Project Acronym:
FUSVET (SEED/1221/0080)

Focused Ultrasound System for veterinary chemotherapeutic applications for oncology

Deliverable number: 2.5

Title: Sponsor presentation in conference

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Date: 01/06/2024

FUSVET

Funded by the European Union NextGenerationEU
Cyprus tomorrow RECOVERY AND RESILIENCE PLAN
Republic of Cyprus
RESEARCH & INNOVATION FOUNDATION

The FUSVET project is funded by the Recovery and Resilience Facility of the NextGenerationEU instrument, through the Research and Innovation Foundation (RIF) of Cyprus.

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Executive summary

This deliverable presents the sponsored Conference paper entitled «Positioning device for MRI guided focused ultrasound for veterinary applications» that was presented by Dr. Kyriakos Spanoudes during the 2nd reporting period of the FUSVET project at the *39th World Veterinary Association Congress* (WVAC2024), which took place between 16-19 April 2024 in Cape Town, South Africa. The paper addressed the functionality testing of the developed system for veterinary applications in terms of MRI compatibility and heating capabilities in agar-based phantoms and freshly excised porcine tissue. Caution was given to avoid disclosing any key features and components of the FUSVET system prior to the relevant patent application. Conference participation was sponsored by the University of Nicosia.

Submitted abstract

Positioning device for MRI guided focused ultrasound for veterinary applications

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ABSTRACT

This paper presents a positioning device for Focused Ultrasound (FUS) technology for the treatment of cancer in cats and dogs using a designed robotic system with 3 cartesian axes and one angular axis. The system was designed to be Magnetic Resonance imaging (MRI) compatible. The positioning device includes a single element spherically focused transducer operating at around 2.7 MHZ. The system was evaluated initially in agar-based phantoms and freshly excised tissue. The positioning device is now under evaluation in cats and dogs with cancer. This technology has potential as a therapeutic solution for veterinary cancer.

KEYWORDS: MRI, ultrasound, positioning device, dogs, cats

ACKNOWLEDGMENTS: The study was co-funded by the European Structural & Investment Funds (ESIF) and the Republic of Cyprus through the Research and Innovation Foundation (RIF) under the project FUSVET (SEED/1221/0080).

Positioning device for MRI guided focused ultrasound for veterinary applications

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OBJECTIVES

This paper presents a positioning device for the treatment of cancer in cats and dogs using Focused Ultrasound (FUS) technology and its preliminary evaluation in phantoms and excised tissue.

METHODS

Development of positioning system

A positioning system with 3 cartesian and 1 angular degrees of freedom was designed and manufactured by rapid prototyping. The system was specially designed to be Magnetic Resonance imaging (MRI) compatible and includes a single element spherically focused transducer operating at around 2.7 MHZ.

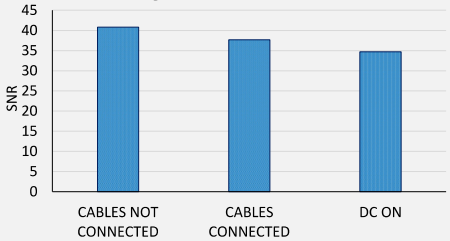
Functionality assessment

The developed FUS positioning system was evaluated in agar-based phantoms doped with silicon dioxide and freshly excised porcine tissue in terms of MRI compatibility and heating capabilities. Experiments were performed inside a 3 T MRI scanner (Magnetom Vida, Siemens Healthineers).

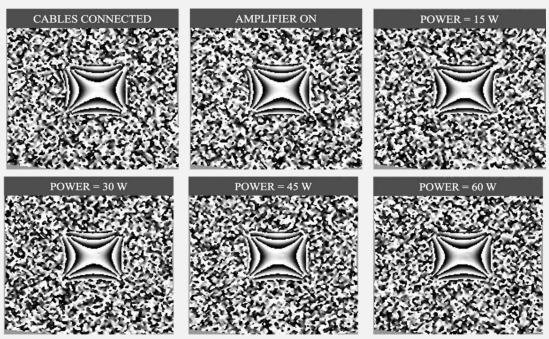
RESULTS

MRI compatibility

Minor decrease of the reference signal-to-noise ratio (SNR) was observed upon connection of the motion cables and activation of the driving system. The SNR remained at sufficiently high levels upon connection and activation of the transducer as well. No significant artifacts were observed.



Bar chart of SNR calculated from coronal FLASH images of the phantom acquired under different activations of the robotic system.

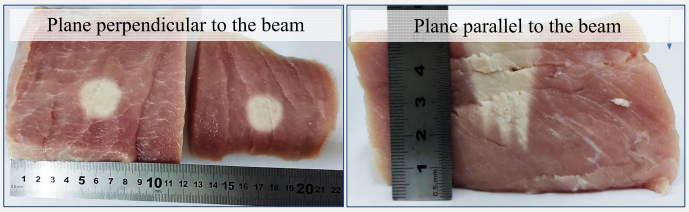


Coronal FLASH phase images of the phantom acquired under different activations of the transducer.

Heating capabilities

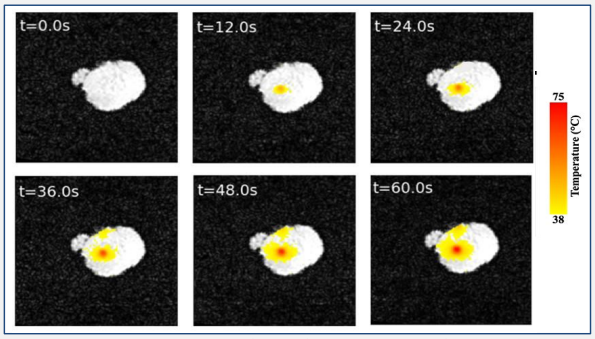
Depending on the applied ultrasonic parameters, both discrete and well-demarcated areas of overlapping lesions were inflicted in tissue by thermal coagulation. The temperature increase during sonication in both phantoms and tissue was accurately monitored using MR thermometry. Successful monitoring of lesion formation was achieved by high-resolution TSE imaging.

Example of overlapping lesions formed on excised pork tissue:



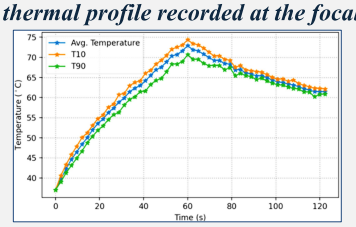
Sonication in 3×3 grid with 7-mm step at 25 mm focal depth, using 60 W acoustic power for 20 s.

Example of temperature monitoring during sonication in tissue:



Sonication at acoustic power of 60 W for 60 s at 30 mm focal depth.

Corresponding thermal profile recorded at the focal point:



CONCLUSIONS

Overall, the developed FUS positioning system was proven MRI compatible and capable of generating controllable thermal lesions on agar-based phantoms and excised pork tissue. This technology is now under evaluation in cats and dogs with cancer to assess its potential as a therapeutic solution for veterinary cancer.

ACKNOWLEDGEMENTS

The study was co-funded by the European Structural & Investment Funds (ESIF) and the Republic of Cyprus through the Research and Innovation Foundation (RIF) under the project FUSVET (SEED/1221/0080).