of the Iowa State University campus, featuring the Old Capitol building with its prominent dome on the left and other campus buildings and trees on the right. The entire image is covered with a semi-transparent red overlay.

Background (recap)

IOWA STATE UNIVERSITY

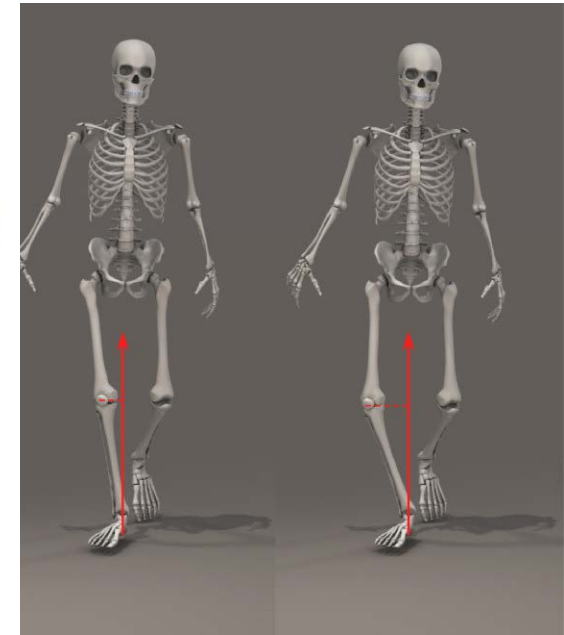
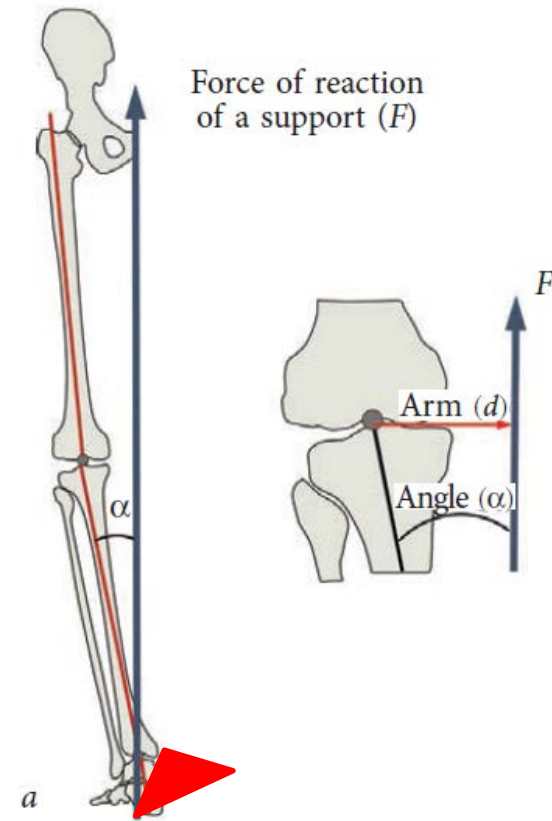
Knee Osteoarthritis

- The knee joint is most commonly affected by osteoarthritis.
- Cartilage in knee begin to break down after sustained stress, leaving the bones rubbing against each other and resulting in osteoarthritis.
- Nearly a third of US citizens are affected by osteoarthritis of the knee by age 70



Knee adduction moment and knee osteoarthritis

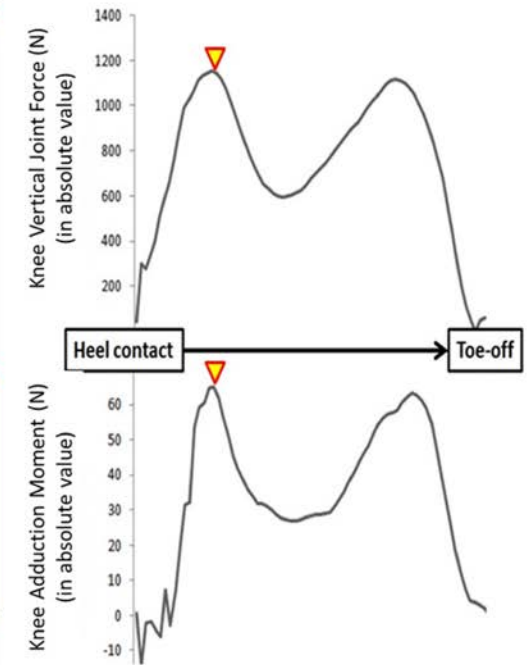
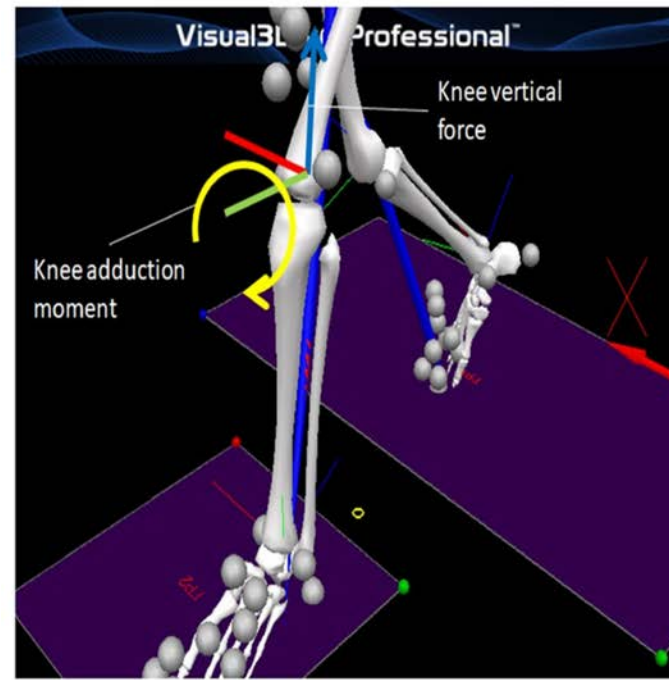
- The **moment of knee joint** is basically from the ground reaction force and muscle force.
- The varus wedge increase the knee adduction moment (become **O** walking).
- **greater adduction moment** at the knee during activities contributes to the high risk of knee osteoarthritis.

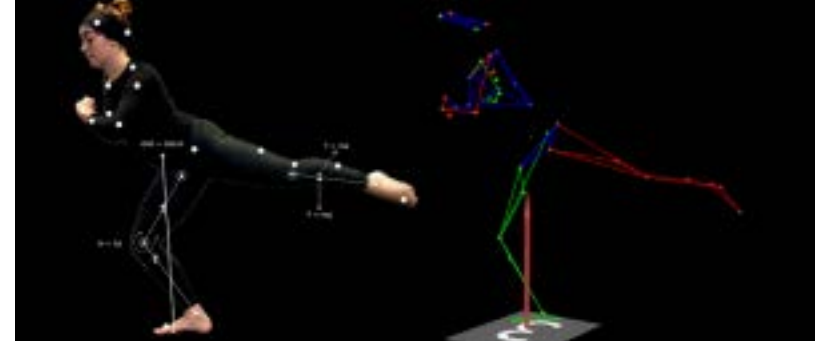
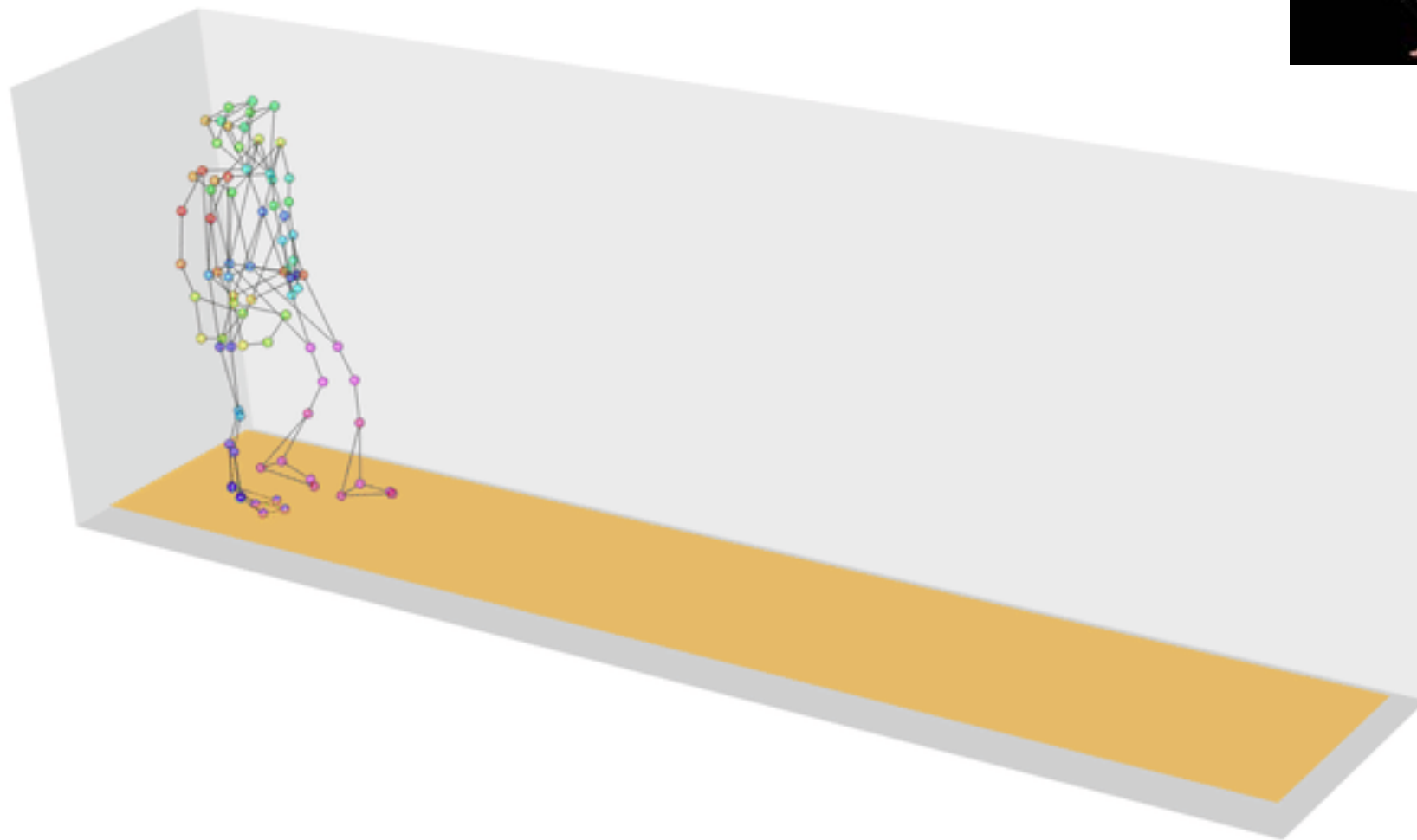


Measure Knee adduction moment

- Put reflective marker on bony landmark
- Use motion capture system – twelve high speed cameras
- Force Platform

Restricted in Lab environment





Possible Adversarial Attack Assumption

- The attacker's intention:
 1. When a patient diagnosis with high risk to develop an osteoarthritis knee, the patient may want to
 - Join a private therapeutic session
 - Buy expansive supplement to nourished the joint
 - Ask for knee joint injection: stem cell, glucose
 - Regular PT treatments
- Literature review to understand how time-series model been attack

The background of the slide is a photograph of the Iowa State University campus, featuring the Old Capitol building with its prominent dome on the left and other university buildings in the distance. The foreground is filled with trees showing autumn foliage. A solid red overlay covers the entire image. The text "Research problem" is written in white, bold, sans-serif font on the left side.

Research problem

IOWA STATE UNIVERSITY

Problem

1. Can we estimate KAM during walking using data measured from wearable sensors?
2. How stable this model is?

The background of the slide is a photograph of the Iowa State University campus, featuring the Old Capitol building with its prominent dome on the left and various other university buildings and trees. The entire image is covered with a semi-transparent red overlay.

Solution

IOWA STATE UNIVERSITY

Solution

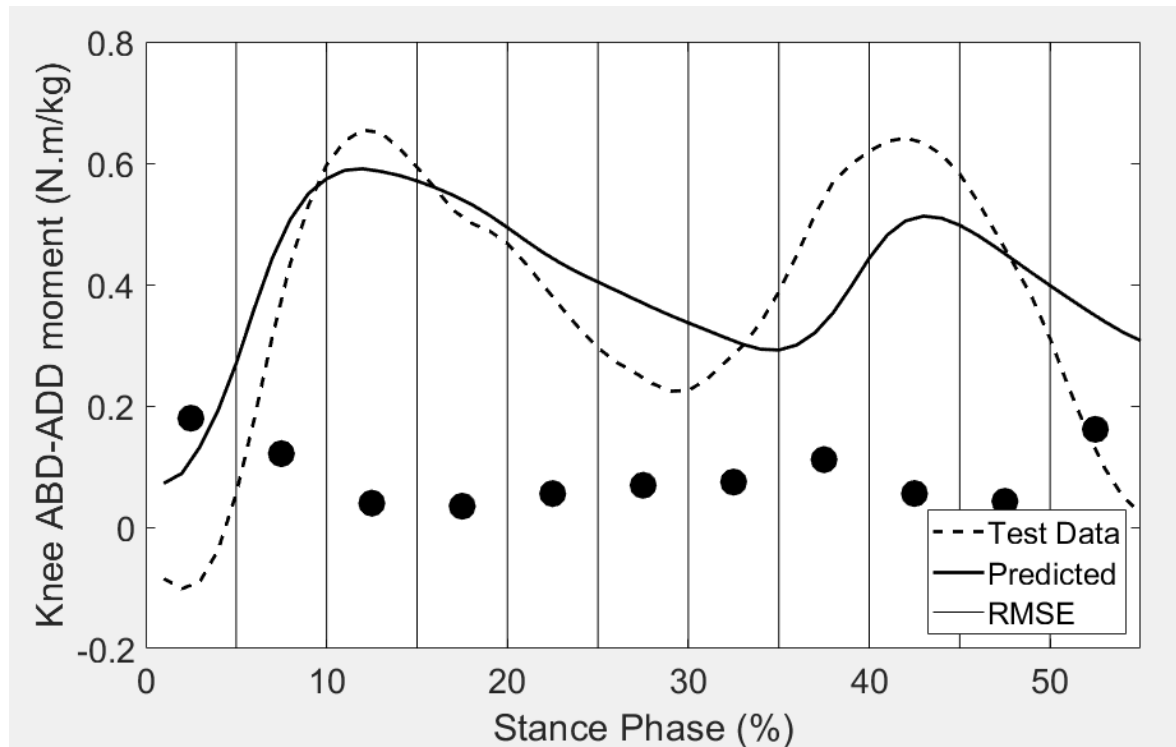
- Collect acceleration from wearable sensor and estimate knee adduction moment during gait
1. Using LSTM model to predict knee joint moment
 2. Adding Gaussian noise to original signal and see how model performed

The background of the slide is a photograph of the Iowa State University campus, featuring the Old Capitol building with its prominent dome on the left, a row of trees in the center, and other campus buildings on the right. The entire image is covered with a semi-transparent red overlay.

Outcome

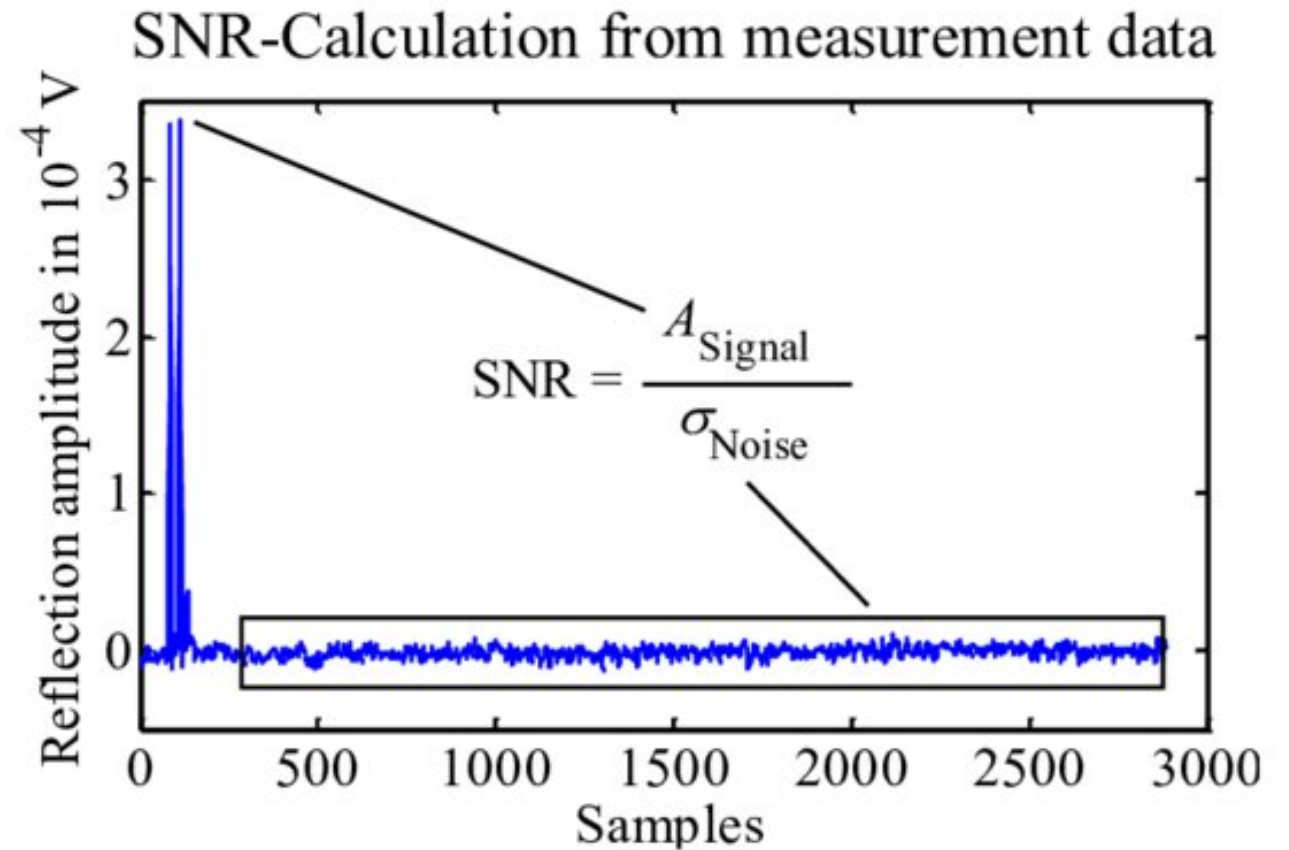
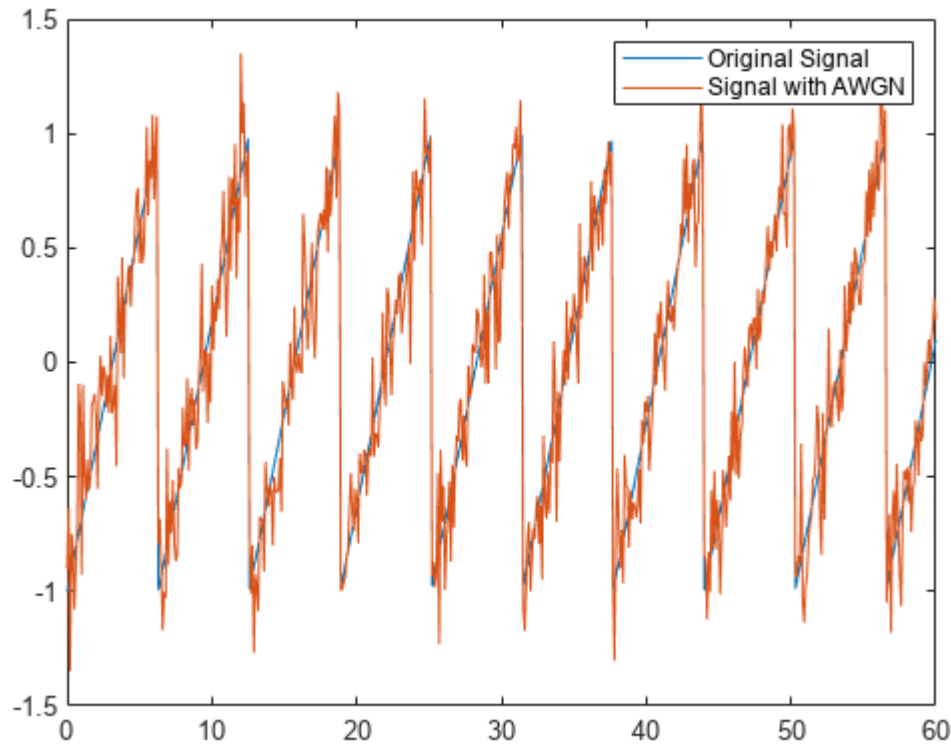
IOWA STATE UNIVERSITY

Outcome – Before adding noise

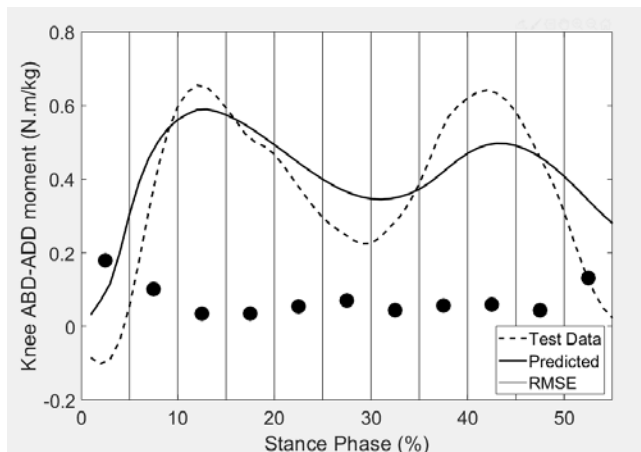


- RMSE = 0.1253
- Model: three LSTM blocks followed by a fully connected layer

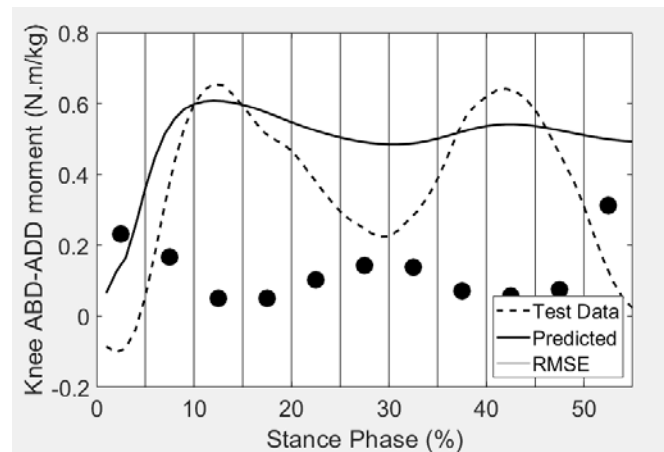
The Noise - Signal-to-noise ratio (snr)



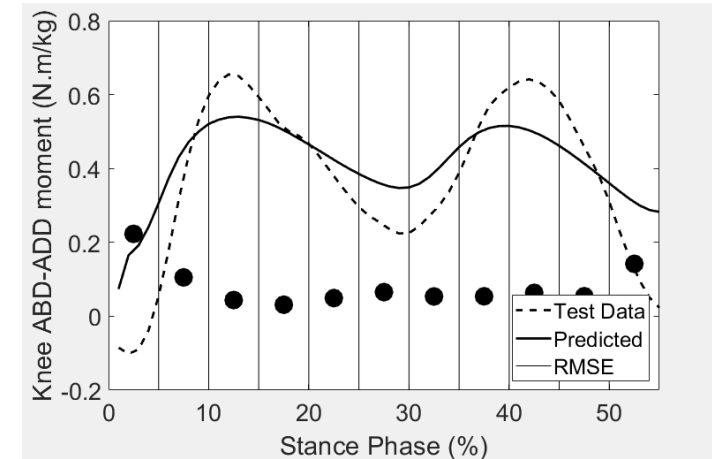
Outcome – After adding Gaussian noise



Signal-to-noise ratio (snr)
= 100
RMSE = 0.1319

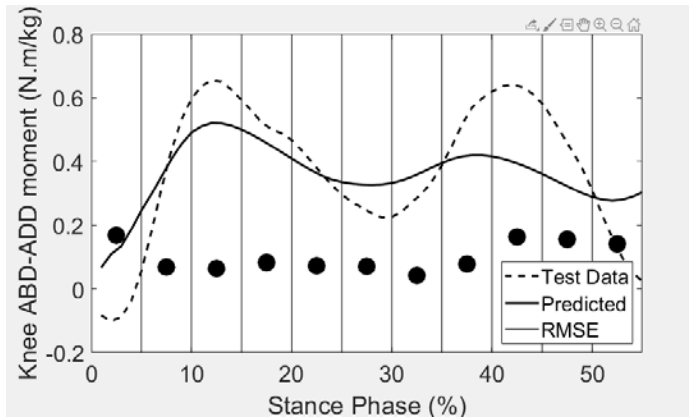


snr = 75
RMSE = 0.2101

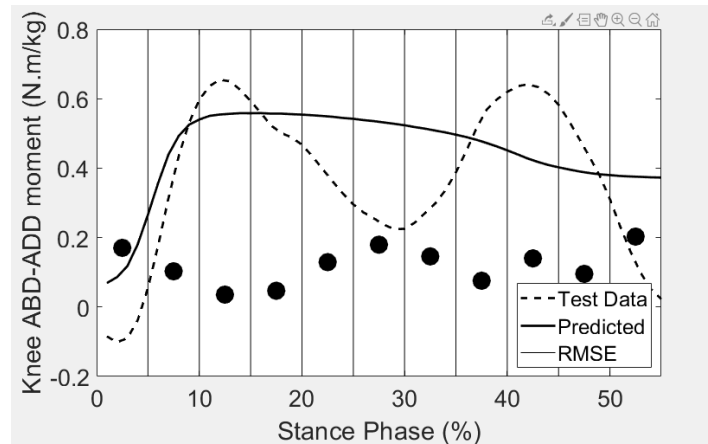


snr = 50
RMSE = 0.2312

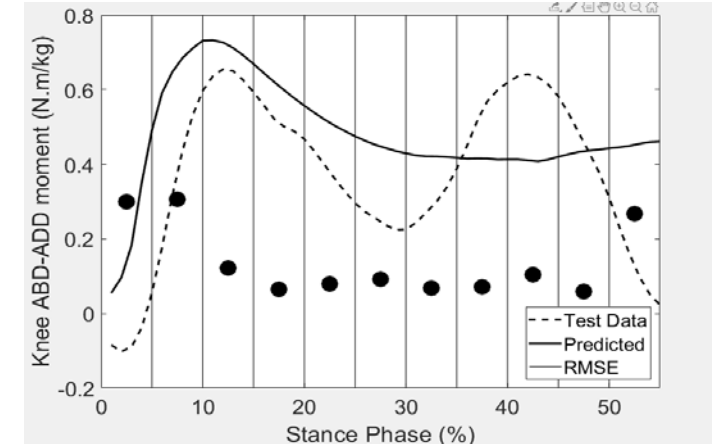
Outcome – After adding Gaussian noise



snr = 25
RMSE = 0.1405



snr = 10
RMSE = 0.2027



snr = 5
RMSE = 0.2673

Some final thoughts

1. LSTM is a good model for handling the time series data input.
2. LSTM is also good at against the white noise perturbation.