

Researchers find an improved method of imaging objects through fog

Imaging of objects in foggy weather conditions may now be clearer. Researchers have found a method that can improve the images captured on such days. The technique involves modulating the light source and demodulating them at the observer's end.



Image by [Maksim Šišlo](#) via [Unsplash](#)

Scientists have long attempted to use the physics of scattering and computer algorithms to process the resulting data and improve the quality of images. Whereas the improvements are not stark in some cases, computer algorithms require processing large volumes of data, involving ample storage and significant processing time.

Research by a team has offered a solution for improving the image quality without heavy computations. The team led by Late Prof. Hema Ramachandran from the Raman Research Institute (RRI), Bengaluru, an autonomous institute of the Department of Science and Technology; Space Applications Centre, Indian Space Research Organisation, Ahmedabad; Shiv Nadar University, Gautam Buddha Nagar; and Université Rennes and Université Paris-Saclay, CNRS, France, modulated the light source and demodulated them at the observer's end to achieve sharper images. The research was published in the journal '*OSA Continuum*'.

The researchers have demonstrated the technique by conducting extensive experiments on foggy winter mornings at Shiv Nadar University, Gautam Buddha Nagar, Uttar Pradesh. They chose ten red LED lights as the source of light. Then, they modulated this source of light by varying the current flowing through the LEDs at a rate of about 15 cycles per second.

The researchers kept a camera at a distance of 150 metres from the LEDs. The camera captured the image and transmitted it to a desktop computer. Then, computer algorithms used the knowledge of the modulation frequency to extract the characteristics of the source. This process is called 'demodulation'. The demodulation of the image had to be done at a rate that was equal to the rate of modulation of the source of light to get a clear image.

The team saw a marked improvement in the image quality using the modulation-demodulation technique. The time the computer takes to execute the process depends on the image's size. "For a 2160×2160 image, the computational time is about 20 milliseconds," shares Bapan Debnath, PhD scholar at RRI and a co-author of the study. That is roughly the size of the image containing the LEDs. His colleagues had [estimated](#) the rate in 2016.

The team repeated the experiment a few times and observed the improvement each time. Once, when the fog varied in intensity during the observation, they did not record a marked improvement in the image quality. In this case, there was a

strong wind, and they observed fog trails across the scene. The density of the water droplets in the air changed as time passed, which rendered the modulation-demodulation technique less effective.

Next, the researchers changed the experimental setup. They made an external material, a piece of cardboard kept at a distance of 20 centimetres from the LEDs, to reflect the light to the camera. The distance between the cardboard and the camera was 75 metres. The modulated light reflected from the cardboard, travelled through the fog, and was then captured by the camera. They demonstrated how their technique still significantly improved the quality of the resulting image.

Repeating the experiment under sunny conditions they found that after performing the demodulation of the source, the image quality was high enough to distinguish the LEDs from the strongly reflected sunlight.

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The cost of the technique is low, requiring only a few LEDs and an ordinary desktop computer, which can execute the technique within a second. The method can improve the landing techniques of aeroplanes by providing the pilot with a good view of beacons on the runway, significantly better than relying only on reflected radio waves as is presently the case. The technique can help reveal obstacles in the path that would otherwise be hidden by fog in rail, sea, and road transportation and would also help spotting lighthouse beacons. More research can demonstrate the effectiveness in such real-life conditions. The team is investigating whether the technique can apply to moving sources.

Author(s) of the research/study :

Shashank Kumar^{1,2}, Bapan Debnath¹, Meena M. S.¹, Julien Fade³, Sankar Dhar⁴, Mehdi Alouini³, Fabien Bretenaker^{1,5}, and Hema Ramachandran^{1,t} —

¹ Raman Research Institute, Sadashiv Nagar, Bangalore, India 560080

² Space Applications Centre, Indian Space Research Organisation, Ahmedabad, India

³ Univ. Rennes, CNRS, Institut FOTON - UMR 6082, F- 35000 Rennes, France

⁴ Shiv Nadar University, Gautam Buddha Nagar, Uttar Pradesh 201314, India

⁵ Université Paris-Saclay, CNRS, ENS Paris-Saclay, CentraleSupélec, LuMIn, 91190, Gif-sur-Yvette, France

[†]Deceased

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For more details Bapan Debnath(bapan@rri.res.in); Fabien Bretenaker (fabien.bretenaker@universite-paris-saclay.fr) can be contacted.