



Final report

Video Based Automated Cattle Weighing System

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Abstract

This project was undertaken to address the limitations of traditional cattle weighing methods, which require physical handling, are labour-intensive, and can cause stress to the animals. The objective was to develop an automated, non-intrusive, video-based system capable of estimating the weight of live cattle as they move naturally through a walking path or high visitation area, without requiring direct contact or disrupting their behaviour.

The project involved five on-site data collection sessions at the Elizabeth Macarthur Agricultural Institute, where synchronized RGB video footage and ground-truth weight were collected from 1,685 cattle.

Two machine learning models were developed using RGB images: a two-view model (top + side views), and a top-view-only model. The top-view model achieved a Mean Absolute Error (MAE) of 23.19. When a side-view camera was available, the two-view model delivered the best results, achieving a MAE of 19.83 kg, highlighting the benefit of incorporating complementary visual perspectives for improved prediction accuracy.

The results demonstrate strong potential for industry adoption, providing a scalable, low-stress alternative to manual weighing with the benefits of automation, labour savings, and improved animal welfare.

Executive summary

This project aims to develop an automated, video-based system for estimating the weight of live cattle in a convenient, non-intrusive manner that avoids disrupting their natural movement or requiring physical contact. The envisioned application scenario places one or two cameras alongside cattle walking path or high visitation area (e.g. water point) on farms, enabling continuous monitoring as animals pass through.

Following the approval of the ethics proposal, the team conducted five data collection visits to the Elizabeth Macarthur Agricultural Institute, Department of Primary Industries and Regional Development, NSW Government. During these sessions, synchronized video footage and corresponding ground-truth weight measurements were gathered from 1,685 cattle. This data formed the foundation for model training, validation, and performance assessment.

To accommodate different deployment conditions, the team developed two types of weight estimation strategies: multi-view (two-camera) and single-view (one-camera) solutions. The two-camera system combines synchronized top-down and side-view RGB images to provide comprehensive visual coverage of each animal, capturing both body width and profile features for improved weight estimation. In contrast, the single-view approach relies solely on top-down RGB images, offering a simpler and more practical setup with slightly reduced accuracy.

Two models were trained using RGB data for cattle weight estimation: Top view and Top + Side view. The Top view model achieved strong performance with a MAE of 23.19 kg, making it a practical and scalable single-camera solution. The Top + Side view model delivered the best overall accuracy (MAE of 19.83 kg) by leveraging complementary perspectives but requires a more complex setup.

Overall, the results demonstrate that the proposed system is a viable alternative to traditional weighing methods, particularly in scenarios requiring automation, non-contact measurements, and large-scale deployment. The findings also highlight the trade-offs between system accuracy and hardware complexity, providing a strong foundation for future field trials and real-time system integration.

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1. Background

1.1 Project background

Cattle weight is a key indicator for health, growth, and market readiness in the livestock industry. Traditionally, weight estimation relies on mechanical scales, which require animals to be physically moved, restrained, and handled—procedures that can be labour-intensive, time-consuming, and stressful for the animals. These limitations are particularly problematic in large-scale operations or remote regions where infrastructure is minimal and labour resources are limited.

To address these challenges, this project set out to develop an automated, non-intrusive, and video-based cattle weighing system. The system leverages multi-view RGB cameras combined with artificial intelligence (AI) to estimate the live weight of cattle as they walk through a designated track. By removing the need for physical contact or interruption to animal routines, the system enhances both operational efficiency and animal welfare.

The motivation for this project stems from growing industry demand for more sustainable, scalable, and stress-free solutions for livestock management. With the red meat sector increasingly focused on productivity, welfare, and data-driven decision-making, there is a strong need for continuous weight monitoring that fits into existing farm routines with minimal disruption. The proposed system addresses this need by providing frequent and reliable weight data that can assist with feeding optimization, health management, and growth trend analysis.

This initiative builds upon previous research by the UTS team in the areas of computer vision for livestock monitoring, including work on poultry behaviour analysis and automated animal density estimation. The team identified a critical gap in existing solutions: while some technologies use wearable sensors to monitor cattle activity, none provide **direct, contactless weight estimation** using visual information.

1.2 Project overview

To validate this concept, the team collaborated with the Elizabeth Macarthur Agricultural Institute (EMAI), where cattle with known weights were recorded using a custom camera system. Over the five visits, more than 26,000 valid cattle RGB images were collected from 1,685 cattle. This dataset enabled the training of machine learning models capable of predicting weight from visual data. Two system configurations were explored:

- **Two-view model** using top-down and side camera images.
- **Single-view model** using top-down view to accommodate situations where fewer cameras are feasible.

A staged development approach—starting with data collection and model training, followed by prototype evaluation and testing—ensures the system is grounded in practical farm conditions. Furthermore, the choice of lightweight machine learning models enables deployment in remote or solar-powered environments where compute resources are constrained.

Ultimately, the project demonstrates that a vision-based system can offer cattle producers an effective alternative to conventional weighing methods. By continuously collecting data and estimating weight passively, it unlocks opportunities for better-informed decisions, reduced labour, and improved animal welfare.

2. Objectives

The primary objective of this project was to develop a non-intrusive, automated video-based system for estimating the live weight of cattle, enabling practical deployment on commercial farms without disrupting animal movement. The key goals included:

- Design and implement an imaging system using RGB cameras to capture top, side, and angled views of cattle as they walk through a monitoring zone.
- Collect a comprehensive dataset of synchronized video footage and accurate ground-truth weight measurements from cattle in a realistic farm setting.
- Develop and train AI models capable of accurately predicting cattle weight from single- and multi-view images, with particular emphasis on robustness and generalization to new cattle.
- Evaluate model performance using metrics such as Mean Absolute Error (MAE) and percentage error, and assess the trade-offs between model complexity and prediction accuracy.
- Identify a commercially viable solution, emphasizing configurations (e.g. single-view) that offer strong predictive performance with simpler, cost-effective hardware for practical field deployment.

3. Methodology

3.1 System Architecture

3.1.1 System setup

As illustrated in Fig. 1A, a top-down layout was implemented using three cameras strategically positioned to capture cattle from different angles as they exited the crush. The setup was installed in an outdoor area immediately following the weighing scale. The top-view camera (marked as 1 in the orange circle) was mounted at a height of 4 meters, located 5.7 meters from the crush, and suspended at the centre of a 3-meter-long horizontal pole. This placement provided a stable and unobstructed overhead view of each animal.

In the Figure 1B, the side-view camera (marked as 2 in the orange circle) was mounted on the same tripod as the top-view camera, ensuring that both cameras operated on the same horizontal plane for synchronized image capture.

This multi-camera configuration ensured comprehensive visual coverage of each animal from top-down, side, and oblique angles, facilitating accurate training data for AI-based weight estimation.

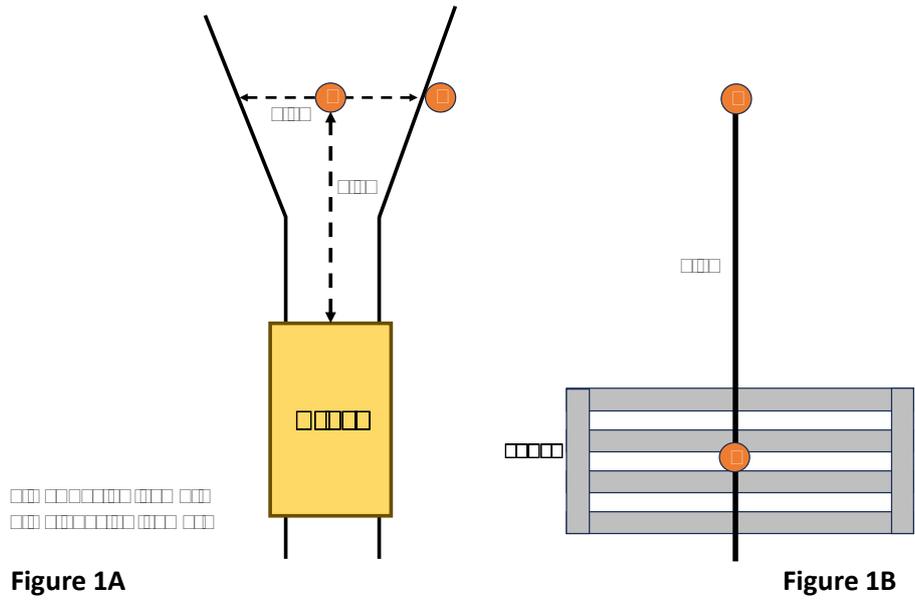


Figure 1 Camera setup

3.1.2 Data collection process

The data collection process involved recording cattle weight using a crush scale and capturing multi-view video footage.

- **Weight Measurement:**

As shown in Fig. 2, cattle were guided into the crush one by one, where their weight was measured using a scale. A team member recorded the weight, tag ID, and weighing order for each animal. This manually recorded data was to ensure write down the right order of cattle going through the crush, as some cattle did not walk through the camera after weighing, those cattle would not include in the dataset



Figure 2 Scale weighing

- **Multi-View Video Capture:**

After weighing, the cattle exited the crush and walked through a designated track equipped with two cameras positioned at different angles—top-down (No.1) and side view (No.2) in Fig. 3. These cameras continuously recorded each animal as it moved through the track, capturing detailed visual data for model training.



Figure 3 Camera Setting

3.2 Data summary

In total, the UTS team collected 1,685 head cattle top-view and side-view image sets, covering a weight range of approximately 93 to 858 kg. For model evaluation, the top-view and top-side view datasets were partitioned into 1,085 cattle for training, 100 for validation, and 500 for testing, with the test set containing cattle not used during training to ensure unbiased performance assessment.

As shown in Table 1 and 2 the training set includes cattle with weights ranging from 93 kg to 858 kg, with the majority concentrated in the 100–300 kg and 500–700 kg ranges. The testing set of 500 cattle follows a similar weight distribution, providing a solid foundation for evaluating the model's performance across a diverse range of body weights, including both lighter and heavier animals.

Table 1 Training data weight distribution

Group (KG)	Count
<100	3
100-200	124
200-300	456
300-400	97
400-500	88
500-600	158
600-700	123
700-800	33
>800	3

Table 2 Testing data weight distribution

Group (KG)	Count
<100	2
100-200	92
200-300	100
300-400	59
400-500	45
500-600	97
600-700	77
700-800	28

4. Results

4.1 Evaluation Results

4.1.1 Evaluation Metric

To assess the performance of the cattle weight prediction model, we adopted two commonly used regression evaluation metrics: **Mean Absolute Error (MAE)** and **Percentage Error**. These metrics quantify the difference between the predicted weights and the actual ground-truth weights, providing insights into both absolute and relative model accuracy.

1. Mean Absolute Error (MAE)

The **Mean Absolute Error** measures the average magnitude of the prediction errors, without considering their direction (i.e., whether the model overestimated or underestimated the weight). It provides a straightforward interpretation of how far the predictions are, on average, from the actual weights.

Equation:

$$\text{MAE} = \frac{1}{N} \sum_{i=1}^N |\hat{y}_i - y_i|$$

Where:

- N = number of samples
- \hat{y}_i = predicted weight of the i -th sample
- y_i = actual (ground-truth) weight of the i -th sample

Interpretation:

A lower MAE indicates that the model's predictions are closer to the actual values. For example, an MAE of 25 kg means that, on average, the model's predictions deviate from the true weight by 25 kg.

2. Percentage Error

The **Percentage Error** expresses the prediction error relative to the ground-truth weight, allowing for an understanding of model accuracy across different weight scales. This is especially useful in livestock applications, where cattle may vary significantly in size.

Equation:

$$\text{Percentage Error}_i = \frac{|\hat{y}_i - y_i|}{y_i} \times 100\%$$

Interpretation:

Percentage error highlights how accurate the predictions are relative to the animal's actual weight. For instance, a 5% error on a 600 kg cow equals a 30 kg deviation, while the same 5% error on a 300 kg cow equals only 15 kg. This metric is useful when comparing model performance across animals of different sizes.

4.1.2 Evaluation Results on Independent Testing Dataset

The weight prediction models were evaluated using a dedicated test set of 500 cattle, spanning a broad weight range from 92 kg to 796 kg. This test set was completely independent of the training and validation data, ensuring a rigorous and unbiased assessment of the models' performance, robustness, and ability to generalize to previously unseen animals.

The two-view model (top + side) achieved the lowest Mean Absolute Error (**19.83 kg**) and the lowest average percentage error (**6.06%**), indicating superior predictive accuracy and consistency. The top-view model, while simpler and more robust in terms of view stability, showed a slightly higher MAE of **23.19 kg** and a percentage error of **6.12%**.

Fig. 4 and 5 present the absolute prediction errors for all 500 cattle in the testing dataset. In each plot, blue dots represent individual predictions, where the horizontal axis indicates the actual weight (measured by scale), and the vertical axis shows the corresponding absolute error between the predicted and actual weight. The red line denotes the average absolute error across the dataset.

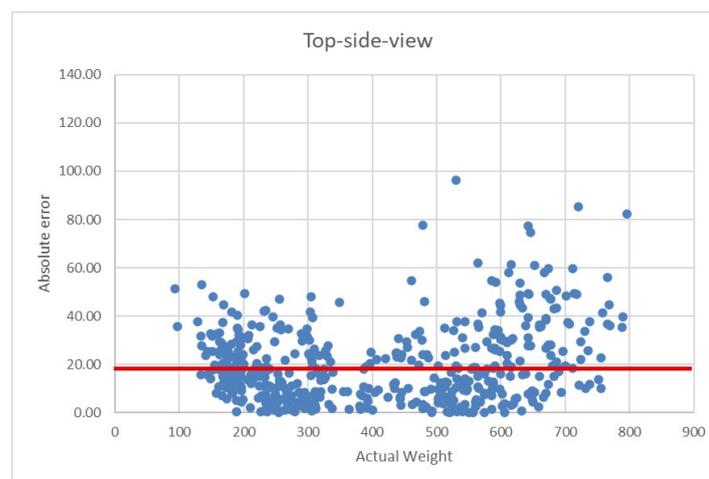


Figure 4 Top+side-view scatter, MAE 19.83kg, percentage error 6.06%

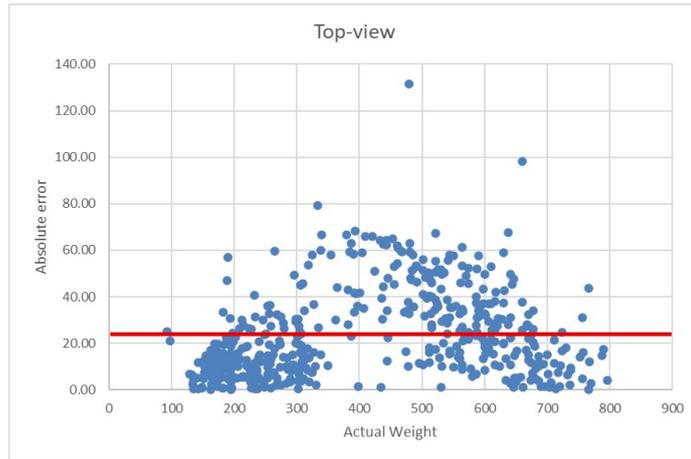


Figure 5 Top-view results scatter, MAE 23.19kg, percentage error 6.12%

Overall, the Top view and Top + Side view models demonstrate strong performance, with prediction errors tightly clustered near the lower range—indicating high accuracy and reliability. Notably, the Top view model stands out for achieving this level of performance with a simpler, single-camera setup, making it a highly practical and efficient solution for real-world applications.

Figures 6 and 7 illustrate a comparison between the predicted weights and the ground truth values across the three camera view configurations. In each plot, the blue line represents the model’s predicted weights, while the red line shows the corresponding ground truth measurements.

It is evident that the Top + Side view configuration produces predictions that closely follow the ground truth line, indicating superior accuracy and consistency compared to other single-view models. This suggests that combining top-down and side-view images provides richer spatial information, enabling the model to better capture the physical characteristics relevant to weight estimation. In contrast, the Top-view model—limited by reduced feature diversity and spatial context—exhibit greater deviation from the ground truth.

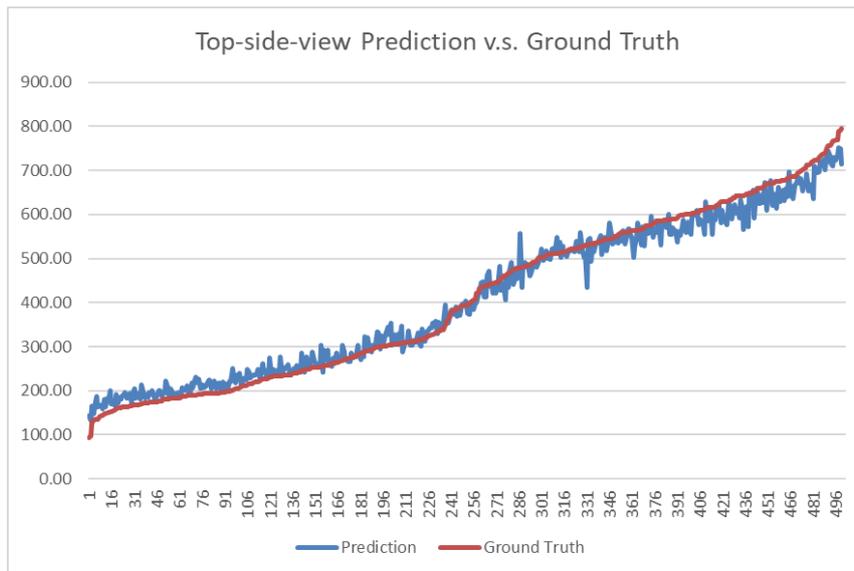


Figure 6 Top-side-view Prediction and Ground Truth comparison

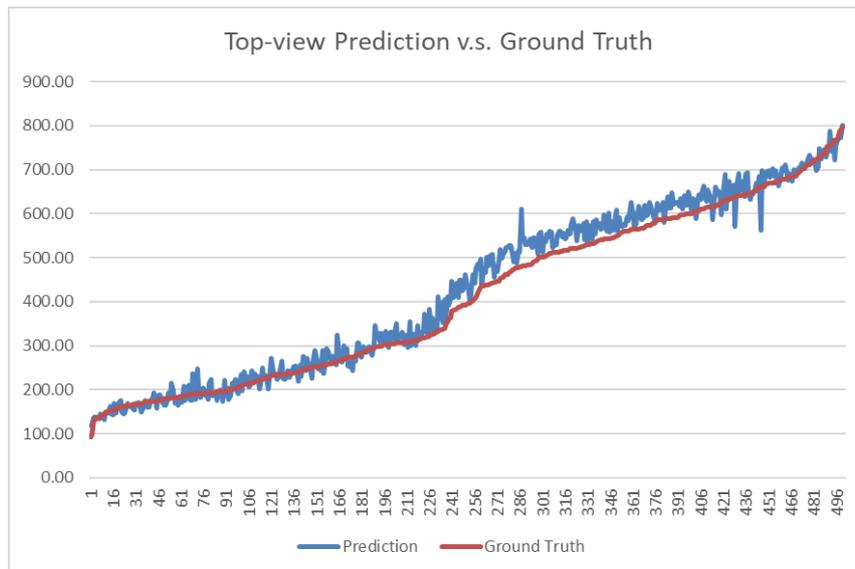


Figure 7 Top-view Prediction and Ground Truth comparison

5. Conclusion

This project successfully developed and validated a prototype for a video-based automated cattle weighing system that leverages RGB imaging combined with AI-driven weight estimation. The system demonstrated its ability to estimate cattle weight with a high degree of accuracy while eliminating the need for physical handling or manual weighing.

5.1 Key findings

Through extensive data collection—spanning five farm visits and 1,685 multi-view samples—the project trained and evaluated multiple model configurations. The two-view model (top + side views) achieved the best overall performance, with a Mean Absolute Error (MAE) of 19.83 kg and an average percentage error of 6.06%. Notably, the single-view (top-view) model also performed competitively, with a MAE of 23.19 kg and offering a more practical setup for remote or resource-constrained deployments.

The results confirmed the feasibility of using AI and computer vision for non-intrusive cattle monitoring, presenting a promising alternative to traditional weighing systems. The system's ability to generalize to unseen cattle and operate under varied farm conditions supports its on-farm application in commercial settings.

5.2 Feasibility and Business Case

This project has demonstrated the technical feasibility of a real-time, video-based cattle weight prediction system using standard RGB cameras and AI models. The developed prototype successfully estimates cattle weights from live video feeds with reasonable accuracy under practical farm conditions. Although the current level of precision may not yet meet the strict requirements for commercial meat trading, it is highly suitable for on-farm use, where absolute precision is less critical than monitoring growth trends and animal performance over time.

The system operates using affordable, easy-to-deploy hardware, such as a single RGB camera and a lightweight computing device. Its non-intrusive nature ensures stress-free monitoring without the need for manual weighing, which is particularly beneficial for improving animal welfare and reducing labour demands. Once set up, the system can function autonomously, continuously capturing weight estimates as cattle move naturally through the camera's field of view.

Although the system is not intended for direct use in commercial saleyards or livestock trading, where precise weight measurements are essential, it addresses a critical need MLA has identified in precision livestock farming. By enabling routine monitoring of cattle growth and providing continuous, automated data collection, the system enhances decision-making related to feeding, health management, and herd performance. Its ability to integrate seamlessly with digital farm management platforms makes it a cost-effective, scalable, and intelligent solution for improving operational efficiency, promoting animal welfare, and boosting overall farm productivity.

5.3 Commercial Recommendations

To transition the prototype into a commercial cattle weight prediction system, several coordinated developments are required across technical, operational, and business domains. The first priority is expanding the dataset to include a wider range of sites (e.g. water points) cattle breeds, ages, and weight categories, especially those underrepresented in the current training data. This would allow the AI models to generalize more effectively across different production environments. The inclusion of more diverse environmental conditions—such as lighting, background variations, and movement patterns—will also help improve robustness and reduce prediction bias.

In parallel, the existing models should be further optimized for real-time inference on edge devices. This involves reducing computational complexity so the system can run efficiently on portable processors such as NVIDIA Jetson or similar farm-deployable hardware. By eliminating reliance on cloud processing, the system becomes more suitable for remote farms with limited connectivity.

On the hardware side, the next step is to integrate the camera and processing components into a rugged, easy-to-install package that can be mounted in typical cattle handling areas, such as walkways or water points. This hardware should be weather-resistant and designed for minimal maintenance. Simultaneously, the software interface should be developed into a user-friendly platform that displays live weight estimates, tracks individual animal progress over time, and synchronizes with farm management tools when internet access is available.

To validate the system's commercial readiness, pilot trials on different working farms are essential. These trials will provide insight for MLA and wider industry into usability, accuracy in uncontrolled conditions, and the system's value in day-to-day management. While the model's accuracy may not yet meet the threshold for formal livestock trading, it offers considerable value in monitoring growth trends, making nutrition decisions, and supporting early detection of underperforming animals.