CHAPTER 8

CONCLUSION & FUTURE WORK

8.1 CONCLUSION

In phase 1 research, an AR-based Didactic System was proposed and implemented for a Learning Factory aiming at education and training in technical education. The Didactic System introduced for the students was the Outcome-Based Education (OBE) model where each micro-lesson of the mobile application was an AR lesson enabling students to learn independently with a self-assessment mechanism on the campus. The rather outcome-based nature of the system was measured and assessed using performance indicators (SCI) and students. The assessments revealed fairly good compliance at the beginning, and the fine-tuning after that resulted in further performance increases and acceptance of the AR-based Didactic System. Regarding the site improvement, the main concerns were content access (90 %), video/audio quality (76.6 %), flexible timetable (90.6 %), practical experience (86.6%), and student collaboration (86.6%).

The paired sample t-test showed the corresponding acceptance of the AR-based Didactic System the results of which proved highly significant at 1% and 5% levels respectively. Thus, these findings reveal the feasibility of using the system to help assist students in their learning process and the necessity for employing AR technology in learning models to improve student's achievement and interest in the subject.

Phase 2 research, introduces deep learning-based approaches to tackle two challenging visual analysis problems: Tracking of an object with six degrees of freedom and also its brightness estimation. The study trained deep convolutional neural networks by using large datasets and attained almost the highest level of performance in both domains. These growths are expected to increase the practicality and realism of augmented reality applications responding to changes in light sensitivity, and dynamic environment in general.

The experiments involved the use of printed and digital markers – it was ascertained that the response time depended on the light intensity. The result showed that the effectiveness of the smart device, the mobile phone was enhanced was far superior to increasing the physical light source. Moreover, it is established that printed markers were more effective in capturing the student's attention than digital markers because of reflections. It was also found out that light source, intensity, distance, object reflection, texture and surface of the object influence the experiment involving real markers, which are the basis of LRF.

Phase 3 research aims at solving the acute problems of identity and space expansion in Augmented Reality (AR) for the identification, tracking, and augmentation of real-world three-dimensional objects. Thus, the achievement of point characteristic integration with line, planar and semantic characteristics enhances the functionality of the system, especially in low texture or high variability situations. The proposed system can be augmented with the Internet of Things (IoT) and if the solutions regarding position estimation and occlusion of moving objects are correctly implemented, AR could be made available to a broader number of people. This advancement will enable the users to physically navigate and command the real objects making the experiences more natural and realistic. Computer-augmented reality applications in areas such as artificial intelligence, education, health care, gaming, military and entertainment fields can benefit a great deal from such development basically in the production of datasets that are imperative in learning 3D objects in artificial intelligence.

8.2 LIMITATIONS AND PRACTICAL CONSTRAINTS OF PROPOSED SYSTEM

8.2.1 Limitations of the Proposed System

Despite its advantages, the proposed system has several limitations:

1. The integration of deep learning, closed-loop tracking, and visual SLAM increases computational demand, which may challenge low-end mobile devices.
2. The client–server partitioning model requires stable and low-latency internet connectivity, limiting effectiveness in bandwidth-constrained regions.
3. Deep learning-based object detection performance strongly depends on the quality, diversity, and volume of training datasets.
4. Although system calibration sensitivity reduced compared to open-loop systems, inaccurate initial calibration or sensor noise can still affect performance.

8.2.2 Practical Constraints in Real-World Deployment

1. Variations in camera quality, sensors, and processing power across user devices can result in inconsistent AR experiences.

2. Extreme or rapidly changing lighting conditions may still impact visual realism and tracking accuracy despite adaptive illumination techniques.
3. Real-time video capture and cloud-based processing raise concerns related to data privacy and secure transmission.

8.3 FUTURE WORK

Future studies will build on the development of the didactic learning system for Virtual Reality, which will give more immersive type of learning. The didactic system will more concentrate on contents of Chemistry, Physics, Mathematics and Engineering Graphics. It will also build functionality of the envisioned AR system in the two following ways. Firstly, optimize the feature resistance by extending point features by the line, planar, and semantic features to work effectively under various conditions. Secondly, semantic segmentation results in advanced semantic mapping technology for navigation demand and enriches the spatial representation for augmented reality applications. These relative intents are towards the enlargement of usability and enhancement of operative AR features for different domains, thus creating extended ways of envisioned operations of users.