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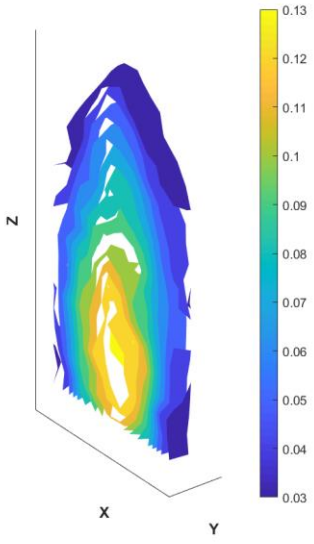
Applying a tomographic technique for imaging of flames to pave the way for a cleaner environment.

In this work a tomographic method for three-dimensional combustion studies is developed and evaluated to act as a proof of concept for future use of the technique. Thereafter, a camera selection and groundworks for a laboratory setup able to perform tomographic studies on flames was done and laid out.

With the current development and improvements made in modern society comes a continuing interest to further reduce harmful emissions originating from combustion devices used in various ways such as transportation or power generation. One way to go about this is to find new or improve existing ways of studying combustion processes. Sometimes employing techniques normally used in other scientific research fields and transferring them into one's own field could bring new solutions to the table.

This work could be seen as such an application, as it builds on the trend of using tomography to allow for full three-dimensional studies of flames and other combustion processes. The technique of tomography is mainly known for its use in medicine where its applied in applications such as Proton Emission Tomography (PET) scans and X-ray measurements that allow for internal imaging of the patient. However, tomography is also applied in other areas such as seismology to look inside mountains or below ground and industrial quality control to search products for internal faults.

The ability of a tomographic technique can be seen as combining multiple different image measurements of an object to give back a result that shows both its internal and external structure. This allows to study internal structures of objects which have proved to be of great use in many fields of research especially in medicine. However, it is important to know that the image measurements used for the tomographic technique must be able to go through the object of interest, that is why x-rays or radio waves usually are used in conjunction with the tomography technique. This allows the measurements to "grab" information on its way through the object and allows for the reconstruction of the interior.



Shows a vertical slice of a tomographic result for a studied three-dimensional flame.

In this work a tomographic technique was developed using an algorithm called ART (Additive Reconstruction Technique) and then applied on two- and three-dimensional synthetic flame objects. This evaluation was performed in a three-dimensional virtual suite where multiple virtual cameras were employed to measure the flame. Because the light captured by each camera comes from the whole volume of the flame object and not just the surface the measurement acquires information about the interior and exterior allowing the technique to compute back the full shape of the measured flame object.

In the end the technique was successful and the interior and exterior of the flame models studied could be acquired. As an example, a tomographic slice result showing the interior of a studied three-dimensional flame object can be seen in the figure. The intensity can be seen to be much higher (yellow) inside of the synthetic flame and lower (blue) in the outer regions.

The initialization of a laboratory setup using ten small machine vision cameras to allow for future practical application of the technique was also started during this work. The cameras used was of the model acA1920-40gm-Basler-ace, that model was selected as the best candidate in an evaluation preformed where multiple different cameras were present.

Because combustion is nearly always a three-dimensional process the goal for this work was to put forward a proof of concept for a technique able to catch three-dimensional aspects of combustion. This work can hopefully pave the way for more tomographic applications for three-dimensional measurements which could lead to improved combustive devices with better efficiency and less harmful emissions.

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