Response to the Referee
Manuscript: sensors-2511842

Summary response statement,

Our detailed response is given below. For a clearer description, we first provide the referees' comments and then our response with the corresponding modifications.

Report of Reviewer 1 (in blue) followed by a detailed response to each point (in red).

Comment 1: Abstract is too simple. Should Summarize the results in abstract. Not just mentioned the measurement result better than simulation.

Reply to Comment 1: Thank you for your valuable suggestions in the abstract section. Based on your suggestions, we have made modifications to the abstract. The modifications to the abstract are as follows:

In laser active detection, detection performance is affected by optical noise, laser interference, and environmental background interference. Conventional methods to filter optical noise take advantage of the differences between signal and noise in wavelength, and polarization. Due to the limitations of traditional methods in the physical dimension, noise cannot be completely filtered out. In this manuscript, a new method of noise filtering based on the spatial distribution difference between the quantum orbital angular momentum beam and the background noise is proposed. The use of beams containing quantum orbital angular momentum can make the signal light have a new physical dimension and enrich the information of emitted light. We conduct a complete theoretical analysis and provide a proof-of-principle experiment. The experimental results are in good agreement with the theoretical analysis results, and there is a signal-to-noise ratio improvement of more than five times in laser active detection. Our method meets the urgent needs of laser active detection and can be applied in the field of high-quality target detection.

The above highlighted content in yellow is the added abstract content, while the highlighted content in blue is the content that has been modified from the original content.

Comment 2: Please provide table results comparison between simulation and measurement.

Reply to Comment 2: Thank you for your comment. We have added Table 1 on line 222 in the manuscript. This table compares the simulation and experimental results.

Result Type (topological charge l=1)	Signal to Noise Ratio (Before noise filtering)	Signal to Noise Ratio (After noise filtering)	Signal-to-noise ratio improvement	Signal to noise ratio improvement multiple
Simulation	1.87	13.01	8.42 dB	6.9 times
Experiment	0.242	1.22	7.03 dB	5.0 times

Table1. Comparison of simulation and experimental signal-to-noise ratio improvement results

Comment 3: Please discuss academically the results instead of reporting the figure in simulation and measurement result section.

Reply to Comment 3: Thank you for your comment. In order to better discuss the results in academia, we have added a discussion section on line 230 of the manuscript. The specific additions are as follows:

5 Discussion

We have demonstrated through experiments a method that can achieve almost perfect noise filtering. Unlike previous methods, orbital angular momentum is chosen as a special degree of freedom to generate spatial distribution differences between signals and noise. By utilizing this difference, signals and noise can be effectively separated. The principle verification experiment has proven the effectiveness and correct-ness of this method. The main reason for the difference between the experimental results and the simulation results is that the simulation process is ideal, and the orbital angular momentum beam will be distorted with the transmission process in the experimental process, so there is a certain impact on the experimental results.

Comment 4: Most of the references more than recent 5 years. Please update.

Reply to Comment 4: Thank you very much for raising this comment. We note that the timeliness of the references is very important. Therefore, we have updated the references.
The added references are as follows:
[4] Li Z P, Huang X, Cao Y, et al. Single-photon computational 3D imaging at 45 km[J]. Photonics Research, 2020, 8(9): 1532-1540.
[5] Bianco V, Mazzeo P L, Paturzo M, et al. Deep learning assisted portable IR active im-aging sensor spots and identifies live humans through fire[J]. Optics and Lasers in Engineering, 2020, 124: 105818.

[6] Budd S, Robinson E C, Kainz B. A survey on active learning and hu-man-in-the-loop deep learning for medical image analysis[J]. Medical Image Analysis, 2021, 71: 102062.
[7] Lertsakdadet B, Dunn C, Bahani A, et al. Handheld motion stabilized laser speckle imaging[J]. Biomedical optics express, 2019, 10(10): 5149-5158.
[8] Krenn M, Handsteiner J, Fink M, et al. Twisted light transmission over 143 km[J]. Proceedings of the National Academy of Sciences, 2016, 113(48): 13648-13653.
[9] Pan J W, Chen Z B, Lu C Y, et al. Multiphoton entanglement and interferometry[J]. Reviews of Modern Physics, 2012, 84(2): 777.
[22] Saadabad R M, Cai M, Deng F, et al. Structured light excitation of toroidal dipoles in dielectric nanodisks[J]. Physical Review B, 2021, 104(16): 165402.
[23] Zdagkas A, McDonnell C, Deng J, et al. Observation of toroidal pulses of light[J]. Nature Photonics, 2022, 16(7): 523-528.
[24] Shen Y, Hou Y, Papasimakis N, et al. Supertoroidal light pulses as electromagnetic skyrmions propagating in free space[J]. Nature communications, 2021, 12(1): 5891.
[25] Basharin A A, Zanganeh E, Ospanova A K, et al. Selective superinvisibility effect via compound anapole[J]. Physical Review B, 2023, 107(15): 155104.