Cage structure application in photoelectric experiment and teaching

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ABSTRACT

A new type of photoelectric system structure, cage system, is introduced. This kind of coaxial modularized structure not only can be quickly assembled, but also can easily realize different purposes by substituting elements in the system. In addition, it's light and portable, which enable teachers to carry it to wherever suitable for teaching. In conclusion, this structure can improve teaching effect and stimulate student's interest in photoelectric courses.
Keywords: Cage System, photoelectric, teaching experiments, innovation

1. INTRODUCTION

The photoelectricity is a multi-disciplinary, practical and interconnected subject. It is a working field that demands good grounding of the knowledge in many disciplines involved and comprehensiveness over many technological aspects, including practice experience. To assist students in mastering Photonic knowledge during their university learning, therefore, lecturers need interacting with students, provoking students' interests, encouraging their involvement, and facilitating their progress.

XunZi wrote in his work on learning that What I hear I forget, what I see I remember, what I do I understand. His words confirm the essence of learning through participation and practice. Guided by this principle, we have developed a product genre, cage system, targeting the difficulties in teaching the subject, such as laborious practical demonstration and monotonous teaching approaches, which could dampen students' motivation. Recent surveys on the effectiveness of university lectures indicate two main causes contributing to it slow level. One comes from the students' own initiative on learning, especially after students' entrance to universities when the outside pressure for studying effort reduces significantly and self-discipline slackened. The other cause is the teaching approaches by lecturers, some of whom their teaching approaches are dated, the learning goals are unclear to students, their uses of multimedia tools are improper, little creativeness is disseminated. Facing such a learning situation, we instigate an idea of Bringing Experiments into the classroom and further devise the 'Cage System Experiment' in the field of photoelectric and Optics.

2. THE ADVANTAGE AND NECESSITY FOR CAGE SYSTEM IN PHOTOELECTRIC EXPERIMENT AND TEACHING

The Cage System for photoelectric Experimental series is much more compact in structure than the traditional teaching experiments. Dramatically scaling down in size enables these experiments not only for the use in the labs, but also being easily set up in a classroom for demonstration. This portability enriches the classroom and stimulates students' enthusiasm. The installed multimedia facilities, currently in all Classrooms of the universities in China, establish the essential conditions and hardware for cage system to enter. Differing from the traditional approaches of teaching, cage system offers experimental demonstrations with interactive learning (via electrical, sound and light) that captures students' interests and therefore improves greatly effectiveness. Research shows that the students' attentions increase more than one fold if a lecture contains experimental demonstrations.

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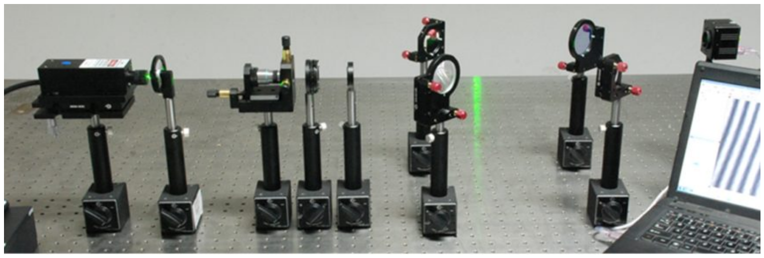

Figure 1. Mach-Zehnder's interferometer experiment system.

Figure 2. Mach-Zehnder's interferometer experiment system after the system miniaturisation.

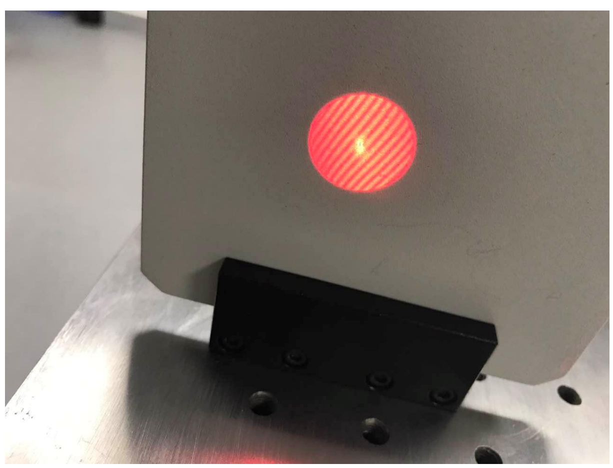

Figure 3. The image of the interference pattern produced by the miniature system.

Furthermore, the students are given an opportunity to get their hands on immediately after the lecture to enhance their practical abilities and to sustain their learning. In addition, a collaborative teaching approach can also be introduced during a lecture to promote teamwork, cooperation and interaction among lecturer and students. Many of these aspects are the concerns in the current higher education system. Figure 1 and Figure 2 are the Mach-Zehnder's Interferometer Experiment Systems before and after the system miniaturisation, respectively. The cage system is only the size of human palm and very portable. Figure 3 is the image of the interference pattern produced by the miniature system.

The interference image signifies no inferior quality in the outcome from the caged system, comparing with the laboratory set-up. But with this major size reduction, the experiment systems become possible to be brought into the Classrooms. While students are listening, they are also watching the experiment demonstration. Their learning becomes far more exciting, direct and effective, as a study shows that the sensitivity of human visual nerve system is ten times as the one of audial system. The realisation of Experiments into Classroom facilitates the teaching improvement, opens the door to the research-based learning, and transforms teaching methods in the subject learning. It is another innovation in teaching based on learner-centred and individualistic approaches following the models of 'Flipped Classrooms' and 'Multiple-Intelligent Learning'.

There is further benefit brought by this innovative system in term of knowledge coverage. As mentioned earlier, Photonics, especially Optical Information and Technology, is an integral subject. Its study programme generally comprises at least the following five key areas: Principles of Laser and Laser Technologies, Optical Engineering and Physics, Optical Testing and Measurement, Information Optics and Opto-Telecommunication. Large of these areas are touched upon and accomplished by the cage system for Photonics Experimental, benefiting from the multiple utilisations in key areas by a single experimental system. Figure 4 shows a typical structure of the cage system experimental for Fourier System. Figure 5 displays a cage system for He-Ne Laser Integrated Experiment. These two systems are the most representative experiment systems in learning Laser Principles and Information Optics.

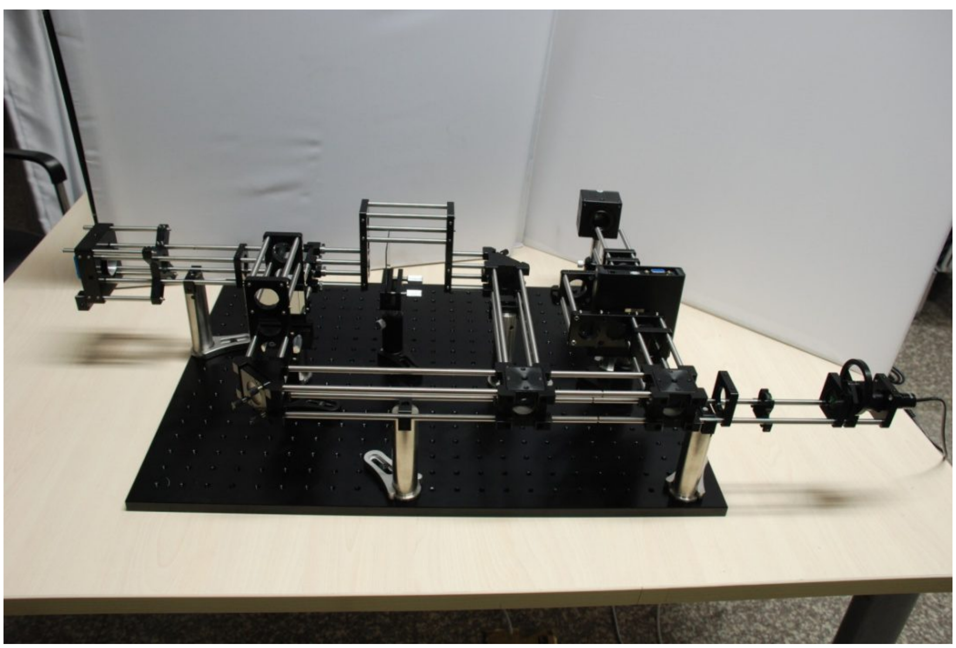

Figure 4. The cage system experimental for Fourier System.

In addition, when developing the cage system experiment, we also consider their universal usage. In the current higher education, we have found a few common hindrances that limit the experimental practice. For example, the equipment can be costly in general, the use of the equipment can be low and the experiments are often complex. These aspects are particularly true in the field of Photonics. The cage systems overcome many of such issues and offer a cost-effective solution in the market. Unbounded within the laboratories, the systems are portable to a lecture room for experimental display and for students' practice, which greatly increase equipment utilisation. Aided with compactness, reliability, easiness of adjustment and delivery, we have found that the cage systems are welcomed by the frontline lecturers in Photonics and Optics.

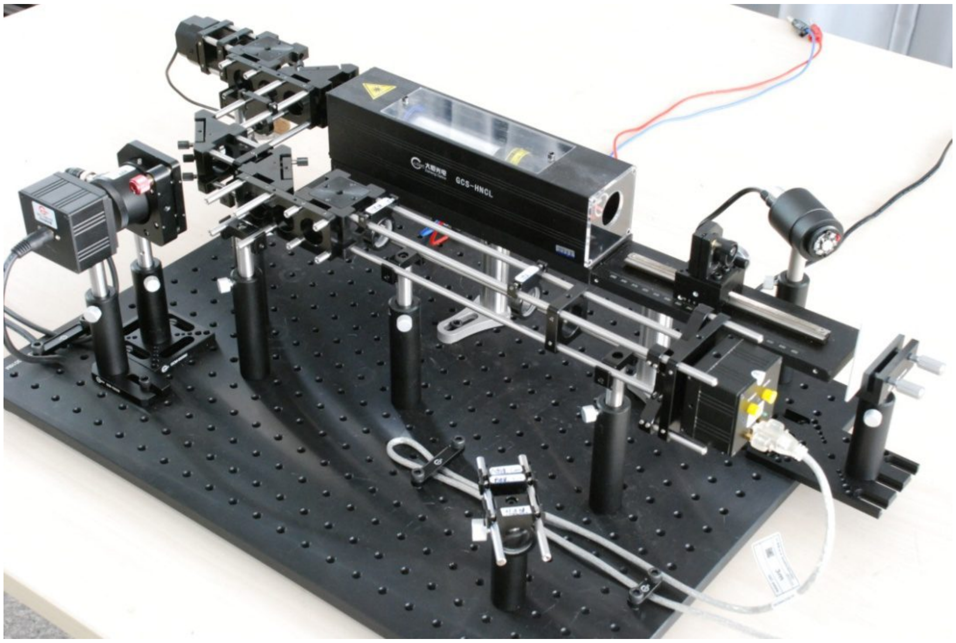

Figure 5. Cage system for He-Ne Laser Integrated Experiment.

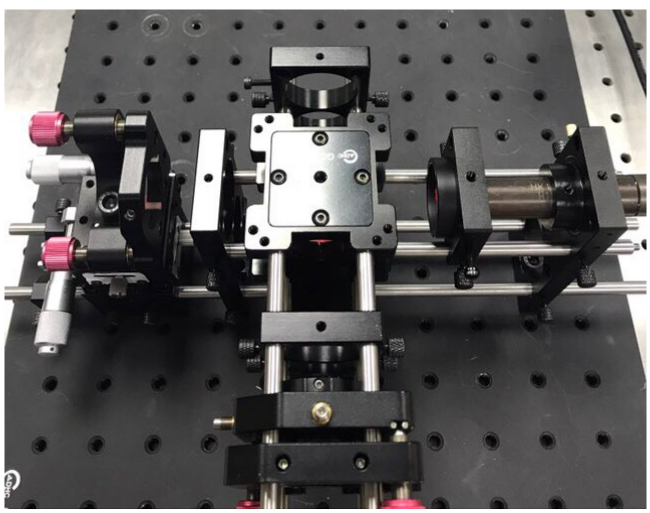

Figure 6. The cage System for Michelson Interference.

The caged experimental systems also transfer the passive experiment practice into active one. In a Classroom, students' cognition and understanding are stimulated and so increase their motivations. As the experiment systems deliver the out comes in a Classroom, students are also evoked to get their hands on and involved in the experiments, which may not be so in a laboratory. The students' learning, therefore, becomes active, stimulated and more towards cognition and personalisation. For example, Michelson Interference Experiment is one of the typical and classic optical interference experiments. Showing in Figure 6 is the cage System for Michelson Interference with its interfering image shown in

Figure 7. The structure is accomplished by a caged set-up with the size of a standard A4 paper and its weight of less than 5 kg, displaying a clear effect of the interference pattern. The presentation of the caged system is refreshing in a Classroom.

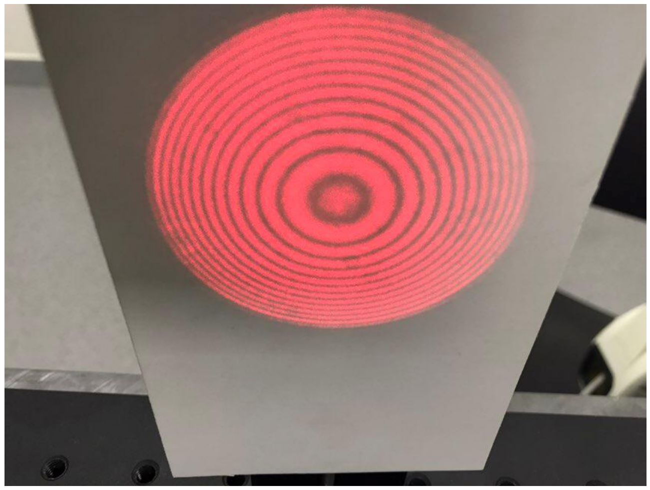

Figure 7. Interfering image of the cage System for Michelson Interference.

Any university course in Photonics stresses its applicability. For the lecturers, practical demonstration is the key assistance to students' learning, where the cage systems play a unique advantage. A good example is the 'Optical Tweezers' experiment, that contains a complicated spatial extension in the optical system that makes almost impossible to deliver under a traditional laboratory set-up. However, it is not the case in the cage system. Figure 8 shows the systematic diagram of 'Optical Tweezers', which is widely used in microscopy and biological applications.

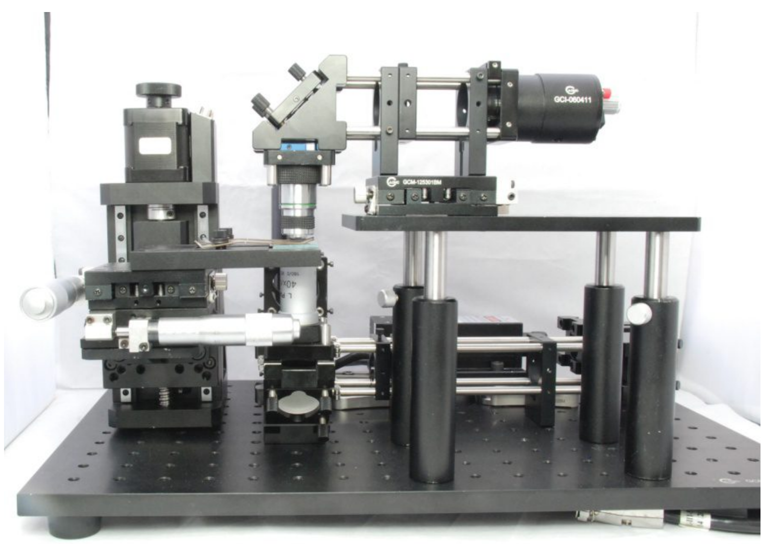

Figure 8. The cage System for Optical Tweezers experiment.

3. CONCLUSIONS

In summary, it is not hard for one to conclude that the Cage Systems, portable to Classroom, provide an active approach in the learning of Photonics field and contributes a realisable programme for the teaching reform. The innovated systems are accomplishable in practice, stimulate the subject learning and enhance application practice.

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