Predicting leg soundness through biomechanical assessment of gait in pigs

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Introduction to lameness

1. Even 'good' farms will have some level of lameness
2. Prevalence of abnormal gait: 10-20% (KilBride, 2009)
3. Uncertainty around high growth rates & hard pen floors
4. Significant animal welfare issue
5. Culling, treatments & reduced growth is costly

Lameness in growing pigs

…two major problems:

Leg weakness

-structural unsoundness, considered the main clinical expression of degenerative joint disease (van Grevenhof, 2012)

Osteochondrosis

-a non-infectious disease causing cartilage/bone failure (4 -18 months of age)

-Can lead to secondary osteoarthrosis in older animals

Overall PhD objectives:

1. To describe normal gait in pigs using motion capture technology

2. To find out how gait changes with increasing age/weight of the pig

3. To determine the effect of floor surface on the gait of pigs at different ages

4. To investigate the predictive power of early gait score measures to identify later predisposition to lameness

5. To further develop quick, simple locomotion assessment methods for commercial application

Potential Industry benefits

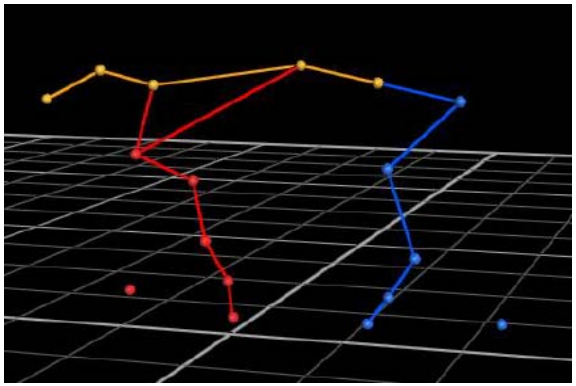
- Repeatable/objective gait assessment method for replacement gilt selection

- Repeatable/objective gait assessment method for leg soundness inclusion in breeding schemes

- Reliable and automated health and welfare monitoring systems

Quantitative locomotion assessment – motion capture

- Infrared-based multiple camera (3D) motion tracking system
- Reflective skin markers
- Pigs follow a human and receive rewards



- VICON NEXUS: motion capture and processing software
- MATLAB: marker model analysis & gait parameter calculations

Longitudinal quantitative gait study

- Started Jan 2012 to Summer 2013
- Recruited all replacement gilts available over a period of 7 months (N= 84 ♀)
- Regular motion capture sessions (strategic dates)

- Prevalence of lameness until May 2013 (17 months):
  - Grade 3 (minimal weight bearing): 13% (11/84)
  - Grade 2 (lameness detected): 14% (12/84)
  - Grade 1(stiffness): 18% (15/84)

Results (1)

Where were the significant movement changes?

$$\frac{steplength}{stridelength} \neq 0.5$$

Flexion changes are present, but more variable

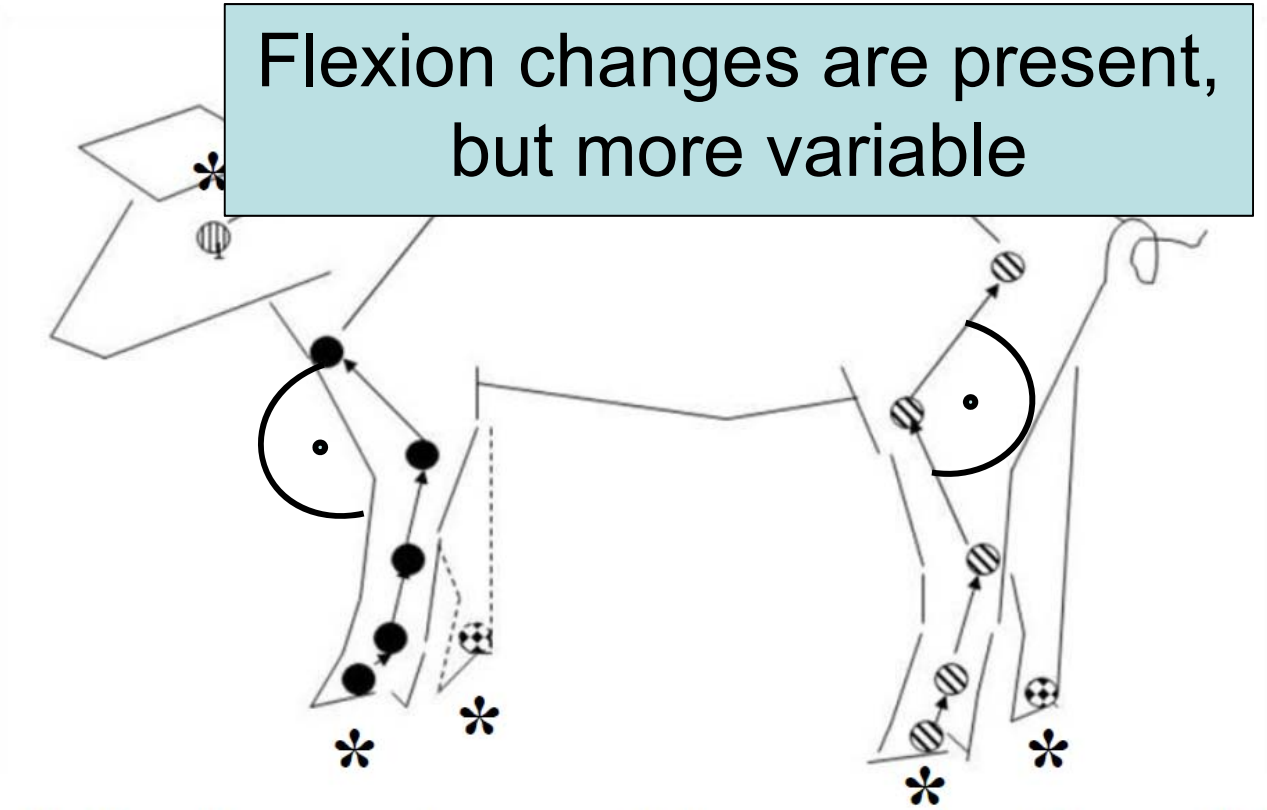
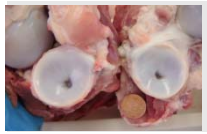


Figure 1: Reflective marker model captured with a 3D optoelectronic technique (* denotes sites where significant movement changes were observed in lame pigs).

Results (2)

Conformational deficiency and osteochondrosis

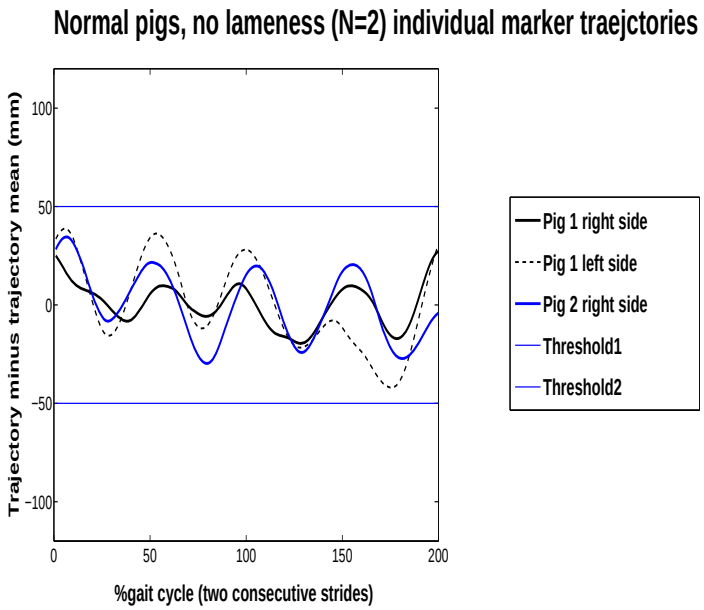
Leg problem	Joint angle measurement
 Post-legged in hind legs	↑ **Swing phase** range of motion Elbow & knee joint
 Buck-kneed in front legs	↓ Elbow flexion ↓ **Swing phase** range of motion Knee
 Moderate hind and front leg lesions	↑ **Stance phase** range of motion Knee & tarsal joint
 Moderate/severe front leg lesions	↑ **Stance phase** flexion asymmetry Elbow & carpal joint
Stiffness (very subtle lameness)	↓ **Swing phase** range of motion Elbow

Results (3)

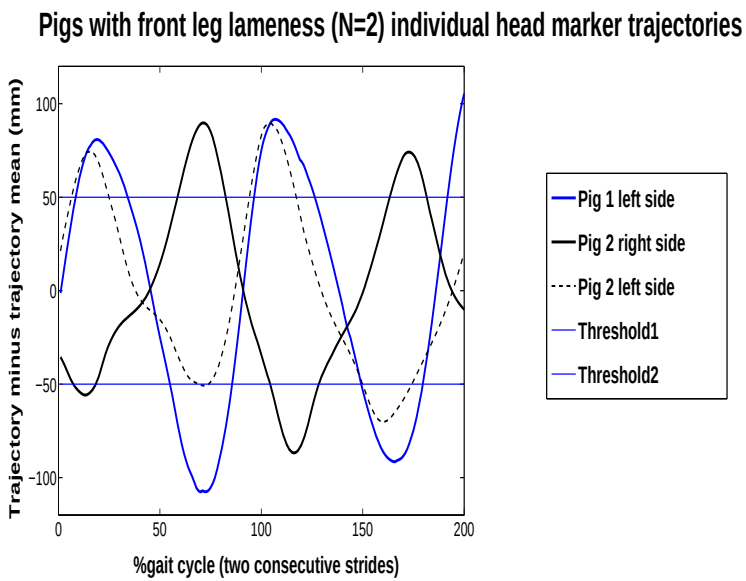
Head bob in pigs with front leg lameness

Vertical displacement (mm)

Control Pigs



Lame pigs



% Gait cycle
= At 100, a stride is completed

Summary (1)

• Housing: growing pigs on fully-slatted, partly-slatted or deep-straw bedded floors had no effect on musculoskeletal development.

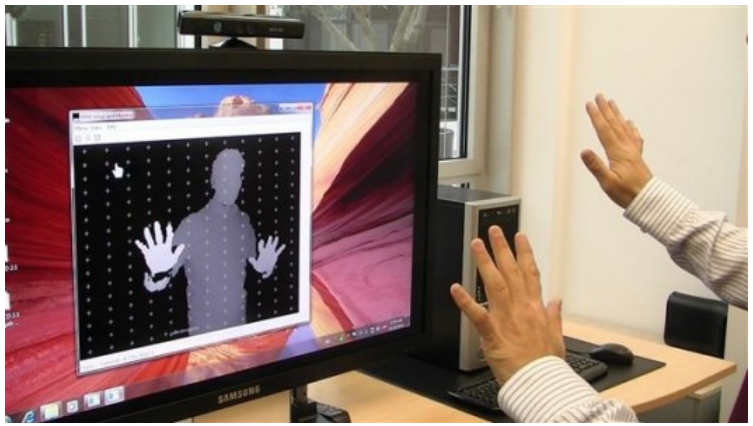
• Growth rate: Fast, intermediate or slow growing pigs showed no differences in gait characteristics (except **weak pastern** and ↓ swing-stance ratio for fast growing pigs at the heaviest point of comparison).

Summary 2

• Step-to-stride length: relationship remains the same in clinically normal pigs, regardless of size, age or walking speed, and was repeatedly useful in differentiating pigs with subclinical & clinical problems.

• **Along with head**, neck, **spine** and **pelvic** movement, these changes are simple and characteristic measures of lameness which could be captured by simple image analysis technology.

• **Development** of a practical on-farm version will continue in a follow-on pilot study to be funded by the Douglas Bomford Trust in 2014.



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