

Smart 3D meat inspection

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Abstract

Meat inspection is an important part of education for every veterinary student. However, traditional teaching methods require the sacrifice of living animals, and are thus considered expensive, inadequate and inhumane. Development of novel technologies has provided opportunities for new, improved ways of education. Smart 3D Meat Inspection (S3DMI) is an e-learning tool that allows veterinary medicine students to acquire required skills using virtual 3D models of animal organs and carcasses. These models can be manipulated and “cut” just like real organs, allowing students to learn this essential skill without the need for animal carcasses. Students are allowed to practice any part of meat inspection as many times necessary, at their own pace, without time, place or resources limitations. This type of education is considered superior to traditional methods. There is no need for sacrifice of animals for educational purposes and the cost of education is greatly reduced, while the educational quality is uninterrupted. Models developed for S3DMI can also be adjusted for courses like animal anatomy and pathology, which also require the use of real animal cadavers. S3DMI is still in its developmental stages, but it has a great potential to minimize the need for animal sacrifice in the education of future veterinarians, while ensuring the quality improvement.

Keywords: 3D models, veterinary education, meat inspection

Introduction

Every year, about 80 billion animals are slaughtered to feed the growing human population. An average person consumes about 43 kilograms of meat per year and along the global wealth increase

this number will rise, followed by higher risk of food-borne illnesses (Ritchie and Roser, 2017). Meat has been and remains one of the most common causes of food-borne illnesses, which led to traditional

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meat inspection development in the 19th century. Through the 20th century, classical meat inspection has been the main way to assure the safety of meat on the market. This type of meat inspection is based on recognizing visible signs of diseases with the focus on detecting classical zoonoses, such as cysticercosis, tuberculosis and anthrax. While these diseases are rare in developed countries, conventional meat inspection is still highly important for developing countries and must be a part of the veterinary curriculum (Blagojevic et al., 2021).

In European Union, postmortal meat inspection requirements are specified by the Regulation (EU) 2017/625, which states that carcasses and accompanying offal must be subjected to postmortem inspection after slaughter immediately. Postmortal meat inspection is a crucial part of education for every future veterinarian and an essential part of the day one competence (EAEVE, 2019). This course is taught in the 8th semester of the undergraduate studies of University of Sarajevo - Veterinary Faculty and includes Ante and Post Mortem inspection of cattle, small ruminants, solipeds, pigs and poultry.

Traditionally, veterinary curriculum is taught using three main tools: textbooks, live animals, and cadavers (DeBose, 2020). The current teaching system requires the sacrifice of animals to demonstrate and practice meat inspection procedure on the carcasses and offal. The meat of these animals is later often unfit for human consumption, due to possible contamination. Students are also exposed to possible risk of injuries, as well as zoonotic diseases that certain animal might have carried.

In addition, this type of education is expensive. Our institution allocates about 3000 KM (~1500€) per year to this part of training. The offal and carcasses covered with this can be used by a maximum of ten students. Due to financial and time restrictions, practical education is limited and students can usually participate in inspection only once, limiting their future capabilities.

However, modern technology can alleviate these concerns.

In the last years, digitally-simulated training environments have proven their usefulness in the education, as they increase the accessibility to training in comparison to real-world practice. These types of software provide opportunities for students to practice rare procedures, but do not sacrifice the interactive components that are missing in text-based study (Kryklywy et al., 2021)

Smart 3D Meat Inspection (S3DMI) is an e-learning tool which is of great benefit to future doctors of veterinary medicine due to its humane approach without reducing the quality of provided education. In order to assess the market openness as well as the quality of the current approach to education, we have conducted a survey with the former and current students of veterinary medicine who have already finished their lessons on meat inspection.

Methods

We conducted a survey on 41 students of University of Sarajevo - Veterinary Faculty, who have already completed the course regarding meat inspection. Throughout questions, they were asked to assess the quality of the current educational system. The questionnaire included five questions and was conducted using online platforms.

Regarding the learning tool, the basis for Smart 3D Meat Inspection are 3D renditions of carcasses, offal, lymph nodes and others parts of the animals that are subjected to postmortem inspection.

Smart 3D Meat Inspection would comprise of 3 different modes:

- a) Basic learning mode:
- b) Pathological findings mode:
- c) Test mode

In Basic Learning Mode, 3D models of carcass and offal could be viewed from all sides and angles, and users could "cut" into them to see inner structures. When using Pathological Findings Mode, students could see possible abnormalities related to animal part in question, including the rare or potentially dangerous ones they would not have the chance to see otherwise. In addition, they would be provided with the procedures related to that finding in accordance to the law. Test Mode would provide students with images and brief descriptions of a case that they would then have to diagnose and prescribe further actions; it would be used for final grading, as well as for students to test their own skills.

The first step in the development of S3DMI is to acquire carcasses and offal from cattle, small ruminants, solipeds, pigs and poultry, that must be healthy and considered typical, that will be used as the basis of the learning tool. Acquired animal parts will be scanned using a 3D scanner,

to create accurate 3D models that can be rotated 360°, as well as be dissected, to reveal their inside. After that, we will describe the procedure related to meat inspection, anatomical descriptions of every part of the entire animal in its physiological state, as well as the most common and most important pathological findings and the procedures they call for. 3D scans and the descriptions that accompany them will be combined into one product with Basic learning mode, Pathological

findings mode and Test mode. The learning tool will be tested by the students of Veterinary faculty in Sarajevo, who then will provide feedback, in order to improve the final product.

Results

The results of the survey conducted among the students are presented in the table 1.

Table 1. The results of the survey conducted among the students of veterinary medicine

Question	Agree	Disagree	Partially agree
I am satisfied with the quality of practical classes in the field of meat inspection.	35 85.37 %	0 0.00 %	6 14.63 %
I am worried about the potential transmission of zoonotic diseases during practical lessons	3 7.32 %	28 68.29 %	10 24.39 %
I think that the practical knowledge I have gathered in the field of meat inspection is enough for my future work.	19 46.34 %	5 12.20 %	17 41.46 %
I believe that the quality of education in this area can be improved by introducing digital learning methods (3D models)?	31 75.61 %	1 2.44 %	9 21.95 %
Virtual learning using 3D models can replace practical work	4 9.76 %	25 60.98 %	12 29.27 %

Discussion

While most students (68.29 %) were not worried about the transfer of zoonotic diseases during practical lessons, S3DMI still offers a safer and cleaner way for other students to interact with animal parts and carcasses. While risk of infection is eliminated, students would still study pathological changes caused by important zoonosis, such as anthrax or tuberculosis.

Globalization will probably lead to higher prevalence of uncommon or exotic diseases, but S3DMI would help future veterinarians to recognize and prevent emerging zoonosis in a timely manner.

While most students were satisfied with the quality of the education, this kind of tool would improve students' practical knowledge they have gathered in the field of meat inspection. It would allow students to study at their own pace, from the comfort of their own homes, for as long as they needed to. Furthermore, teachers could evaluate their students as well as help them learn more, without having to acquire new animals and carcasses. Similar tools have proven useful in other areas of veterinary medicine, like obstetrics, where the use of 3D animations and interactive models had a positive effect on students' comprehension of the

subject matter scores, as measured by essay questions (Scherze et al, 2010). In a study conducted by DeBose (2020), where 3D models and VR (virtual reality) were used to teach students canine anatomy, 57 % of respondents said they are highly or very highly likely of continuing to use VR as a learning tool.

The vast majority of students (40 out of 41) think that the quality of the education could be improved with the use of 3D models. Also, colleges and universities focused on ethical aspect of food production would also find a great use for this tool, as fewer animals could be sacrificed without losing the educational value.

Strong benefit of S3DMI is that it is not limited to the academic environment. Applying a slight modification, this learning tool could educate farmers, butchers and others who work in the meat production industry to recognize signs of notifiable and important diseases. Meat inspectors could use Pathological Findings Mode to aid with unusual and rare cases as well as exchange information with colleagues, which could help outbreaks of important food-borne illnesses to be noticed and contained sooner.

Conclusion:

Ante and Post Mortem inspection of animals, carcasses and offal, as well as their evaluation regarding their safety for human consumption, is a part of the curriculum of every veterinary course in the world. The universality of this subject dictates that new methods of education, based on novel technologies, ought to be developed. Similar programs are present on the market, but none of them are aimed at this particular niche of veterinary medicine.

However, S3DMI is not a complete solution to the issue of animal sacrifice in veterinary education. Most of the students agree that Virtual learning using 3D models cannot replace practical work. As life-like as the program could potentially be, it would not be a complete replacement for the specificities of a real carcass and offal. More advanced lessons might still require the use of real animal parts, but to a much lesser extent and capacity. Thus, for students of veterinary medicine who need basic education on this subject, S3DMI is a far more efficient and ethical solution.

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Pametna 3D inspekcija mesa

Sažetak

Inspekcija mesa važan je dio obrazovanja svakog studenta veterine. No, tradicionalne metode poučavanja zahtijevaju žrtvovanje živih životinja te se stoga smatraju skupima, neadekvatnima i nehumanima. Razvoj novih tehnologija pružio je priliku za nove, poboljšane načine obučavanja. Pametna 3D Inspekcija Mesa (S3DMI) je e-alat za učenje koji omogućava studentima veterine da steknu potrebne vještine koristeći 3D modele životinjskih organa i trupova. Ovim modelima može se lako upravljati te organi mogu biti „rezani“ baš kao i pravi, omogućavajući studentima da nauče ovu neophodnu vještinu bez potrebe za životinjama. Studentima je omogućeno vježbati bilo koji dio inspekcije mesa koliko god puta je potrebno, vlastitim tempom, bez vremenskih, prostornih ili financijskih ograničenja. Ova vrsta edukacije smatra se superiornijom naspram tradicionalnih metoda. Nema potrebe za žrtvovanjem

Životinja pa je trošak obrazovanja uvelike umanjen, a kvaliteta edukacije je nenarušena. Modeli razvijeni za S3DMI mogu se prilagoditi i za tečajeve poput onih iz anatomije i patologije životinja, koji također zahtijevaju uporabu pravih životinjskih leševa. S3DMI je još uvijek u razvojnoj fazi, no ima visoki potencijal za smanjivanje žrtvovanja životinja u obrazovanju budućih veterinara, istodobno osiguravajući napredak kvalitete edukacije.

Key words: 3D modeli, veterinarsko obrazovanje, inspekcija mesa

Intelligente 3D-Fleischinspektion

Zusammenfassung

Die Fleischinspektion ist ein wichtiger Teil der Ausbildung für jeden Tiermedizinstudenten. Herkömmliche Lehrmethoden erfordern jedoch die Tötung lebender Tiere und gelten daher als teuer, unangemessen und inhuman. Die Entwicklung neuer Technologien hat Möglichkeiten für neue, verbesserte Lehrmethoden geschaffen. Die intelligente 3D-Fleischinspektion (S3DMI) ist ein E-Learning-Tool, mit dem Tiermedizinstudenten die erforderlichen Fähigkeiten anhand virtueller 3D-Modelle von Tierorganen und Kadavern erwerben können. Diese Modelle können wie echte Organe manipuliert und "geschnitten" werden, so dass Studenten diese wichtigen Fertigkeiten erlernen können, ohne ein Tier untersuchen zu müssen. Die Studenten können jeden Teil der Fleischinspektion so oft wie nötig und in ihrem eigenen Tempo üben, ohne zeitliche, örtliche oder finanzielle Einschränkungen. Diese Art der Ausbildung wird als besser angesehen als traditionelle Methoden. Es müssen keine Tiere für Ausbildungszwecke geopfert werden, und die Kosten für die Ausbildung werden erheblich gesenkt, während die Ausbildungsqualität erhalten bleibt. Die für S3DMI entwickelten Modelle können auch für Kurse wie Tieranatomie und -pathologie angepasst werden, die ebenfalls die Verwendung von echten Tierkadavern erfordern. Das S3DMI befindet sich noch im Entwicklungsstadium, hat aber ein großes Potenzial, die Notwendigkeit von Tieropfern in der Ausbildung zukünftiger Tierärzte zu minimieren und gleichzeitig die Qualität zu verbessern.

Schlüsselwörter: 3D-Modelle, Tierarztausbildung, Fleischinspektion

Inspección inteligente de carne en 3D

Resumen

La inspección de carne es una parte importante de la educación de todos los estudiantes de veterinaria. Sin embargo, los métodos tradicionales de educación requieren el sacrificio de animales vivos, y por lo tanto, se consideran costosos, inadecuados e inhumanos. El desarrollo de nuevas tecnologías ha proporcionado una oportunidad para nuevas y mejoradas formas de aprendizaje. Inspección inteligente de carne en 3D (S3DMI) es una herramienta de aprendizaje electrónico que permite a los estudiantes de veterinaria adquirir las habilidades necesarias utilizando modelos 3D de los órganos y cadáveres de animales. Estos modelos se pueden manipular y "cortar" como órganos reales, lo que permite a los estudiantes aprender esta habilidad esencial sin necesidad de sujetos animales. Los estudiantes pueden practicar cualquier parte de la inspección de carne tantas veces como sea necesario, a su propio ritmo, sin limitaciones de tiempo, espacio o recursos. Este tipo de entrenamiento es considerado superior a los métodos tradicionales. No hay necesidad de sacrificar animales con fines educativos y el costo de la educación se reduce considerablemente, manteniendo la calidad. Es posible adaptar los modelos desarrollados para S3DMI para cursos como anatomía y patología animal, que también requieren el uso de cadáveres de animales reales. S3DMI todavía está en la fase de desarrollo, pero tiene un alto potencial para reducir el sacrificio de animales en la educación de los futuros veterinarios, garantizando al tiempo el progreso de calidad.

Palabras claves: modelos 3D, educación veterinaria, inspección de carne

Ispezione delle carni “intelligente” in 3D

Riassunto

L'ispezione delle carni è un importante aspetto del percorso formativo di ogni studente di veterinaria. I metodi tradizionali di studio delle carni richiedono il sacrificio di animali vivi e, quindi, sono ritenuti dispendiosi, inadeguati e disumani. Lo sviluppo di nuove tecnologie ha offerto la possibilità di individuare metodi d'insegnamento nuovi e più efficaci. L'ispezione delle carni “intelligente” in 3D (S3DMI) è uno strumento didattico digitale che consente agli studenti di veterinaria di acquisire conoscenze fondamentali per il loro percorso formativo utilizzando modelli tridimensionali degli organi e delle carcasse animali. Si tratta di modelli tridimensionali che possono essere manipolati e “sezionati” come se fossero dei veri e propri organi, il che consente agli studenti di acquisire competenze fondamentali per la loro formazione senza la necessità di sacrificare la vita di alcun animale. Gli studenti potranno esercitarsi su qualunque parte dell'ispezione delle carni quante volte lo riterranno necessario, ognuno secondo il proprio ritmo, senza limiti temporali, spaziali o di risorse. Così facendo, sacrificare la vita degli animali a fini didattici diventerà superfluo, i costi d'insegnamento saranno notevolmente ridotti, mentre la qualità della formazione didattica sarà sempre migliore. I modelli sviluppati con la tecnologia S3DMI possono adattarsi anche a corsi di anatomia o patologia animale, che normalmente richiedono l'impiego di carcasse animali. Lo strumento didattico digitale S3DMI è ancora in una fase evolutiva di sviluppo, ma evidenzia fin d'ora un gran potenziale in termini di riduzione dei “sacrifici” animali per la formazione dei futuri veterinari, garantendo, nel contempo, grandi progressi in fatto di qualità dell'insegnamento.

Parole chiave: modelli 3D, formazione veterinaria, ispezione delle carni