Equine Lameness Detector

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18-444 Embedded Machine Learning

What does equine lameness look like?

Grade 4/5 Lameness

Grade 2/3

Abstract:

What: Equine wearable device to detect early signs of lameness or other injuries.

Why:

- Equine lameness is one of the most prevalent health issues
  - causing early retirement
  - over $5,000 in average vet costs per case

- What's currently on the market: Multi-sensor lab rigs ($15K+)

- 2 to 3 million of horses a year suffer from lameness

Target users:

Amateur Riders

Professional Riders

Veterinarians

BLERP Model:

Bandwidth: Reduces wireless transmission volume making real-time streaming feasible in barns or arenas with limited connectivity

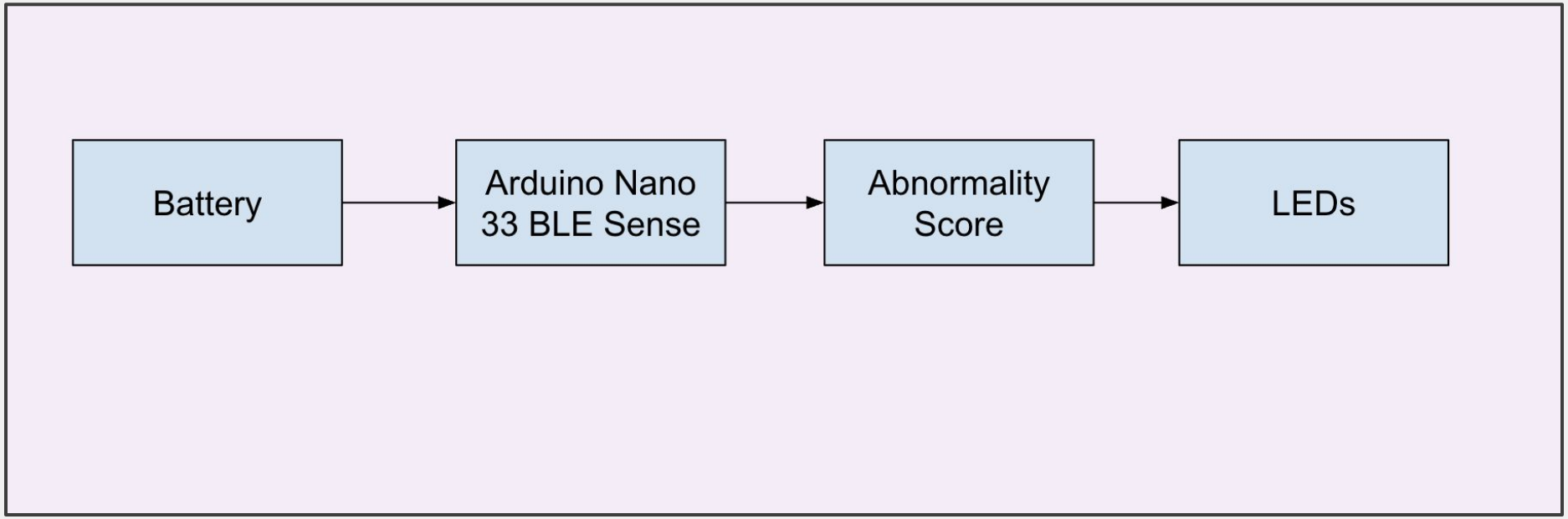
Latency: Real-time stride-level inference can alert the rider or vet during motion

Economics: Eliminates the cost of continuous data uploads

Reliability: Continues operating during weak or lost connections

Privacy: All motion data are processed locally, meets veterinary-data confidentiality expectations

Block Diagram



Hardware:

1. Arduino Nano 33 BLE Sense
2. 3.3V Buck Boost
3. Li-Ion Battery Charger Module
4. 250mAh Lipo Battery
5. LEDs
6. On/off switch
7. 3D printed Case

Model/ Data:

Method 1: Public dataset

Dataset: Kinematic data from owner-sound horses walking and trotting on a straight line (Original data)

Pros: very good accuracy result on process data

Cons: not raw data → hard to use on Arduino

Model: Anomaly detector on Edge Impulse

Inertial measurement unit technology for gait detection: a comprehensive evaluation of gait traits in two Italian horse breeds

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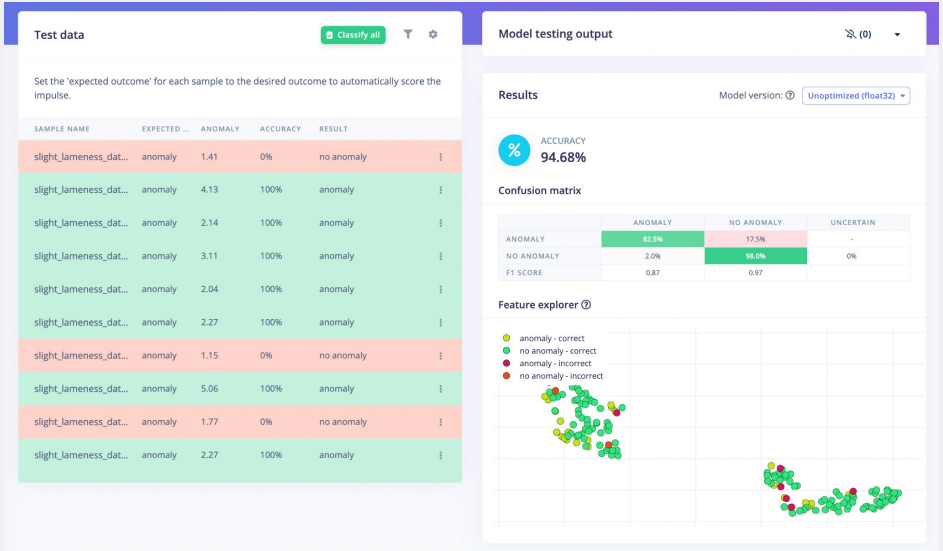
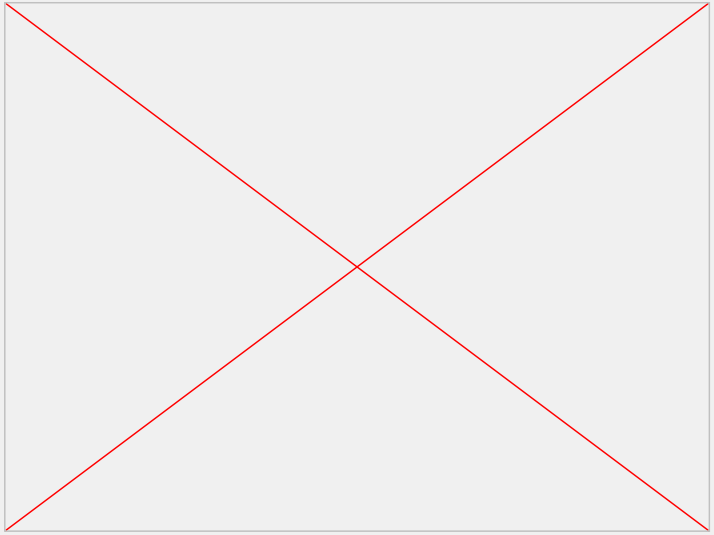


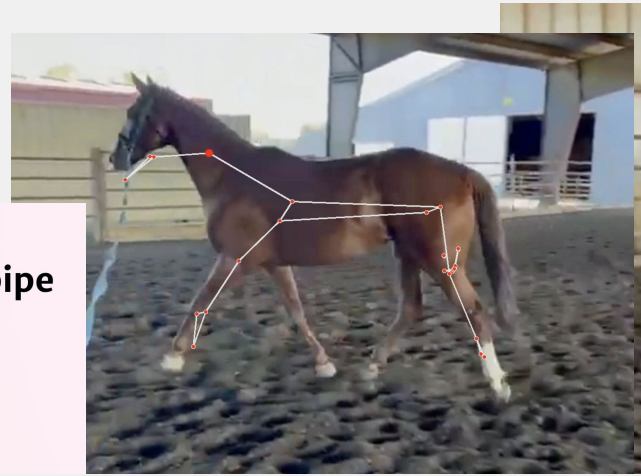
Model/ Data:

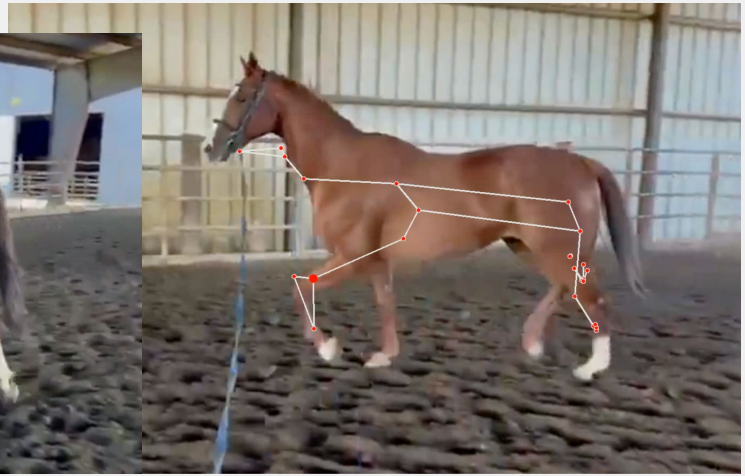
Method 2: Mediapipe BlazePose

Pros: extracted x, y coordinates from video

Cons: since the model was made for humans, it wasn't that accurate for horses







Home › Advances in Visual Informatics › Conference paper

Movement Estimation Using Mediapipe BlazePose

Conference paper | First Online: 16 November 2021

pp 562–571 | Cite this conference paper

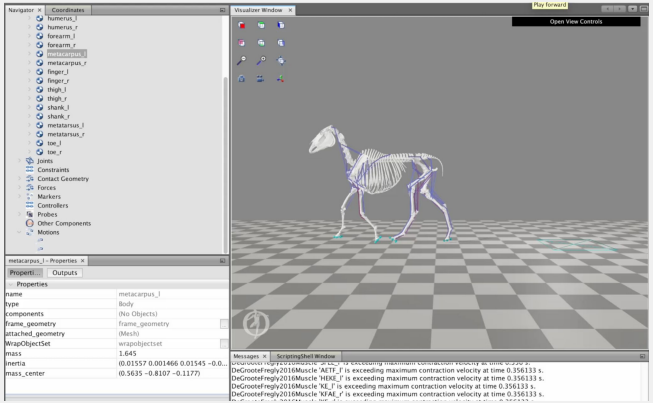
Access provided by Carnegie Mellon University

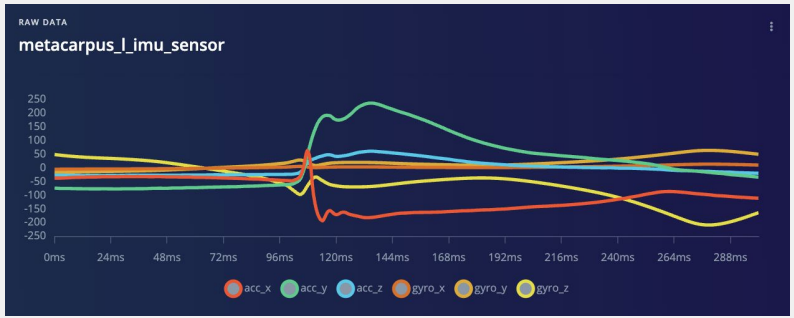
Model/ Data:

Method 3: OpenSim

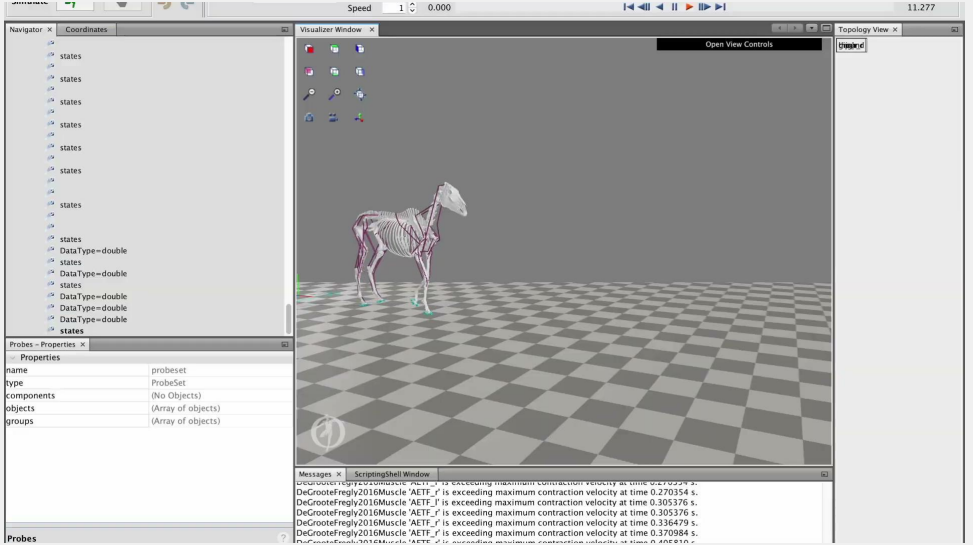
<u>Pros</u>: can obtain realistic imu data from different horse models

<u>Cons</u>: limited to available models (no lame horse model)

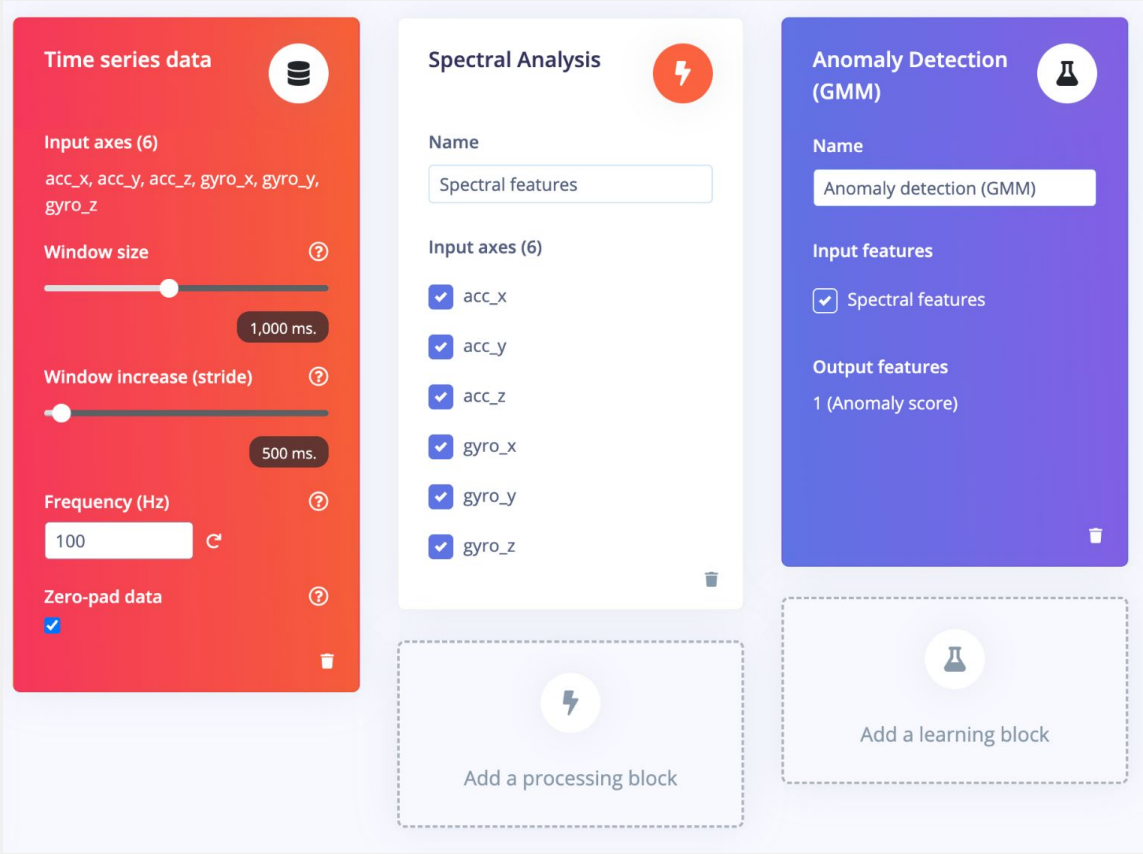




Musculoskeletal model of the horse (Equus ferus caballus) for gait simulations



Model/ Data:



SAMPLE NAME	EXPECT...	LENGTH	ANOM...	ACCUR...	RESULT
metacarpus_l_...	anomaly	2s	60.46	100%	2 anomaly
metacarpus_l_...	anomaly	2s	78.52	100%	2 anomaly
metacarpus_l_...	anomaly	2s	838.67	100%	3 anomaly
metacarpus_l_...	anomaly	303ms	8.27	100%	anomaly
metacarpus_l_...	anomaly	303ms	0.48	0%	no anomaly
metacarpus_l_...	anomaly	202ms	0.51	0%	no anomaly
metacarpus_l_...	anomaly	202ms	7.02	100%	anomaly

ACCURACY
81.82%

Confusion matrix

	ANOMALY	NO ANOMALY	UNCERTAIN
ANOMALY	81.8%	18.2%	-
NO ANOMALY	-	-	-
F1 SCORE	0.90	0.00	

Challenges

1. Data Collection
    a. Approval by CMU Animal Care Committee
    b. Finding willing participants
    c. No available public dataset that work

2. Recreating imu data from acc.sto and vel.sto files

3. Working with new software/ waiting for approval to use it

Demo showing anomaly