Report

Smart Scale – Pig Weight Estimation

This report contains a high-level overview of the pig-weight estimation app using computer vision algorithms. Details about algorithms are omitted intentionally due to confidentiality concerns.

Summary

In this project we designed, developed, and deployed a pig smart scale android application utilizing various sophisticated algorithms and technologies. The app is mainly used to estimate the weight of a pig from its 3D scanned image. A scanner to capture the 3D image of the pig is attached to the backside of the device. We use *openNI library to access the scanner and openGL* library for the 3D visualization of the pig using point clouds. We develop regression formulas to find the weight of a pig from the girth and length of it using the collected dataset. During the development we used clustering and *consensus and alignment algorithms* to detects anomalies, align the pig, and reduce the processing time. Last but not least, we used android's SQLit to store the result of estimation inside the android device and further deployed post-processing techniques to draw a productivity graph of the pig. The application is tested and verified using Samsung Tab S3 with a processing time of 7 seconds and an accuracy of 97%.

Introduction

The shape of the pig is the most important indicator of its health, whether for breeding or for carcass quality. Currently, the most used tools to assess the conformation of the pig are done manually, either by eye or scale to measure its weight. The traditional weighing method without a scale relies on the girth size just behind the front legs, but some researches have proposed 2D image based, whereas others have proposed that it can be also estimated from 3D point clouds.

To measure the weight of the pigs, we implement a portable scanner called Structure Sensor to collect the point cloud data of pigs. The scanning process was a bit challenging because of the pigs' behavior. The body scanning in all our experiments is shown in Figure 1. The dataset contains all the necessary information needed; it covers all the pig's body. However, it also includes meaningless components such as walls and the ground as the scanner process was conducted in pigs' farm.

1. Floor and wall Removal:

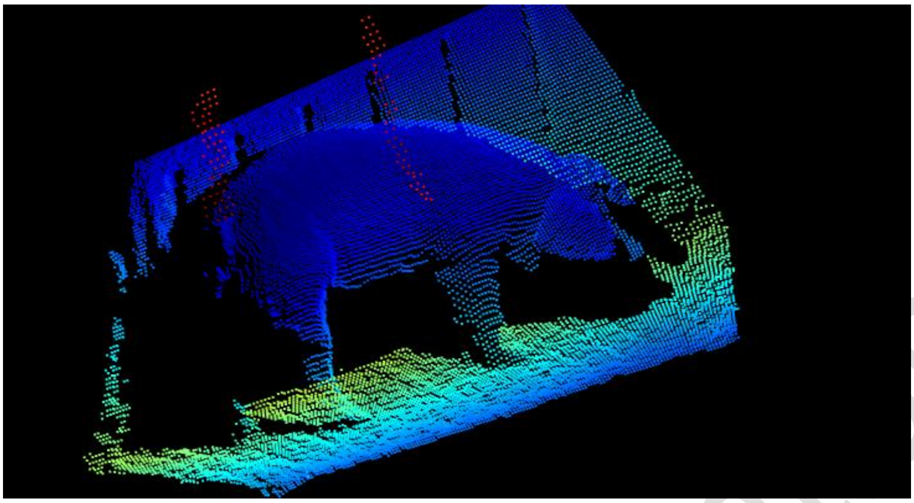


Figure 1: Raw point cloud data including walls, floor and noise

After scanning the pig in a certain environment, all scene is being collected including the pig as shown in Figure 1. Our aim in the section is to remove all the walls and the floor in the point cloud. To do so, we must detect the planes (the flat surfaces) in the 3D point cloud and thus remove them.

We implemented a consensus algorithm to obtain point clouds without flat surfaces as shown in Figure 2.

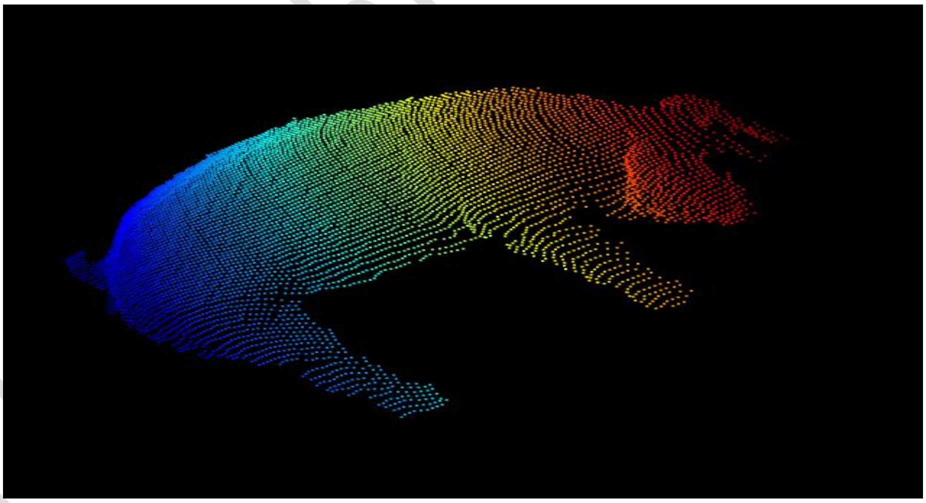


Figure 2: The point Cloud after removing the flat surfaces

2. Pig clustering:

The collected point cloud does not always contain the pig and flat surfaces only but also it may have other pigs and noise (outliers) as well as shown in Figure 3. Therefore, we need to be able to detect our target through these unnecessary data.

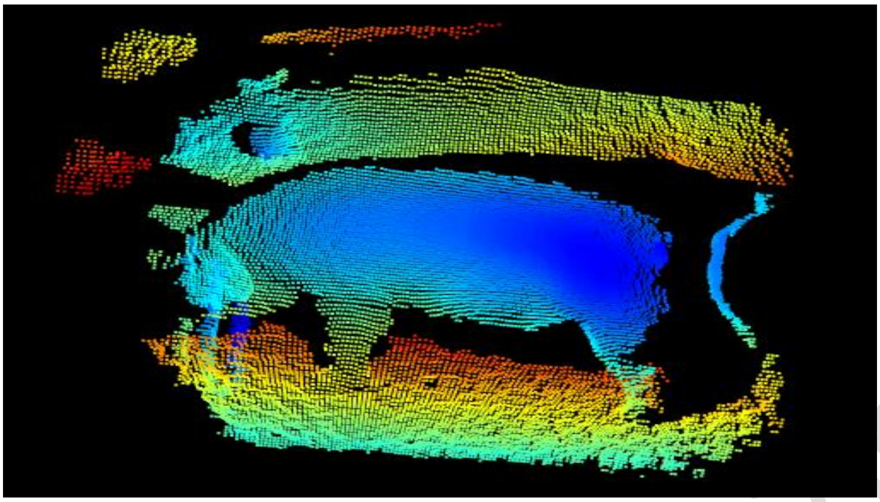


Figure 3: A different scenario where the point cloud has more than one pig and noise

In order to segment the target pig, we perform clustering. The clustering helps to subdivide the data into groups then extract the group (cluster) which has the highest density (In this case it is our goal).

Figure 5 shows the flat surface removal algorithm; it successfully removes the floor. However, it is mandatory now to segment the target pig.

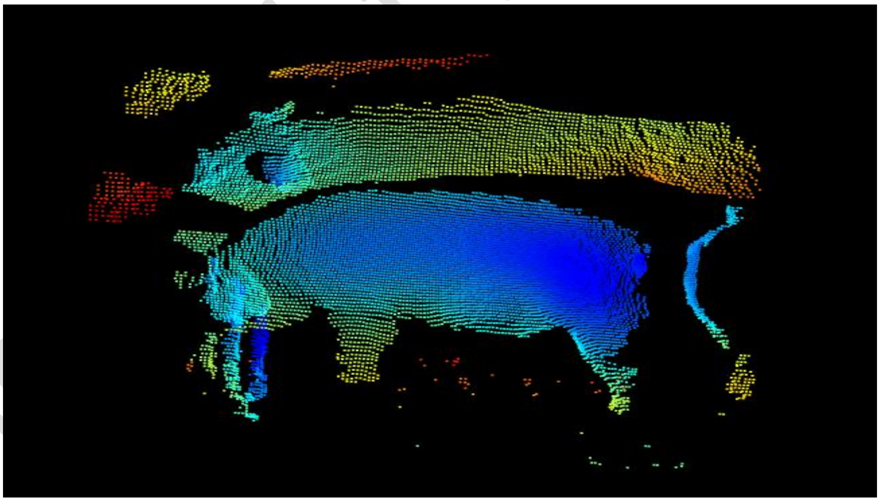


Figure 4: The point cloud floor removal after applying the clustering algorithm

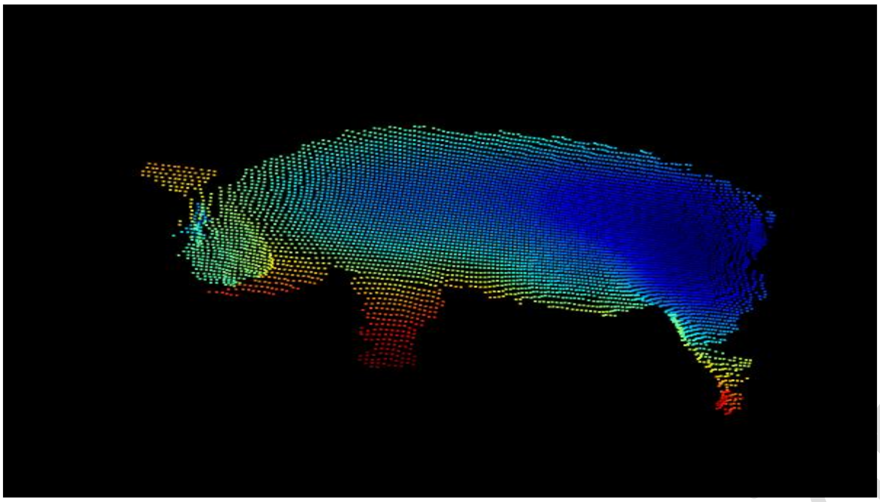


Figure 5: After clustering, the pig is successfully segmented

Combining plane fitting algorithm and the clustering algorithm allows us to reach our target pig neatly without outliers as shown in Figure 6.

3. Alignment

In order to perform the plane sweeping, we need to select which axis to sweep. Thus, the alignment process is needed. The alignment process is just transforming the point cloud to a different coordinate system.

To align the point cloud, we used an approach based on Principal Component Analysis (PCA).

After solving the PCA equations, we will end up with the affine transformation matrix. In Figure 7, we show how the point cloud shifted to the origin of the coordinate system using the alignment process.

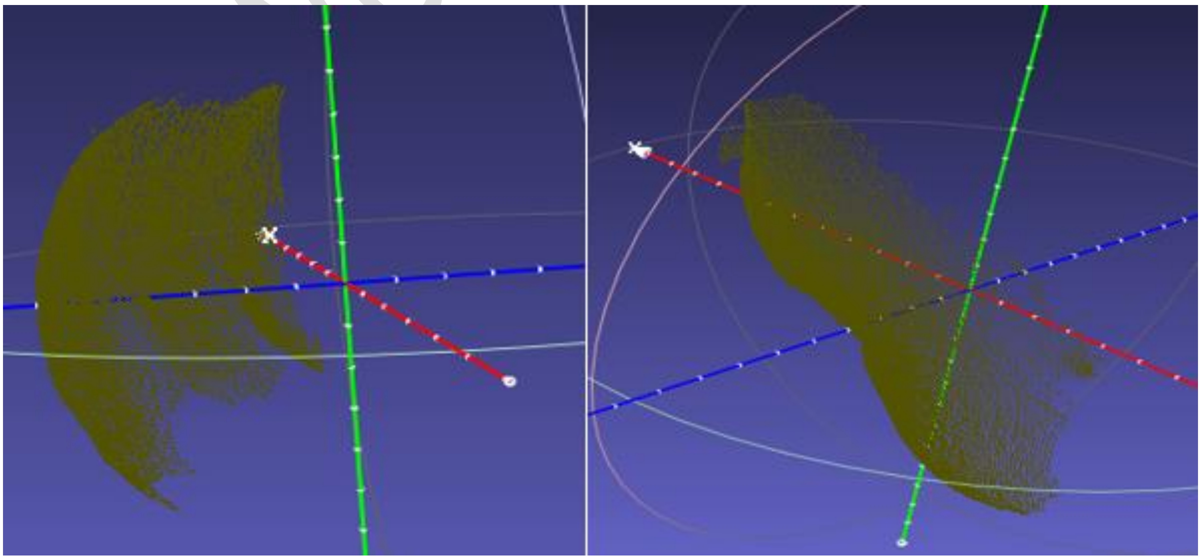


Figure 6: Left: Before alignment. Right: After alignment

The reason behind using the alignment is to use cross-sectional plane with the resulted point cloud in order to detect the girth size and back length through an axis and estimate it.

Demo

We test the application using Samsung galaxy tab S3 as illustrated in Figure 8 and Figure 9. In the first view of the application, a user can take a scan of the pig and visualize it in 3D point cloud. By tapping the *calculate* button the user sees the calculated weight of the pig.

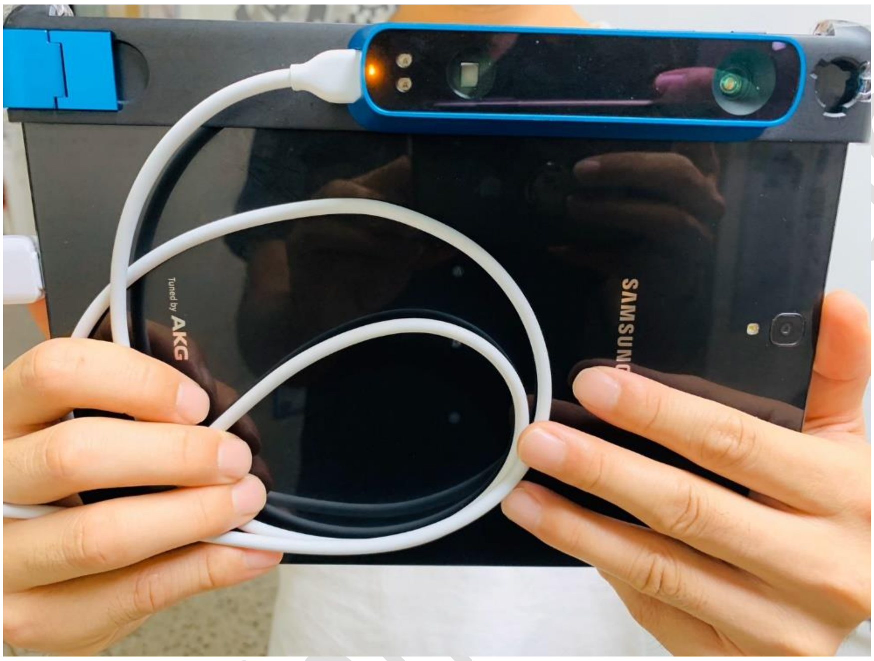


Figure 7: Back view – The attached portable device (Structure Sensor) is used to collect 3D information of the scene which is required to build 3D point cloud of the pig.

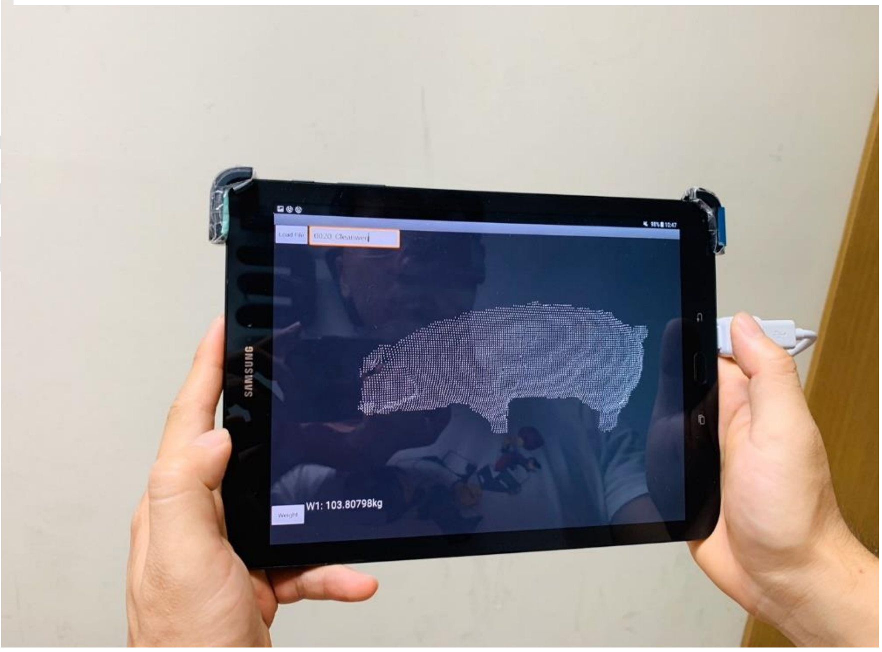


Figure 8: Front view - The app visualizes a clean pig point cloud while all the outliers are removed.

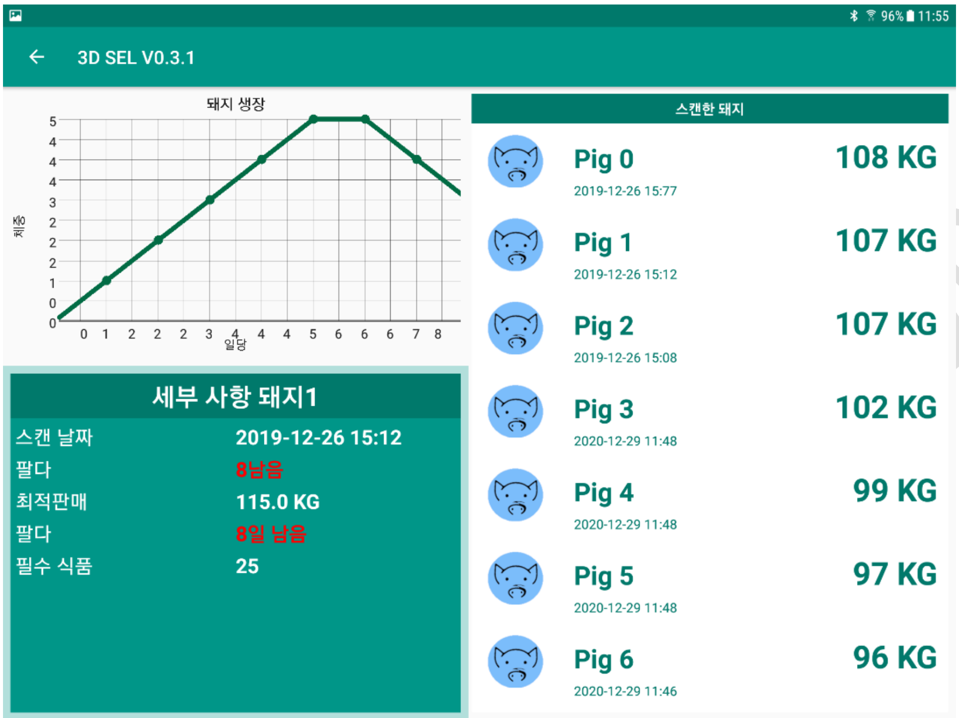
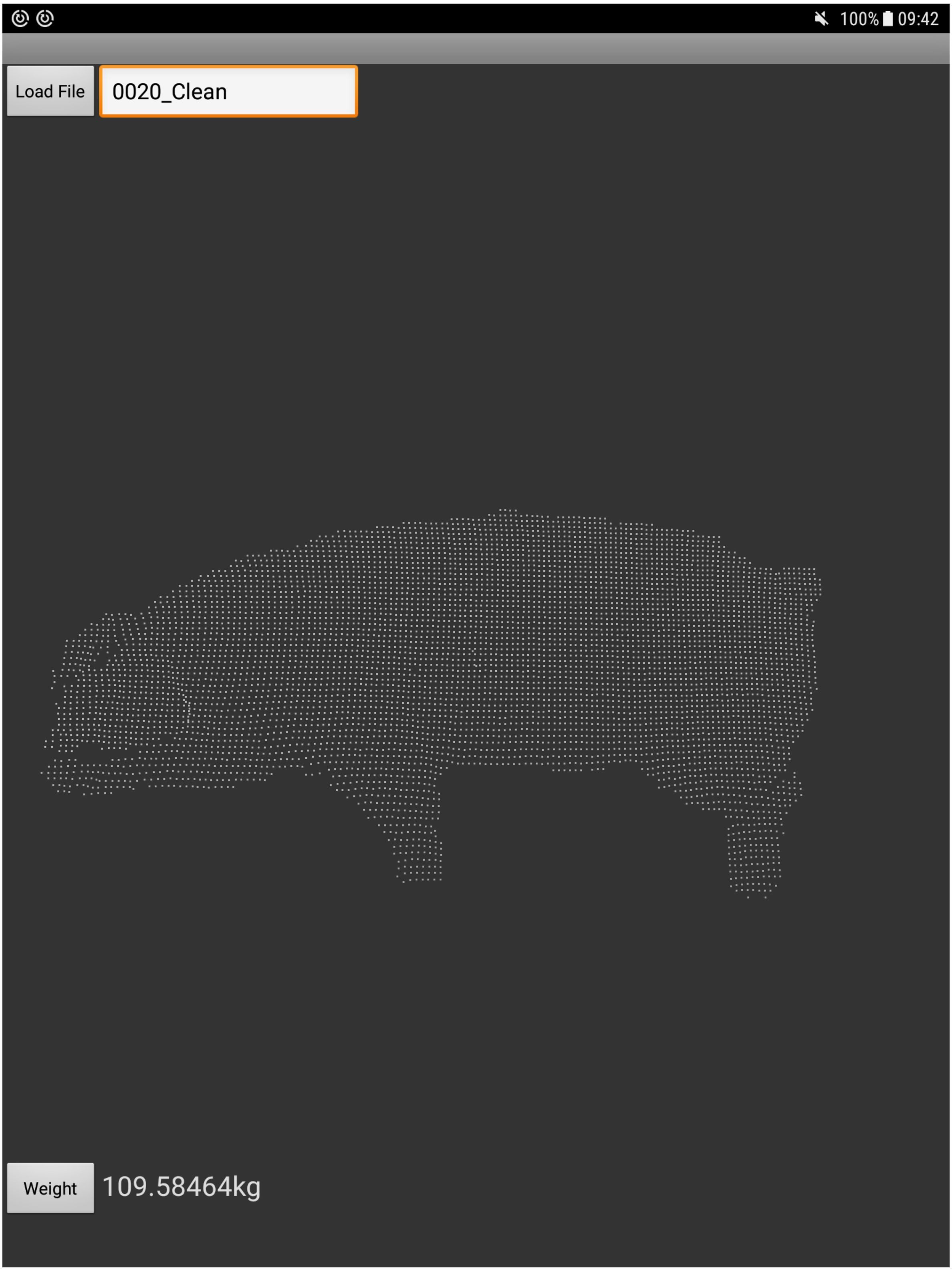


Figure 9: Interactive UI interface: Displays the list of scanned pigs along with its estimated weights (right) and details – date of scan, days left for the optimum sell point, and required food to get to the optimum sell point(left).

Miscellanies



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