Research Reports

Improving lameness detection on dairy farms: developing a cyborg assessor

Lameness causes pain and reduces the longevity of dairy cattle, and also harms the welfare of farmers who care for them, in part because of the resulting economic losses. Despite these serious implications, lameness is frequently underrecognized by farmers and veterinarians and seldom identified in its early stages. That many cases are missed is likely due to the absence of sensitive and affordable diagnostic methods, which impedes early intervention and prevention. This may also explain why, despite comprehensive research into the causes, diagnosis, and treatment of lameness over the past twenty years, there has been little progress in reducing prevalence in dairy herds.

Conventional lameness evaluations require that trained observers visit a farm in person and then manually score to each cow based on specific characteristics such as gait and body posture. This approach is labor-intensive, time-consuming, and requires trained staff, meaning that on many farms cows are not routinely scored. To make matters worse, visual assessments of lameness are known to suffer from low interobserver and intra-observer reliability, particularly when conducted by inexperienced observers.

With recent developments in automation and artificial intelligence, there has been an increasing interest in automatic lameness detection technologies; for example, using sensors and computer vision systems. Up until now at least the high cost of these technologies makes them inaccessible for many dairy farms, and the sensitivity and accuracy of commercially available systems remains subpar.

One reason for the poor performance of automated systems is that these are ultimately all validated upon our current ‘gold standard’ for lameness assessment, but as is clear from our discussion above, there are good reasons to be skeptical of these measures. Ultimately the development of good automated systems requires the development of large reliable data set that could be used to ‘train’ these systems.

In recent work at UBC we have begun to develop a pipeline for a method that to develop a very large data set of lameness videos scored with a high degree of precision, that could then provide a strong training data set for future models. A key feature of our method is that it overcomes one of the limitations of manual scoring -- the reliance on comparing the assessed cow with an absolute standard that the observer has been trained to recognize. Our method is instead based upon a large body of literature in psychophysics showing that comparison-based assessments are more accurate and sensitive than absolute ones. We were so confident in the power of this relative assessment approach that we hypothesized that comparison-based lameness assessment could be successfully performed by untrained assessors. We presented 90 video pairs to crowd workers (n = 50 per video pair) recruited from Amazon MTurk, asking them to choose which cow is more lame and by how much (Figure 1). We then

evaluated how different data filtering and clustering methods affected the number of crowd workers required to reliably score lameness.

We found that crowd workers were able to reliably perform these assessments. When averaged, there was high agreement between the scores of experienced assessors and crowd workers regardless of data filtering and clustering methods (Figure 2). We found that only 10 crowd workers were needed to produce responses that were in high agreement with experienced assessors. This result shows that comparison-based lameness detection can be conducted rapidly and inexpensively.

Our approach provides an efficient method of generating training data to train computer vision systems to automatically detect which cows are lame. We are now working on other elements of scoring pipeline to develop a large data base with a sufficient number of video comparisons between different cows to develop new automated systems.

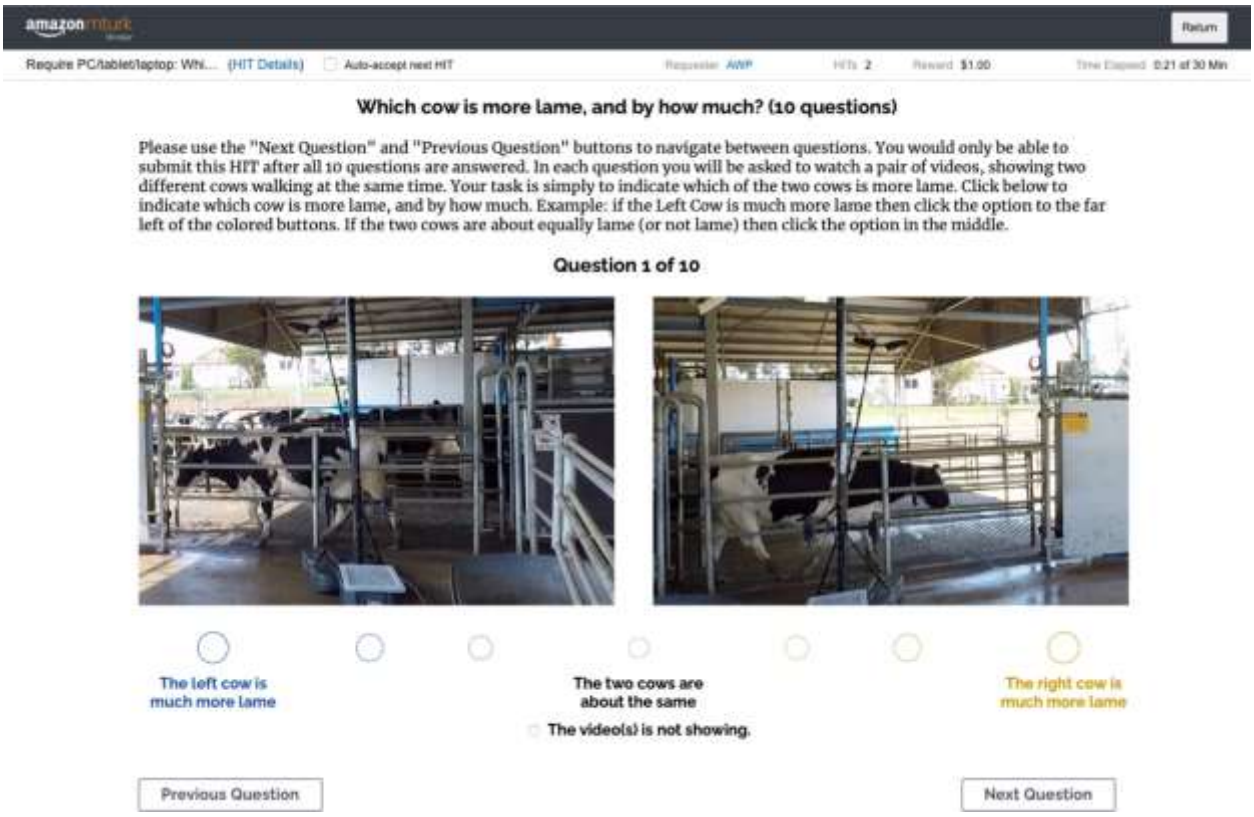

Figure 1. The user interface published on Amazon Mechanical Turk to recruit crowd workers for comparative lameness assessment. For each question, workers were asked to choose which cow they consider more lame and by how much, by clicking on one of the 7 bubbles below the videos. Videos were autoplayed simultaneously on a loop with the 2 cows walking in opposite directions.

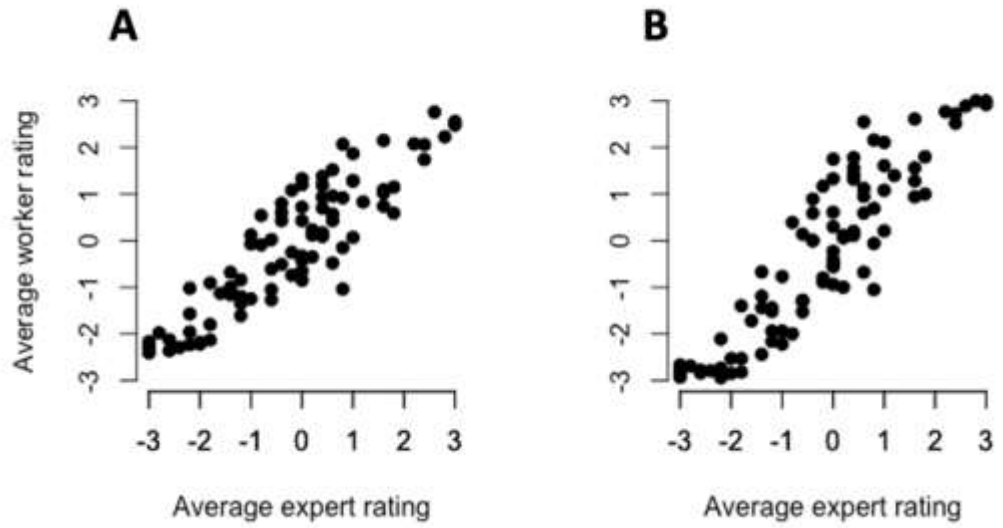

Figure 2. The graph illustrates the agreement between the average scores of the five experienced lameness assessors (represented on the x-axis) and the average scores of the crowd workers (represented on the y-axis) for each of the test video pairs presented. Values below 0 indicate that the cow in the left video was more lame, and values above 0 indicate that the cow in the right video was more lame. The first graph (A) shows the average of all worker responses without any filtering, resulting in an intraclass correlation coefficient (ICC) of 0.89. The second scenario (B) presents the average of worker responses after applying strong filtering and clustering, resulting in an ICC of 0.90.

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