Multimedia Meets Archaeology: A Novel Interdisciplinary Teaching Approach

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***Abstract*—Multimedia information processing course includes image processing, text processing, video processing, audio processing, graphics, and animation. Classical multimedia information processing course is to lecture these contents as independent course units, making the course teaching inconsistently and student's learning interest and attention lost easily. Archaeology is a cross-disciplinary field, where an archaeological research project needs to use a variety of multimedia information processing technologies. This paper introduces a novel cross-disciplinary course teaching approach to combine traditional multimedia information processing techniques with archaeological research content in the new engineering era, which increases students' attention and interest in the multimedia information processing course. Teaming up with the archaeology professor, we present two multimedia-archaeology projects: intelligent pottery fragments splicing and intelligent Oracle inscription recognition. We have addressed a few challenges in our courses: 1) how to guide students efficiently to implement different project contents, e.g., using the scanner to acquire three-dimensional porcelain fragment data skillfully. 2) How to inspire students to learn and use various multimedia processing technologies and archaeology knowledge. 3) How the teacher adapts the teaching content according to the dynamic interests of the students. To address these challenges, students are grouped into two project teams based on their strengths and interests. We introduce collaborative learning and active learning strategies to help students learn and use different knowledge and address project problems and learning problems. We also invite the archaeological professor to teach basic archaeology knowledge in the class. Furthermore, to better understand the students' learning situation, we present a weekly project progress report approach, which can also help the teacher adjust the teaching content. This teaching approach can enhance the continuity of multimedia information processing teaching and stimulate students' enthusiasm and creativity in learning. Moreover, it can deepen the cultural atmosphere of the teaching in an engineering course.**

***Index Terms*—Multimedia, Archaeology, Oracle inscription, Cross-disciplinary, Pottery fragments**

I. Introduction

Multimedia is a commonly used communication form comprised of different forms like text, audio, animation, images, and video through a single presentation [1]–[3]. With the rapid development of multimedia computer techniques in the past decades, especially artificial intelligence (AI) techniques [4], [5] and hardware support (e.g., powerful GPU), multimedia has been applied to various application areas such as education, advertisements, art, education, entertainment, engineering, medicine, mathematics, and business, etc [6]–[8]. Career opportunities in multimedia have never been greater in the digital era. This is because it has become a significant component in daily life.

Multimedia is a cross-disciplinary field that requires computer science, engineering, art, psychology, and other disciplines. Unfortunately, we found that few universities have opened multimedia information processing (MIP) courses for computer science (CS), Computer Engineering (CE), Electronics Engineering (EE) today based on the Internet survey. There are two reasons to explain this phenomenon: (1) MIP course comprises too much content like image processing, text processing, and video processing, independent of each other. In the class, teachers usually teach these contents separately through different course units, making students unable to grasp key points in the MIP course and gradually lose interest in learning. (2) With the advent of artificial intelligence (AI), many universities have opened a series of AI-related courses, such as deep learning (DL), machine learning (ML), natural language processing (NLP), and image processing. These courses usually teach one type of media type with AI methods, and students are more willing to learn them, which marginalizes the MIP course. However, the main goal of the MIP course is to enhance the ability of CS students to apply multimedia techniques to deal with multimedia application problems rather than single media application problems. MIP pays more attention to cross-disciplinary applications than basic multimedia theories and techniques because most of these MIP techniques and theories have been taught by other CS courses.

Recently, cross-disciplinary talent training and education have been a hot topic in society and education, and a lot of universities are developing new engineering, new medicine, and new business, etc. Motivated by society's requirement, the author's University has increasingly emphasized cross-disciplinary education for students to improve their practice and innovation abilities. As previously introduced, multimedia is a cross-disciplinary field; thus, multimedia information processing is a cross-disciplinary course, which is suitable for cross-disciplinary educational practice. However, none of the existing multimedia information processing courses have presented a concrete and good example for reflecting the cross-

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disciplinary nature in this field. Therefore, this paper attempts to develop a novel cross-disciplinary teaching mode for the MIP course, combining multimedia applications with archaeology. Archaeology is also a cross-disciplinary discipline, which requires cross-disciplinary collaboration to complete an archaeology project that includes multimedia information processing techniques. Furthermore, Archaeology is a prevalent and interesting topic in universities and society, attracting many students. Hence, the authors introduces archaeology into the MIP course by teaming up with the professor from Center for Social Science to motivate student's learning interests and build a novel and interesting cross-disciplinary teaching practice.

We present two multimedia-archaeology projects in our MIP course: intelligent porcelain fragment splicing and intelligent Oracle inscription recognition to enhance students' cross-disciplinary practice and innovation ability. Students are grouped into two project teams based on their strengths and interests. We introduce collaborative learning and active learning techniques to help students learn and use different knowledge and address the project problems based on team collaboration, which is significant and necessary for their career development. We hope that these cross-disciplinary projects can deepen the cultural atmosphere of engineering course teaching. The following section describes this course content in detail.

II. A Cross-disciplinary Multimedia Information Processing Course

The primary goals of this MIP course can be summarized as follows:

- We attempt to build a novel cross-disciplinary teaching practice, presenting a different and exciting teaching attempt for cross-disciplinary education through MIP course in the new engineering era.
- Enhancing cross-disciplinary practice and innovation ability of students, working to build and evaluate thoughtful and meaningful multimedia-archaeology applications using learned skills from other courses and their domains of expertise.
- Cultivating students' collaborative learning and active learning abilities are essential for their career development.

In the university, the authors met with faculties and students from Communication, Computer Science to discuss appropriate prerequisites, skills, and learning objectives wanting to acquire in the MIP course. Through these discussions, it gradually became clear that students are more intended to take the MIP course if this course can offer cross-disciplinary multimedia applications by using different techniques. Hence, this course works with Center for Social Science and introduces two cross-disciplinary and challenging multimedia team projects: intelligent porcelain fragment splicing and intelligent Oracle inscription recognition. This course has the following prerequisite courses: image processing, machine learning, and artificial intelligence.

A. Teaching Structure for Cross-disciplinary MIP Course

Fig. 1 presents the teaching structure for cross-disciplinary MIP course. this course is taught by both the computer science (CS) professor from Department of Computer Science and Engineering and the archaeology professor from Center for Social Science. The CS professor from Department of Computer Science and Engineering teaches multimedia concepts, multimedia types and algorithms, and multimedia applications. The archaeology professor from the Center for Social Science lecture on the archaeology concept, the historical background of Oracle inscriptions and pottery fragments, the practical value and archaeological value in the archaeology field. They can help archaeologists better discover and restore history. Two professors then discuss how to use multimedia techniques to help archaeologists finish some archaeology research works efficiently.

CS professor analyzed and sorted out the archaeology professor's lecture, then integrated them into MIP course content, and finally taught these cross-disciplinary contents in the class, which can help CS students to develop a cross-disciplinary mind and enhance the coherence of course content. Furthermore, to combine this cross-disciplinary course teaching with engineering application practice, this course designed two multimedia-based archaeological projects: intelligent porcelain fragment splicing and intelligent Oracle inscription recognition. In order to guide CS students to complete these two team projects efficiently, and each team project has a course teaching assistant (TA). In the author's university, TAs are Ph.D. candidate students and postgraduate students who have solid professional knowledge and provide effective instruction for course projects. The course TAs discuss with two group members every week and give feedback to the CS professor, which can let the CS professor know the learning conditions and adjust the course content in time.

To develop and enhance collaborative learning and active learning abilities of students, each team project is required to report the progress of their projects fortnightly, where the works of each group member are presented and how they work together includes difficulties and debates.

B. Multimedia Information Processing Course Content

The course content of MIP can be summarized into four units: multimedia concepts, multimedia types and processing algorithms, multimedia applications, and archaeology introduction, as shown in Fig. 2. In the multimedia concept unit, students learn what multimedia is and common multimedia types in daily life. Then they discuss and share their ideas and opinions of the development trend of multimedia in the future. The CS professor would introduce text, image, video, signal, and other encoding and processing algorithms with the recent AI techniques in the multimedia type and processing algorithm unit. Moreover, this unit requires students to understand and summarize the similarities and differences of these algorithms based on multimedia types.

The CS professor selects popular multimedia applications such as VR, AR, XR, MR, small videos, and machine

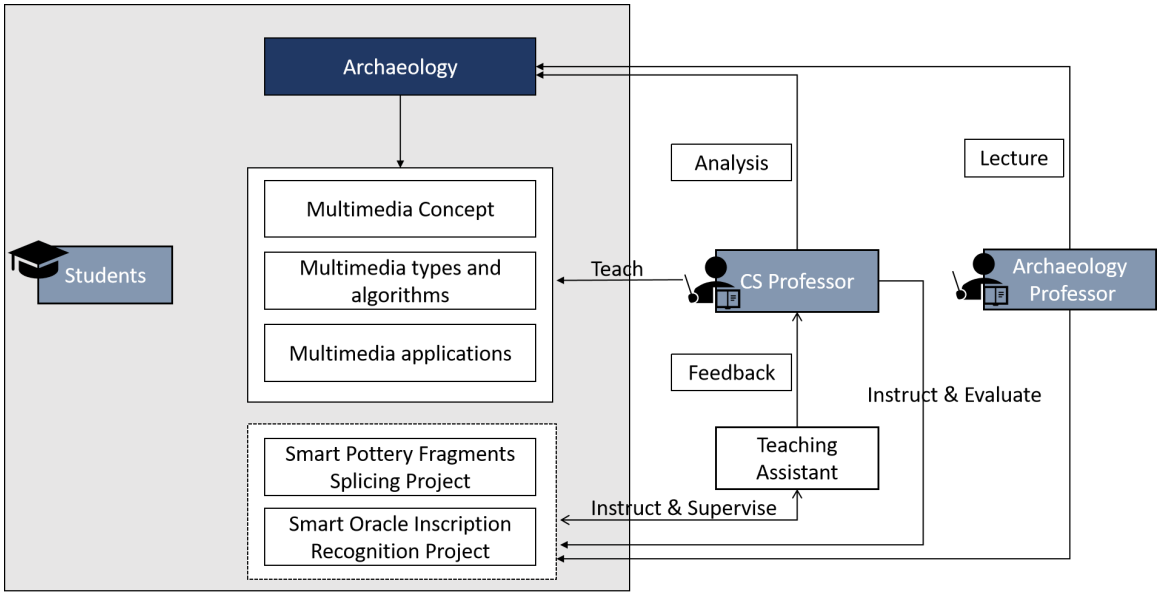

Fig. 1. Teaching Structure of Cross-disciplinary Multimedia Information Processing Course.

dialogues in the multimedia application unit. Further, the professor also teaches multimedia technology used behind these multimedia applications as well as introduces multimedia applications in the archaeology research field, e.g., historical story animation production technique. Furthermore, students are divided into different groups based on their favorite multimedia applications to choose multimedia application scenes, and introduce algorithms used behind them through PowerPoint presentations. The CS professor and TAs make comments on their presentation. We hope students can enhance the application and innovation ability between computer techniques and applications based on the multimedia application unit.

The archaeology introduction unit comprises the concept and significance of archaeology, the historical background of Oracle inscription and pottery, and the practical value and archaeological value in the archaeology field. This archaeology content can prepare students to learn archaeology knowledge quickly and easily.

To test students' learning effects, the professor would assign related homework after students completed learning each multimedia type course unit. TAs would promptly finish marking of homework and give feedback to the CS professor. Thus, the CS professor can know the teaching effectiveness and students' mastery in time, which can help the professor improve the teaching method and adjust teaching content, as shown in Fig. 1.

C. Intelligent Pottery Fragment Splicing Project

Cultural relics are items of historical and cultural value and significance, which are leftover by human beings in the past production activities. Pottery is one of the most common cultural relics. The unearthed pottery is usually used as essential and important materials in studying ancient history and culture by historians. It is an important reference and guidance for restoring historical events and cultural features of the corresponding historical period. Before being unearthed, most of the pottery had been improperly preserved for thousands of years, being weathered, eroded, rusted, or broken under the action of external forces.

The number of well-preserved unearthed potteries is scarce. The restoration of cultural relics is very important to promote archaeological research, but the number of potteries that archaeologists can restore is not much based on the unearthed pottery fragments. Although this manual splicing method can restore cultural relics, it is inefficient, time-consuming, and labor-intensive, may cause further damage to cultural relics. It is difficult and impossible to efficiently restore large-scale cultural relic fragments unearthed in batches by archaeologists.

After discussing with the archaeology professor from Center for Social Sciences, we thought that the manual restoration of pottery based on porcelain fragments could be automatically realized with the help of multimedia technology, which can assist archaeologists in efficiently splicing pottery fragments. It is a meaningful cross-disciplinary project in both scientific research and engineering fields. Thus, this course introduces a team-based pottery splicing project based on multimedia information processing technology.

In this team project, students work together to complete an intelligent pottery splicing system application. The entire team project can be divided into four parts: pottery fragments data acquisition, data processing, automatic pottery fragments splicing, and presentation website, as shown in Fig. 3. Each team member is responsible for completing different parts of the project based on their abilities and interests.

1 **Pottery fragments data collection.** According to the literature survey and suggestions of archaeologists, students conclude that three-dimensional (3D) data is more

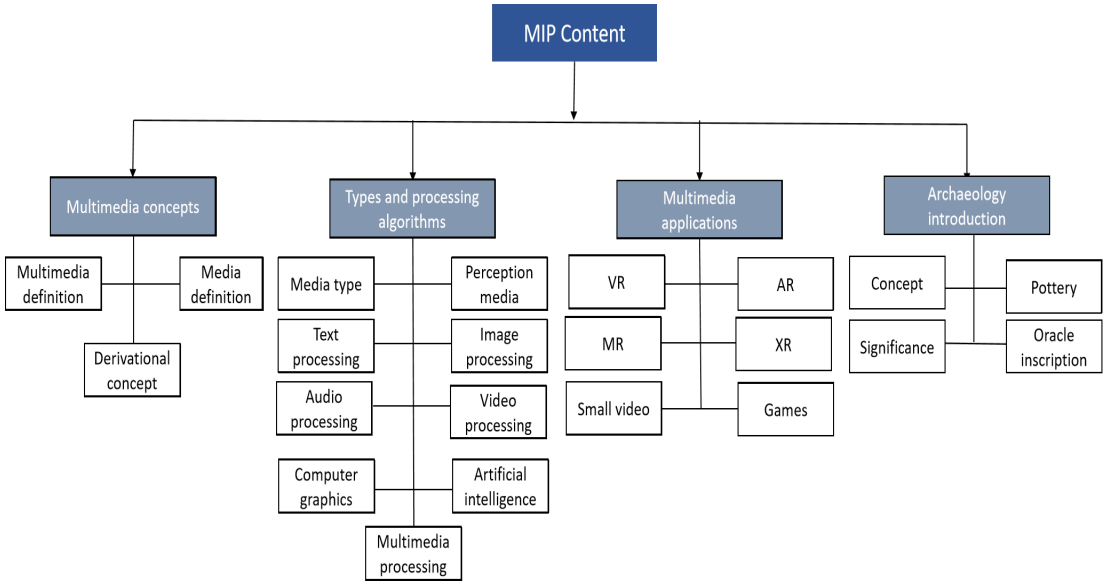

Fig. 2. Cross-disciplinary Multimedia Information Processing Course Content.

suitable for automatic pottery fragments splicing than two-dimensional (2D) data. Hence, the team members used a 3D scanner to scan the pottery fragments, as shown in Fig. 3, where the 3D scanner comes from Artec 3D corporation. It can make fast, high-quality scans of any object; there is no need for targets or calibration. Accuracy and resolution of it are up to 0.1 mm and 0.2 mm, respectively.

2 **Data processing.** The 3D pottery fragments data acquired by the 3D scanner cannot be directly used as input for pottery splicing algorithms. This is because there are many noises in the data; the background and shape information of pottery fragments are missing . Students need the 3D data repair software to manually repair the pottery fragment data and get available pottery fragment data.

3 **automatic pottery fragments splicing.** Based on archaeologists' experience in manually repairing pottery, students designed the automatic pottery splicing process through processed pottery fragment data, as shown in Fig. 3. It is comprised of size classification of pottery fragments; contour feature and surface feature extraction from pottery fragments; shape matching based on spatial curve matching and shape similarity measurement methods.

4 **presentation website.** In order to better display the intelligent pottery splicing project, the team also designed a presentation website. It has the following Web pages: the history and significance of the pottery, pottery fragment data, complete pottery data, videos, animation, and automatic pottery splicing process.

D. Intelligent Oracle Inscription Recognition Project

Oracle Inscription is the earliest mature writing system discovered in China so far, which is recorded on the tortoise shell or the animal bone. It is an essential and significant foundation for studying the development of Chinese characters and Chinese culture. After discussing with the archaeologists, students found that they can use multimedia processing technology to intelligently recognize oracle inscription by developing an oracle inscription intelligent recognition application. This application can help the public identify unknown oracle inscriptions accurately and understand the origin and evolution of Chinese characters. It is a valuable method to prompt the development of oracle inscriptions and improve humanities literacy.

According to the Oracle inscription identification literature survey and the professional archaeologists' suggestions, the students divided the project into two groups: the algorithm group and the web-side group, as shown in Fig. 4. The algorithm group is responsible for Oracle inscription data collection, data preprocessing, and Oracle inscription prediction model construction, where popular convolutional neural networks (CNNs) are used. The website group designs presentation web pages: historical background of Oracle inscription, visualization of algorithm prediction results, and human interaction interface.

E. Summary

Table I summarizes the multimedia and AI techniques used in these two archaeological projects: intelligent pottery fragment splicing project and intelligent oracle inscription recognition project. The intelligent pottery splicing project needs to use image processing, video processing, animation production, signal processing, website, database, and classification techniques. Intelligent Oracle inscription recognition project

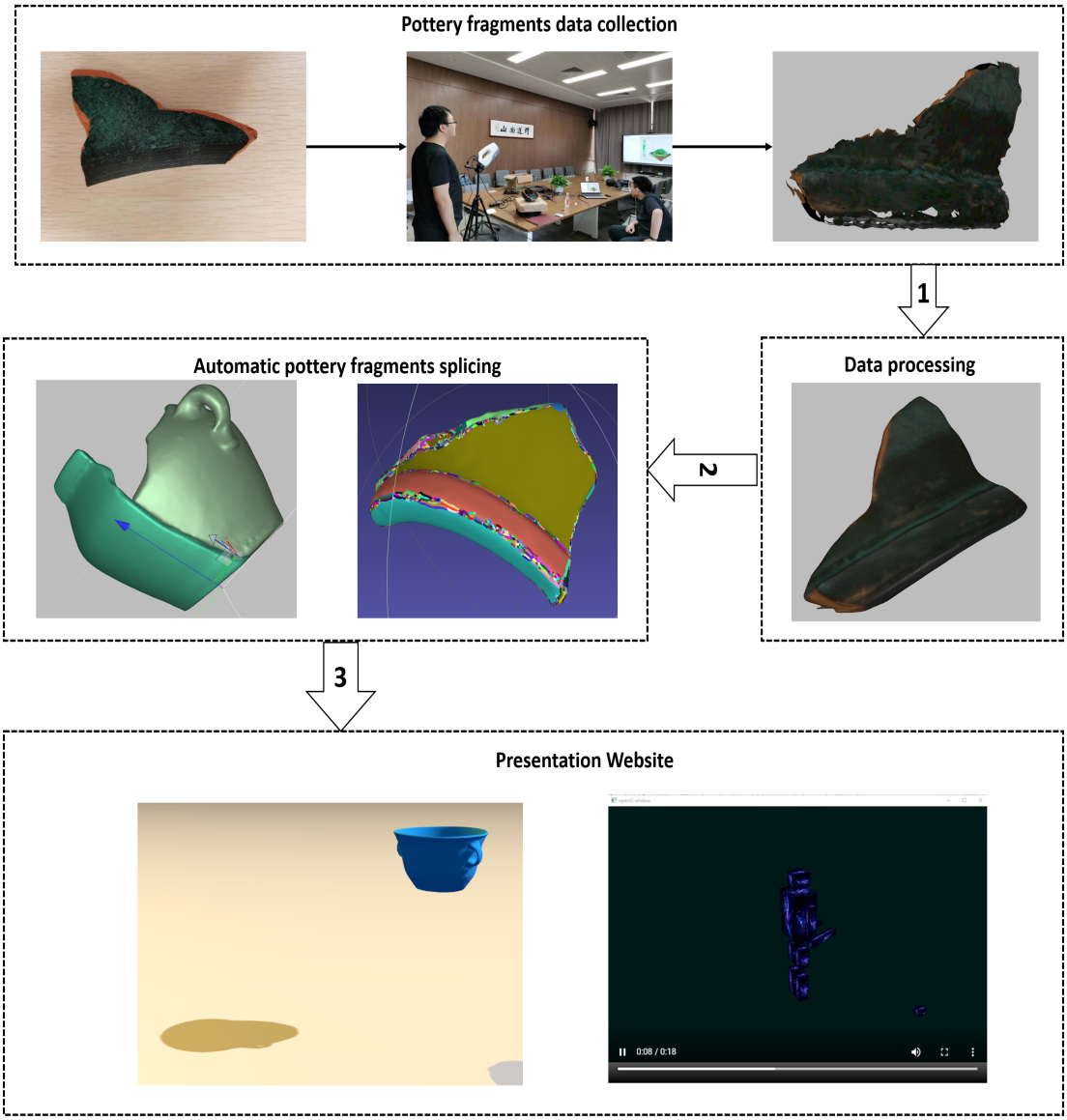

Fig. 3. Intelligent Pottery Fragment Splicing Project.

TABLE I
MULTIMEDIA PROCESSING TECHNIQUES FOR TWO MULTIMEDIA-ARCHAEOLOGY PROJECTS.

Techniques	Course	Smart pottery fragments splicing project	Intelligent Oracle inscription recognition project
Database	Database Principle, Operating Systems, Data Structure	✓	✓
Text processing	Natural Language Processing, information retrieval	✗	✓
Image Processing	Digital Image Processing, Computer vision,Deep learning	✓	✓
Website	Software Engineering, Program Design, Software Testing	✓	✓
Video Processing	Computer vision, Deep learning, Intelligent Robotics	✓	✗
Signal Processing	Deep learning, Intelligent Robotics text, Natural Language Processing	✓	✗
Classification	Machine Learning, Artificial Intelligence, Deep learning, Data Mining	✓	✓
Animation	Computer Graphics, Computer vision	✓	✗

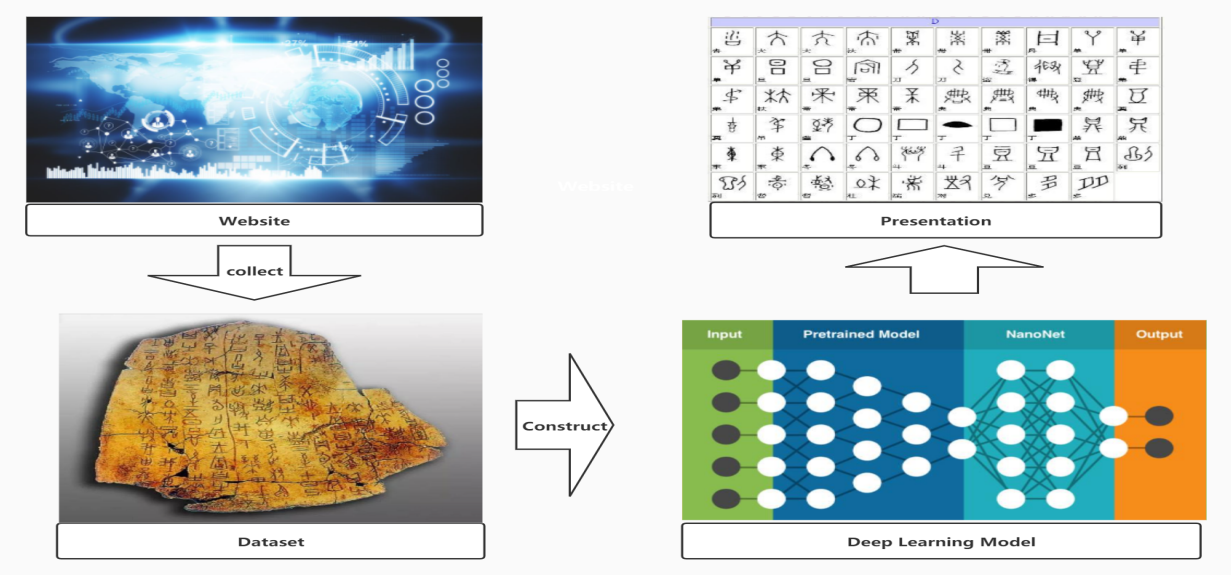

Fig. 4. Intelligent Oracle Inscription Recognition Project.

uses image processing, text processing, website, database, and classification techniques.

In table I, we also see that students have learned these techniques in other CS courses such as teachers have taught various classification methods in machine learning (ML), artificial intelligence (AI), deep learning (DL), and data mining (DM) courses. Nevertheless, these courses focused more on algorithm theories rather than applying these algorithms to address real application problems. To highlight the difference between the MIP course and other CS courses, the MIP course stresses the application innovation ability of students. That is, how to use what they have learned from other courses to deal with application problems by active learning and collaborative learning. The applications of multiple multimedia processing technologies in a project is conducive to students' mastery of multiple multimedia processing technologies, enhancing their career competence by practice.

III. Course Evaluation

Thirty-five students completed this course, which all came from the Department of Computer Science. Students were asked to complete a brief anonymous questionnaire during the last week. The questionnaire and administration procedure were approved by the department in charge of teaching at the author's university.

Thirty-one students finished anonymous questionnaires, and the other four students ask for a leave. The anonymous questionnaire contains the following Likert scale items and each student is required to circle the phrase that best describes your agreement with the statement:

1. "This course enhances your understanding of cross-disciplinary applications and research through the course content, teaching approach, and course projects."
2. "I feel that this course helped me improve collaborative learning and active learning ability."
3. "I feel that multimedia-archaeology course projects may be helpful for my involvement in cross-disciplinary projects or cross-disciplinary research in the future."
4. "I feel that timely homework feedback help me better grasp the course content efficiently and achieve higher marks in the MIP course."
5. "I feel that the course teaching assistant's effective communication and guidance help me better complete the course team project and learn the course content?"
6. "I feel that this course improves my practical ability and application innovation ability?"

Each item has the following choices: strongly agree; agree; neutral; disagree; and strongly disagree.

Fig. 5 shows the questionnaire results of six items. For item 1, twenty-four students strongly agreed, and seven students agreed concerning the statement. Students felt this cross-disciplinary MIP course gives them an interesting perspective on cross-disciplinary applications and research.

For item 2, nineteen students strongly agreed, nine students agreed, two students were neutral, and one student disagreed agreed with regards to the statement. Most students wrote that "Cross-disciplinary course project is an exciting experience, which surely improved their collaborative learning and active learning abilities." One student disagreed with the statement because he did not want to work with another teammate.

For item 3, twenty-five students strongly agreed, three students agreed, and three students were neutral regarding the statement. Students believed that Cross-disciplinary research would become a trend in new engineering. Course projects provided a chance for them to develop knowledge transfer ability and improve the practical innovation ability.

For item 4, twenty-four students strongly agreed, and seven

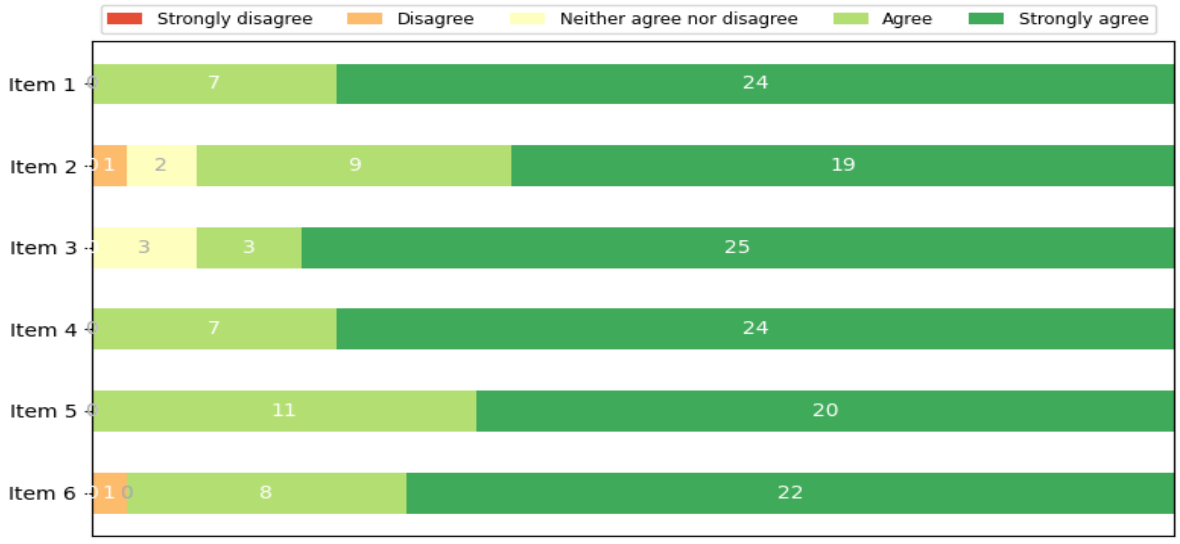

Fig. 5. Questionnaire results.

students agreed with regards to the statement. All students agreed with the statement. This is because timely homework feedback tested the learning results effectively and made them adjust their learning status immediately.

For item 5, twenty students strongly agreed, and eleven students agreed with regards to the statement. Students agreed with this statement indicated that TAs playes an important role in the MIP class, who helped students address learning problem in the class and gave useful advice for students to deal with diffculites in course projects. Furthermore, students expected that TAs interact and communicate with them more frequently in future courses.

For item 6, twenty-two students strongly agreed, eight students agreed, and one student with regards to the statement. Two students who strongly agreed with the statement wrote, "cross-disciplinary course projects let them learn to use what they learned from classes to solve real application problems innovatively." One student who disagreed with the statement wrote, "He had difficulty in applying learned knowledge to real application problems and did not communicate well with other teammates."

IV. Related Work

Cross-disciplinary course teaching is one of the most popular course teaching methods in various disciplinary courses [9]–[13]. This is because teachers want to increase the diversity of teaching content and improve the attention of students in class. With the rapid development of new engineering, cross-disciplinary education and practice have been placed an emphasis on students.

In the recent, several CS courses have used cross-disciplinary teaching methods by combining different course contents. Onyeka Ezenwoye [14], [15] found that integrate security into various CS courses which can help students knowing security issues better in software systems. Aneet [11] introduced artificial neural networks (ANNs) on thermodynamics introduction course for enhancing students' competitiveness in the job market. Bo Liu [12] discussed how to incorporate machine learning (ML) concepts into data structure (DS), which intrigued the study enthusiasm of students and made students know how to use DS structure in real applications.

Collective learning and active learning are widely used learning techniques in large class teaching, which is capable of increasing engagement in class [16]–[19]. Whittington [20] used team-based learning technique in a programming language class. They found that students obtained good performance through teamwork. Alark Joshi et al [21] used collective learning for the sophomore-level systems programming course , which provided opportunities for students to apply their knowledge to address problems. The performance of students gets a significant improvement based on thier scores.

V. Conclusion

This paper describes how to develop a cross-disciplinary multimedia information processing (MIP) course with effort, comprised of teaching structure, teaching content, and course project. feedback from the questionnaire suggest that many students believe that the MIP course not only better made them grasp different multimedia processing techniques entirely and masterly, but also enhance cross-disciplinary practice and innovation ability based on collective learning and active learning. Furthermore, they also think that some aspects of this course can be improved, such as helping students to work together efficiently for cross-disciplinary projects, and how to enhance interactions through interesting ways. Moreover, this course presents a concrete cross-disciplinary teaching example in the MIP course, showing that it is possible to introduce other disciplinary applications into computer science courses,

which is a good way to enhance the attention of students in the course and the application innovation ability.

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