final report

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Study to investigate the development of an automated chine bone cutting solution for Australian cattle boning lines.

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Abstract

The object of this project was to investigate whether the developed software for finding data in pig middles, to control the sawing off the chine bone of pig middles, also has the feasibility to identify similar data in cattle middles to saw off the chine bone of beef middles.

As basis for the project, the body of this report shows where in the world the cattle chine bone cutting is used. Furthermore, how the backs or middles can be scanned, how the known software reacts and finally, a draft concept for a cattle chine bone cutting cell set-up.

The project provides a solid basis for continuing the development of an automatic chine bone saw for cattle, which can reduce OH&S costs and lift the yield in this area significantly.

Executive Summary

The Meat Industry Strategy Plan 2020 has identified that the automation technologies and objective measurement will be the primary avenue to increasing efficiency and minimizing costs to Australian red meat supply chain. In that connection MLA recognized the precise vision-controlled automatic robotic Chine Bone sawing of pig spines from Frontmatec in a Danish pig-deboning department. The process saves manpower and performs an accuracy which will lift the yield significantly. Furthermore, it will reduce the number of OH&S risks.

As basis for the chine bone cutting of cattle, a study is made of how cattle carcasses are deboned in different countries. Different Frontmatec employees around the world collected videos and wrote methods, how the deboning of cattle is performed. It identifies how the cutting up of the carcasses is performed and where in the world sawing off the cattle chine bone is performed.

To investigate if the known software for controlling the chine bone sawing of pig middles is able to control the chine bone sawing of cattle middles, a temporary camera system is established and a row of scans is made in a Danish cattle slaughterhouse.

It identifies what challenges to overcome at the practical scanning process and how similar and different the scans are, compared with the known scans from pig middles.
An analysis of the scans and how the known software reacts is made, showing that the known software can form a significant basis for a further developed software, able to control a saw along an optimized path through beef middles and saw off the chine bone.

The information from the different steps in the project is collected and together with the experience collected in connection with a well-running robot cell cutting chine bones from pigs, a draft concept for a cattle chine bone cutting cell set-up is drawn up.

Next steps for the development of an automatic process for cutting cattle chine bones are suggested in the Conclusion and Recommendations sections.

With the conducted project, a significant step was taken towards the development of an automated process for cutting off cattle chine bones.

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1 Background

The Chine Bone sawing of the Strip loin and the Rib loin is performed in countries where a high amount of cattle is bred and slaughtered, e.g. Australia and North and South America.

Currently, the process is performed manually using industrial band saws which are dangerous tools posing significant OH&S risks. The task is arduous to all operators, and due to the requirement of accuracy in order to maximize yield unskilled persons cannot perform it.

MLA recognized the precise automatic robotic Chine Bone sawing of pig spines from Frontmatec in a Danish pig deboning department as a possibility of reducing the number of OH&S risks, save manpower and get an accuracy which will lift the yield.

With the given actuality of the sawing off the Chine Bone at cattle and the possible advantages, the idea to use this process at cattle Chine Bones was born.

Consequently, the project to investigate whether a similar software and the principles for sawing pig Chine Bones could be used at cattle was initiated.

2 Projective Objectives

2.1 Project outputs/outcomes

The purpose of this project: "Investigate the development of an automated chine bone cutting solution for Australian cattle boning lines" is focused on investigating the basis for the process and if the developed precise robotic process for chine bone sawing of pigs can be developed into a chine bone saw for cattle.

Project outputs/outcomes:

- An overview of how beef is cut up and deboned around the world, and how widely the chine bone sawing of cattle carcasses is performed.
- Design a setup for performing scans at a slaughterhouse and get agreement with a slaughterhouse.
- Perform test scans of beef backs in order to analyze what challenges to overcome.
- An analysis if the developed software for sawing pig Chine Bones could also find the different features for defining the sawing path in the scans of the beef backs.
- A draft concept (drawing) for a Chine Bone cutting cell setup for cattle.
- Conclusion and recommendations for the next step in the development of an automatic Chine Bone sawing cell for cattle.

3 Methodology

3.1 Milestones

The project is divided into the following milestones forming the structure of the project.

3.1.1 Milestone 1

Study current manual cutting processes of cattle chine bone and at different cutting lines. Compare methods in Europe, North America and Australia.

- Visit cattle slaughterhouses in North and South America and in Europe.
- Contact customers for information
- Contact salesmen for information
- Collecting videos
- Collecting information on the different ways of deboning.

3.1.2 Milestone 2

Install temporary camera system and scan numerous middle pieces at (at least) one beef cutting line (Europe-based plant).

- Visit a Danish cattle slaughterhouse
- Contact an American slaughterhouse
- Agreement with a Danish slaughterhouse
- Agree on setup for scans and how to practice
- Order and manufacture parts for set-up for scans
- Deliver, install, run in set-up for scans
- Preliminarily evaluate the first scans
- Conduct changes
- Perform scans of beef backs.

3.1.3 Milestone 3

Analyses of beef middle scans.

- Evaluate finally the quality of the scans
- Evaluate if the scans give sufficient information
- Identify challenges in connection with scanning
- Evaluate if the scanning and cutline prediction principle / the software developed for pork middles, can be upgraded so it can be applied for beef, or if a new principle and software need to be developed.

3.1.4 Milestone 4

Develop draft concept (drawing) for chine bone cutting cell setup.

- Collect gathered information in the project
- Collect and compare information and experience with existing running pig chine bone saw
- Build up 3D model and drawing for cattle chine bone saw.

4 Results and Discussion

4.1 Milestones

4.1.1 Milestone 1

Study current manual cutting processes of cattle chine bone and at different cutting lines. Compare methods in Europe, North America and Australia.

The study of current manual processes of beef deboning and especially chine bone cutting in different areas of the world showed that the deboning of cattle is not carried out in the same way from one region to another. So splitting of the carcasses is different, following old traditions of splitting and the different ways of consuming cattle meat.

Cutting primals:

There are several methods of departing cattle carcasses. The carcasses are typically hung into the chilling room in complete half carcasses. After that, different methods are applied:

1) In North and South America, the back is departed in two parts between lumbar vertebras and the rib vertebras in connection with the grading of the carcass. After chilling, the primals are cut off the complete left and right carcasses after the chilling room. The cuts made on the hanging carcass to get the primals are mainly horizontal cuts. After that, the different primals are cut up typically at tables or pace lines.
   Capacities up to 380 cattle/hour.
2) In Australia, the back is also mainly departed in two parts between the lumbar vertebras and the rib vertebras in connection with the grading of the carcass. The primals are also cut off the complete right or left carcasses after the chilling room. A row of different primal cuts is made at the different companies, where a row of vertical cuts also can be performed. The cuts made on the hanging carcass to get the primals are mainly horizontal cuts. After that, the different primals are cut up, typically done at tables or pace lines.
3) In Europe, the grading of the carcasses is typically performed by vision and weight. Here, the main way of departing the half carcasses starts with dividing the right and the left carcasses in a ham quarter (pistol) and a shoulder or fore end quarter. This process is executed just before (Norway) or just after the chilling room. The ham quarter consists of the ham and the back without ribs until blade bone, which means that a vertical cut of the ribs along the spine is made during hanging. After that, the quarters are cut into smaller pieces, which typically are deboned at tables or pace lines.
   Capacities up to 120 cattle / hour.

Sawing Chine Bone:

The spine is typically removed out of the back before consuming, except at few products like T-bone steak. The removing is mostly done by sawing off the Chine Bone, which is primarily performed in North and South America and in Australia but only a few sites in Europe.
At all other sites in Europe, the Chine Bone is removed together with the rest of the spine, featherbones and part of the ribs by manual deboning.

The sawing off the Chine Bone in North and South America and in Australia is due to the grading cut normally performed on two parts:

A rib part with 6^{th} to 13^{th} rib vertebras with ribs (see fig.1, cuts 2 & 3) and a part with lumbar vertebras, tale bones and sirloin (see fig.1 cut 2&9).

In connection with the rib part, some of the cuts: separation of Navel (fig.1 cut 4), Short ribs (fig.1 cut 5), Spare ribs and Cube (fig.1 cut 7) typically are performed together with cutting the Chine Bone from the Cube (fig.1 cut 6), which are all performed manually at a band saw.
In connection with the part with lumbar vertebras, tale bones and sirloin, the cuts: Separation of sirloin (fig. 1 cut 8) and separation of flank (fig.1 cut 12) are made together with cutting the Chine Bone from the Striploin fig.1 cut 11), which are all performed manually at a band saw.

These manual cuts are heavy, very dangerous and require high accuracy to maximize the yield, especially the Chine Bone cut, where the price difference / kg between the Chine Bone and meat underneath is high, and a too deep cutting is therefore quickly lowering the yield. On the other hand is a too high cutting resulting in too high costs in the deboning department.

This together with saving workers gives a robust basis for developing a machine for performing the Chine Bone automatically in a secure and precise way, if possible.

Fig. 1

4.1.2 Milestone 2

Install temporary camera system and scan numerous middle pieces at (at least) one beef cutting line (Europe-based plant).

Based on a visit at a cattle slaughterhouse in Denmark, a way to scan cattle middles was planned and a setup was defined:

1. We want so far as possible to scan the whole range of the different types of sorting available.
2. We want to get approx. 1000 scans.
3. Based on our experience at the visit we expected the backs with flat bones or short ribs could be placed well defined and stable at a plane conveyor belt.

Therefore, the scans could be done in two different ways:

1.) Scanning of about 300 backs from the different types of sorting several times, each a bit different, handed manually.
2.) Find a production where space was available to set up cameras for scanning the striploin and cube roll directly at the line on conveyor belts and scan approx. 1000 pieces.

Agreement with slaughterhouse:

At the beef slaughterhouse in Denmark, the cattle are quartered at the chilling room before cutting down in the deboning room. At the deboning room, the complete back is cut down from the ham (pistol) and after that, ham and other hind quarter parts. Therefore, the single backs were to be separated for a scanning and later put back to the deboning.

In parallel to this, it was investigated to get space at a line in the USA to scan directly where striploin and cube roll were passing, but we did not succeed in finding space at any line. Second problem was that we had to find space at more than one line, as we had to replace the system at at least two different lines to get the different types of sorting.

Based on that, an agreement with the cattle slaughterhouse in Denmark was made to get complete backs from blade bone to hip bone, so far as possible, from all different types of sorting available at the plant, for scanning. It was agreed that the slaughterhouse would remove the tenderloins before scanning.

The types of sorting was as follows:

1) Calves, age 9 – 11 months, 180 – 220 kg slaughter weight, 1 day I chilling room before deboning.
2) calves, age 7 – 11 months, all outside 180 – 220 kg slaughter weight, 1 day in chilling room
3) young cattle, age 12 – 24 months, 1 day in chilling room before deboning
4) milk cows, age 24 month to 90 months, 1 day in chilling room before deboning
5) beef cattle, age 2,5 to 3 years, 10 days in chilling room before deboning

We agreed to get the backs after primal cutting, manually handle them and deliver them to the deboning line.

Based on our experience we expected a flat modular belt could give the required basis for transporting the backs during the scanning.

A new belt conveyor 0.5m x 4m with a drum motor for a speed of 0.2 m/ sec, a cutting lamella belt and legs for a height of 800mm was designed and produced. To have the possibility to regulate the speed, a frequency convertor was added.

As scanning cameras, the same cameras as used for sawing chine bone off pork middles were used. Based on that experience and an analysis of the angles of the cattle backs the camera for looking at the splitting surface was placed at an angle of 30 degrees to the horizontal, while the camera looking at the ribs was placed at an angle of 45 degrees to the horizontal (Fig. 2).

To get as much knowledge as possible in connection with the later analysis of the images, a row of backs in some of the types of sorting was turned some degrees clockwise or counter clockwise before scanning (Fig.3).
Furthermore, some were bowed more than naturally (Fig. 4).

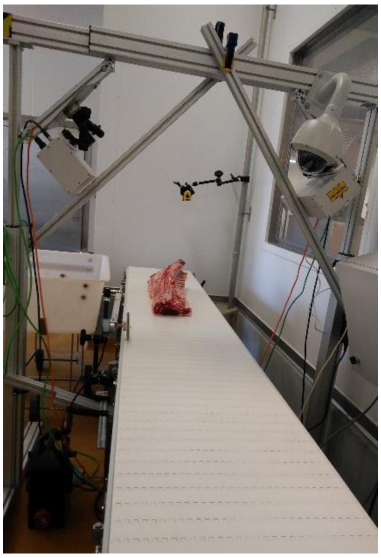


Fig. 2

Fig. 3

Fig. 4

After a row of scans, a preliminary analysis of the quality of the scans was made. It was observed that the important junctions between ribs/flat bones and spine were not visible in the full length of the back (Fig.5).

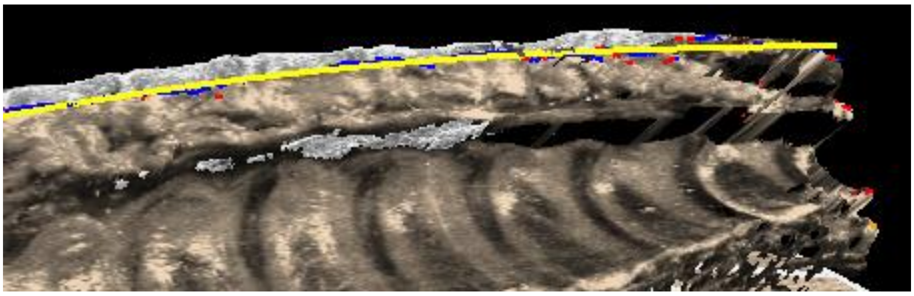


Fig.5 The white and black areas are without data, which is not usable as the junctions between spine and ribs/flat bones are covered here

Based on that, the camera looking at the junctions was also placed at an angle of 30 degrees compared to the horizontal. The movement (see Figs 6 & 7) resulted in visibility of the junction between ribs / flat bones and spine in the full length and invisibility of some unimportant areas between the ribs (see Fig 8).

Fig. 6

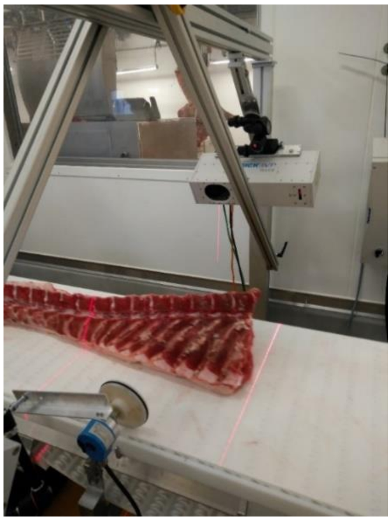


Fig. 7

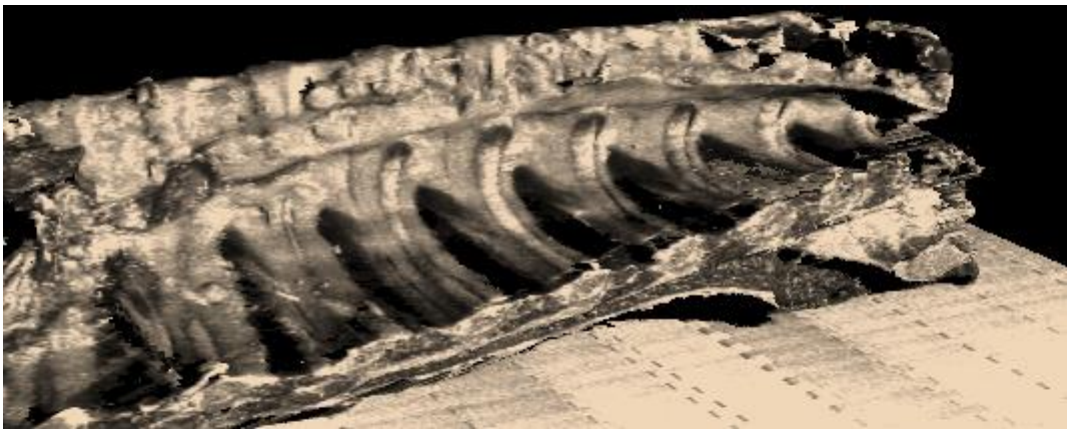


Fig. 8 The movement resulted in visibility of the junction between ribs / flat bones and spine in the full length and invisibility of some unimportant areas between the ribs

Result:
After two days approx. 300 backs were scanned three times.

First day: 20/11 2017 backs from:
10 pcs calves: age 9 -11 months 180 – 220 kg slaughter weight, 1 day in chilling room
50 pcs beef cattle: age 2.5 – 3 years, 10 days in chilling room
30 pcs milk cows: age 36 – 90 months, 1 day in chilling room
In total 90 backs.

Second day: 21/11 2017 backs from:
Approx. 30 pcs young cattle: age 12 – 24 months, 1 day in chilling room
Approx. 100 pcs calves: age 7 – 11 months, all outside 180 – 220 kg, 1 day in chilling room
Approx. 80 pcs calves: age 9 - 11 months, 180 – 220 kg slaughter weight, 1 day in chilling room
Total approx. 210 backs.

All in total approx. 900 scans.

After the new placing of the camera looking for the junction between ribs /flat bones and spine, the different types of sortings, the turned backs and the extra bowed backs did not cause any problems in connection with the scanning. Areas wanted to be visible were visible.

Nevertheless, a longer row of different pieces will maybe identify some further challenges with shadowed areas in connection with big and small cattle or other extremely formed backs. However, as we got a big spread of sorts, the possibility of that going to happen is maybe limited to very big or very old animals.

At the end of the second day our contact person at the slaughterhouse, who earlier had worked with pig deboning, sawed off the Chine Bone of one of the backs from cattle under one year with a band saw. The result looked very similar to sawing pig chine bone (Fig.9). The view of both parts were very similar, also the flexibility of the removed chine bone, (Fig. 10 and Fig. 11) but we were informed that the backs gets stiffer and stiffer the older the animal is.


Fig. 9


Fig. 10


Fig. 11

4.1.3 Milestone 3

Analyses of beef middle scans. Evaluate if the scanning and cutline prediction principle, (the software developed for pig middles), can be upgraded to be used for beef, or if a new principle & software need to be developed.

Analysis of physical factors:
It was possible to scan the variation of the given backs and their placings with two cameras, each placed at an angle of 30 degrees to the horizontal on each side of the conveyor. The placing of the backs on the conveyor did not have remarkable influence on the quality of the scans. The width of the scans was set to maximum, which required a low velocity of the conveyor. The velocity is expected to be higher in real production, which can result in a request for a narrower camera width and following a more precise placing of the backs on the conveyor. However, scanning with the same width at the cameras as when scanning pigs and when the same requirements for placing of the products are fulfilled, scanning of the cattle backs should be possible at the same speed as when scanning pig middles. As the radiuses of the backs were very high, which means only bowed a bit, it should be possible to place the parts as precisely as pig middles.

The requirement to place both cameras as low as at an angle of 30 degrees to the horizontal can possibly give problems if in future complete cattle middles are to be sawn. If the breastbone is stiff and high enough it possibly can give disturbing shadows. As the middles at the Danish slaughterhouse were separated lengthwise, this problem did not appear. (Fig. 2 - Fig. 6).

Fig. 12

Leavings after removing the tenderloin and other parts were recognized as disturbing factors like at sawing pig middles, which also here will require great attention. (Fig. 12).

Based on the dimensions and physical form of the given backs and the previously analyzed flexibility of the chine bone at young cattle, it looked like a circular saw with approx. the same diameter should have a chance to saw the given backs, if a circular saw should be preferred to a band saw.
(Fig. 13).

Fig. 13

Analysis of images:

The image analysis at pig middles has three main areas:

1) An analysis, which finds the placing of the junctions between ribs and spine, compared to the splitting surface at the part.
2) An analysis, which finds the placing of the junctions between flat bones and spine.
3) An analysis of the position of the counter hold compared to the splitting surface.

Reg. 1)
The rib heads are bigger and more visible at cattle than at pigs, which should make it easier to find the junction between ribs and spine.

Reg. 2)
The junction between flat bone and spine is also very visible, but not if it is covered with rests of tenderloin. Therefore, to find the precise placing of the junction, it is necessary to remove the tenderloin and other parts carefully.

Reg. 3)
The top camera gives the basis of the analysis of the position of the counter hold, which is the only function of this camera. The analysis is used only for placing the counter hold touching the splitting surface, which is only necessary in connection with a circular saw.

The used analysis for pigs was tested on the images from the Danish slaughterhouse to evaluate points 1 & 2. Cattle is very similar to pigs, so the pig analysis was running without changes! However, the result was not usable as the difference in size is so remarkable that the cutting curve taken from a pig model is not correct for cattle. However, the interesting point was mostly to find out if the developed analysis for pigs was able to find the features, which we were looking for, and not so much if the analysis could be used directly.

Conclusion on the image analysis:

- Cattle are very similar to pigs. Cattle are bigger, but in that way the features looked for at the parts are also bigger and easier to recognize. Based on that and so far that the parts are not containing rests of tenderloin and other parts, it is fully likely that an image analysis, which in general works like the one for pigs also, will work on cattle.
- The existing analysis is to be customized for cattle. This requires knowledge about the optimal placing of the sawing curve compared to where the features are placed. A preliminary customizing of the analysis program is possible based on the scanned images, where final adjustments and changes are to be made under production-like conditions.

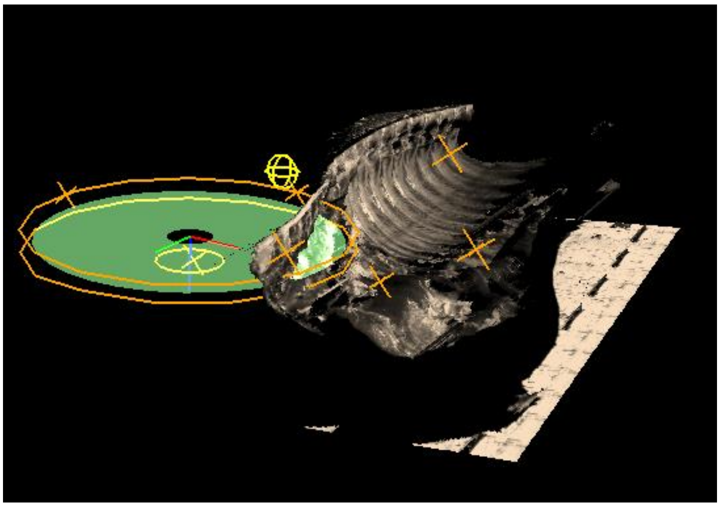


Fig. 14

4.1.4 Milestone 4

Develop draft concept (drawing) for Chine Bone cutting cell set-up.
Based on the former milestones and the experience from automatic chine bone cutting of pig middles, the draft concept for a chine bone cutting cell setup for cattle resulted in a cell similar to a cell for cutting pig chine bone, but of a bigger size. So the setup is based on chine bone sawing of complete cattle middles up to L 1300mm, W 800 and H 400, corresponding to cattle up to approx. 1500kg:

The machine consists of the following main components:

1.) A robot with suit and foundation
2.) Tool for robot with circular saw
3.) 2 x 3D cameras with support stand
4.) Robot conveyor with lamella belt with steel spikes
5.) Robot fencing with secured door
6.) Control cabinet with pc, robot controller, other controlling units, operator panel and touch screen.

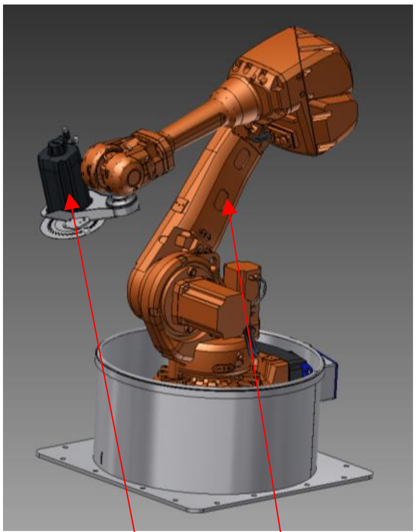


Fig. 15

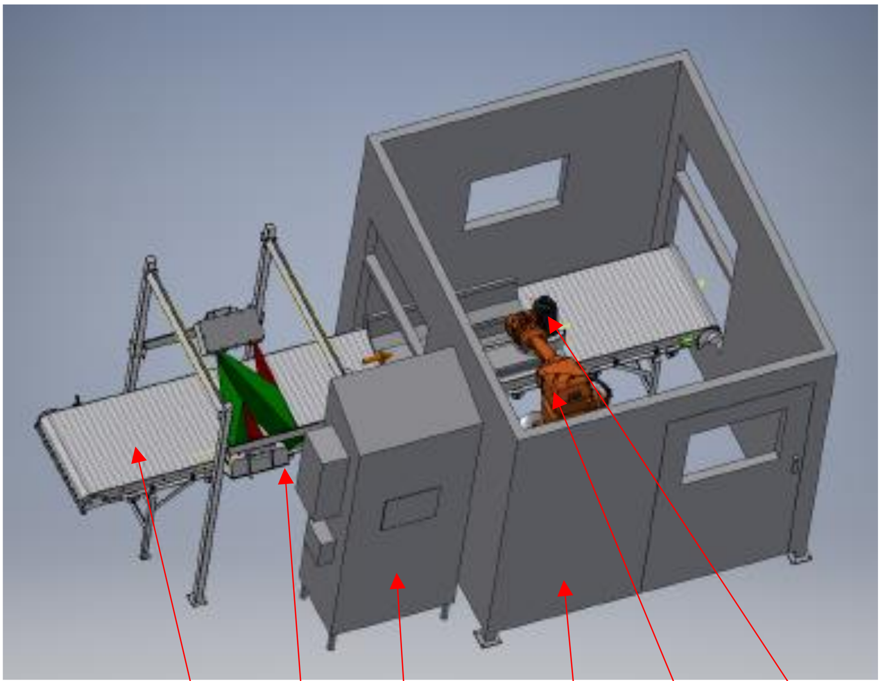


Fig. 16

Functional description of the machine:
Before entering the Chine Bone cutting cell the middles are to be turned so they come lengthwise with outside downwards, the back aligned along the edge of the conveyor belt at the robot side and with a defined distance.
After transferring the middles to the cell setup, the slat conveyor (Fig. 16 (4)) with steel spikes take over the transport of the middles.
The conveyor transports the middles under the cameras (Fig. 16 (3)) into the robot cell (Fig. 16 (5)).
For controlling the robot with the saw to saw off the Chine Bones of the middles, the angled 3D cameras (Fig. 16 (3)) are used to pick up data and sending them to the PC in the control cabinet (Fig. 16 (6)).
The PC builds up a 3D model of the middle and create data for controlling the robot through the middles.
The data are sent to the robot controller in the control cabinet (Fig. 16 (6)) which controls the robot (Fig. 15 &16 (1)) with the saw (Fig. 15 & 16 (2)) to follow an optimized path through the middles to release the Chine Bone.
The spikes in the slat belt together with the weight and the form of the complete middles secure that the middles are fixed during the sawing.

Background for the different choices

Circular saw or band saw and backs or complete middles

As our experience in sawing chine bones of pig middles until now is based on using a circular saw and this way of sawing is experienced as a very robust process with good sawing results, the draft of the robot cell for Chine Bone sawing of cattle is based on sawing with a circular saw. Unfortunately, the circular saw has the disadvantage to have long contact with the part to be removed compared with a band saw. This maybe clashes with the information that the backs go stiffer and stiffer the older the animal is. Based on that and on our other experience with pigs, we have chosen to run with complete beef middles and steel spikes in the slat belt, which give the part a high weight and a good stability to secure the middle/back to be fixed during the entire process.
Further advantages of this set up is that the hand over to the robot cell set up and the handling in the cell is very simple and robust. When going with backs without the rest of the middle it is to be expected that another fixation will be necessary, which will complicate the transporting unit and handing over.

Camera angles

Based on our experience in connection with picking up scans at the cattle slaughterhouse in Denmark, both cameras are inclined at an angle of 30 degrees to the horizontal. In connection with complete middles in contrast to backs separated from the rest of the middles, it is expected to result in backs fixated in other angles. Based on this and on the fact that the angle is very important to get usable images, the camera setup is built flexibly, where it is easy to adjust the position and angles of the cameras.

Diameter of the circular saw and sizes of saw motor and robot

The measured length/depth of the necessary sawing in connection with cattle under one year is up to 90mm.

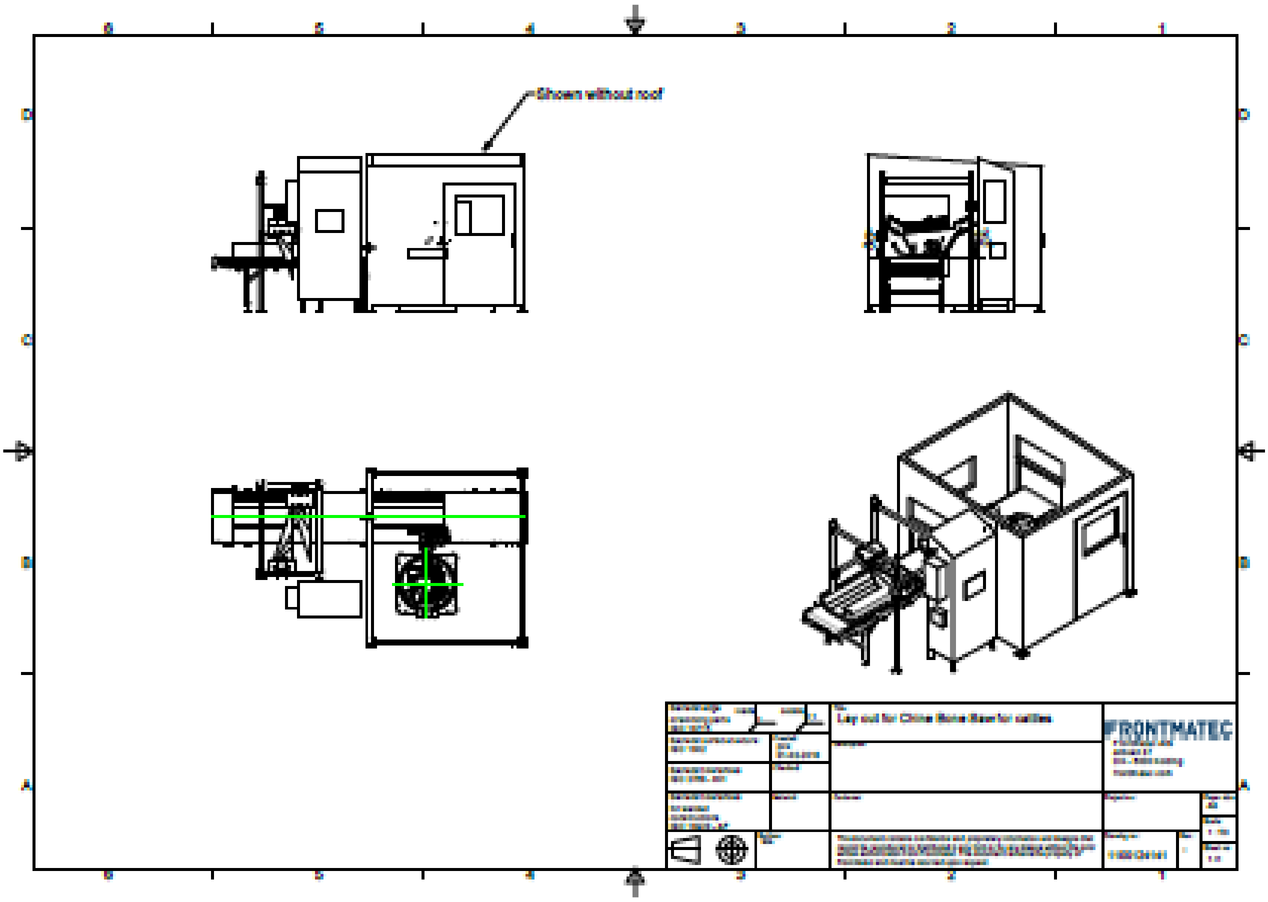
As this length / depth is similar to the length / depth in connection with sawing chine bones off pig middles, the used circular saw is similar to the saw used for pig middles and consequently, also the saw motor and the size of the robot. Furthermore, as the setup has shown more power than needed it is expected to have sufficient power to execute sawing of cattle Chine Bones whatever it is necessary to extend the sawblade diameter or not.

Fig. 17

Robot cell dimensions

The set-up robot cell is dimensioned for cattle up to approx. 1500kg, resulting in middles up to L 1300 mm, W 800 mm and H 400 mm. (Sizes informed from Danish cattle slaughterhouse).

The length of the robot conveyor and the size of the robot cell are based on experience from the robot cell for sawing Chine Bones from pig middles in connection with time for creating data, space for handing middles and robot security. The robot cell for sawing Chine Bones from pig middles is currently performing well in a pig deboning line.



5 Conclusions/Recommendations

5.1 Conclusions

A) The market for an automatic Chine Bone saw for cattle backs / middles appears to be a very significant market:

1) The Chine Bone sawing is a process, which gives significant yield improvements in connection with deboning of middles.
2) The Chine Bone sawing is performed in North and South America and Australia representing a huge cattle production.
3) The Chine Bone sawing of cattle is performed manually by band saw, which is posing high OH&S risks.
4) As the precision of the Chine Bone sawing is very important, unskilled persons cannot perform it.
5) In big parts of Europe, the yield improvements at Chine Bone sawing are known in deboning of pig middles, which can be expected to be an opener of the European market, too.
6) The robotic automated Chine Bone saw for pigs achieves very high constant precision and eliminates the OH&S risks.
7) The robotic automated Chine Bone saw safe manpower.

B) Regarding issues impossible to solve in connection with the performed test, the scans only show minor problems, like at pig scans, like leavings after removed parts and angles of cameras.

C) The performed test to use the given software for finding the features at the backbones at pig middles showed that the principles in the given software were applicable also in connection with analyzing cattle middles. Therefore, it is fully likely that an image analysis, which in general works like the one for pigs also, will work on cattle. As the software did not give correct values, a customizing of the software is required.

Overall, the entire project gives a reliable basis for continuing the development of an automatic chine bone saw for cattle.

5.2 Recommendations

Based on the above conclusion, it is recommended to continue the development of an automatic chine bone saw for cattle. There is a market and no issues, which seem to represent significant unsolvable problems. Furthermore, the manual workplace for chine bone sawing of cattle is hard and very dangerous, both pushing to an automation of the process.

As there are still a number of unknown topics, which could stop the development of the process abruptly, or change cutting cell layout significantly, we recommend that more investigations be made before manufacturing a complete prototype:

1) How stiff are the backs of older animals?
2) Is it possible to saw chine bone of cattle with a circular saw? – Cattle of all ages?
3) If not, is a band saw then the solution?
4) Are there other saw / cutting solutions?
5) Is it possible to handle complete cattle middles in cattle deboning departments?
6) What influence does the grading measurement of the rib eye in America/Australia have to the automatic chine bone sawing?
7) Does that require separate sawing off the Chine Bone from Rib loin and from Strip loin?
8) Is it possible to saw before separating ribs and rib loin?
9) When handling of complete middles is possible, at which angle should the cameras be mounted?
10) When running complete middles, is the breast meat a problem in connection with shadows? – Cattle of all ages must be looked at.
11) If not possible to run with complete middles, is it then possible to saw the cattle chine bone off cattle backs with an acceptable precision? – From cattle of all ages? Does that require a specific fixation?
12) Is it ok to use steel spikes together with meat without skin?
13) Will one plant be able to run cattle of all sizes and ages?

After checking these issues and conclude that there is still a way for continuing the development, a prototype is to be designed to get to the next step of the development.

6 Key Messages

The performed project demonstrates that there is a robust potential in the existing vision-based automatic chine bone cutting equipment for pig middles making it possible at reasonable development costs to take a huge leap forward towards the development of a state-of-the-art tool for automatic chine bone cutting of beef middles. Such a cutting tool will convert the sawing of beef middles from being an arduous, heavy and hazardous process into a perfect process that will reduce the number of OH&S risks, save manpower and give a product accuracy that will lift the yield.

All things considered, it is an investment that will pay for itself within a short period.

7 Bibliography

Nothing to inform.

8 Appendix

Nothing to inform.