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Artificial Intelligence Course Design: iSTREAM-based Visual Cognitive Smart Vehicles

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Abstract—New intelligent era calls for new learners and thus urgently needs a series of artificial intelligence. As a good educational platform for teaching artificial intelligence, smart cars have aroused concern and practices of all parties. However, at present, most courses and training pay more attention to basic knowledge and technology of smart cars, seldom to training based on artificial intelligence curriculum system and comprehensive competency integrating science, technology, art and management. Therefore, based on concept of iSTREAM (intelligence for Science, Technology, Robotics, Engineering, Art, and Management) and Raspberry intelligent vehicle teaching platform, this paper introduced a smart car-themed artificial intelligence courses including basic courses, specialized courses, specialized technical courses and elective courses. This course can guide learners to develop smart cars based on visual cognition, in-depth learning, VR and 3D printing integrated artistic creativity. It combines disciplines such as science, technology, art, games and management to upgrade a single knowledge and technology course into a comprehensive competency course that integrates knowledge, skills, emotion and management. Practice in Beijing NO.13 and NO.101 High School shows that this course allows students to experience scientific research process, learn artificial intelligence related knowledge and skills, understand scientific way of thinking and scientific research methods, stimulate learners' responsibility and scientific passion, and cultivate leadership skills through self-learning and partly project management.

Key Words: iSTREAM, Curriculum Design, Smart Cars, Project-based Learning, Project Management, Self -learning

I. INTRODUCTION

STEM (Science, Technology, Engineering, Mathematics), which was proposed by the U.S. President Bush in the 《USA Competitiveness Plan》 [1] in 2006, pointed out that one of goals of new knowledge-based economy is to cultivate people with STEM literacy. Since STEM was introduced into China in 2007, the wave of STEM research in China has been set off , including policy[2][3] idea[4][5][6], curriculum[7][8], evaluation[9], related techniques[4][5] and others. From STEM to STEAM (Science, Technology, Engineering, Art, Mathematics) to fuse A (Art), and then to STREAM (Science, Technology, wRiting, Engineering, Art, Mathematics) to extended version of iSTREAM (intelligence for Science, Technology, Robotics, Engineering, Art, Management) [4][5] , proposed by Professor Wang Fei-Yue for new IT age to cultivate a leading cadre of comprehensive competency. iSTREAM believes that Robotics will become an independent discipline in new IT era and turn Mathematics into Management, and that prospective talents not only possess knowledge and skills of various disciplines, but also leadership skills of advanced management.

It involves a wide range of disciplines, such as artificial intelligence, automatic control, pattern recognition, sensor technology, automotive electronics, electrical, computer, machinery, energy and so on, so it is a natural comprehensive teaching platform. From patrol line obstacle-avoidance intelligent car teaching platform and competition for primary and middle school students to various types of smart car challenge competition for college students and enterprises, such as Future Challenge of Intelligent Vehicles in Changshu City, Jiangsu Province has been held continuously for 8 years [10], smart cars have inspired interest of the society in learning smart related science and technology. At present, most courses and events focus more on vehicles' functionality and usability, or only on vehicles' artistry such as cart carts, but less on vehicles' comprehensive ability from functionality and artistry.

Therefore, based on iSTREAM, self-developed intelligent vehicle teaching platform, project-based learning method, CDOS design process, and self-developed artificial intelligence curriculum system including basic courses, specialized courses, specialized technical courses and elective courses, Set of intelligent vehicles courses were developed to guide learners to develop intelligent vehicles based on visual cognition, in-depth learning, VR and 3D printing integrated artistic creativity. By combining disciplines such as science, technology, art, games and management, this course upgrades a single knowledge and technology course into a comprehensive course that integrates knowledge, skills, emotion and management. Practices in Beijing NO. 13 and NO.101 High School shows that this course allows students to experience scientific research process, learn artificial intelligence related

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knowledge and skills, understand scientific way of thinking and scientific research methods, stimulate learners' responsibility and scientific passion, and cultivate leadership skills through self-learning and partly project management.

II. COURSE DESIGN

A. Course Introduction

This course is an artificial intelligence themed, comprehensive practical creative course for new IT era. Based on iSTREAM, it integrates science and technology, engineering, art and management together by seamlessly fusion of vehicles electronics, software and hardware design, artificial intelligence, computer vision, deep learning and algorithms, software engineering, project management, VR design and 3D printing.

B. Course Objects

Under guiders' help, learners got to understand basic knowledge and technology of smart vehicles, train and cultivate their self-taught abilities, creative thinking and project process management skills through group-based learning, software programming and artistic creation.

C. PBL-based Learning

Based on project-based learning approach, this course will recruit students in the form of hiring for project managers, software designers, hardware designers, and art designers. Students will learn through variable forms of class-teaching, group discussions, after-class exercises, online Q & A, professionals' academic reports, S&T visits, English defense. In an atmosphere of equality, learners will experience fun of true learning, understand steps of scientific research, cultivate way of scientific thinking and exercise management and leadership skills, reflecting "My study, I call the shots"!

D. Course Highlight

Based on learner-centered philosophy, learners are treated as project managers so that learners' initiative would be greatly stimulated; By adopting autonomous learning method under guiders' help, it could cultivate learners' autonomous learning ability. By integrating science, technology, art, humanities, management and other elements, it could cultivate overall leadership quality of learners; By introducing deep learning based visual cognitive algorithm, it could enable learners to contact and understand knowledge and algorithms of artificial intelligence; By fusing eco-friendly car bodywork and logo design, it could release learners' creativity and reflect unique concept of learners, ideas and culture.

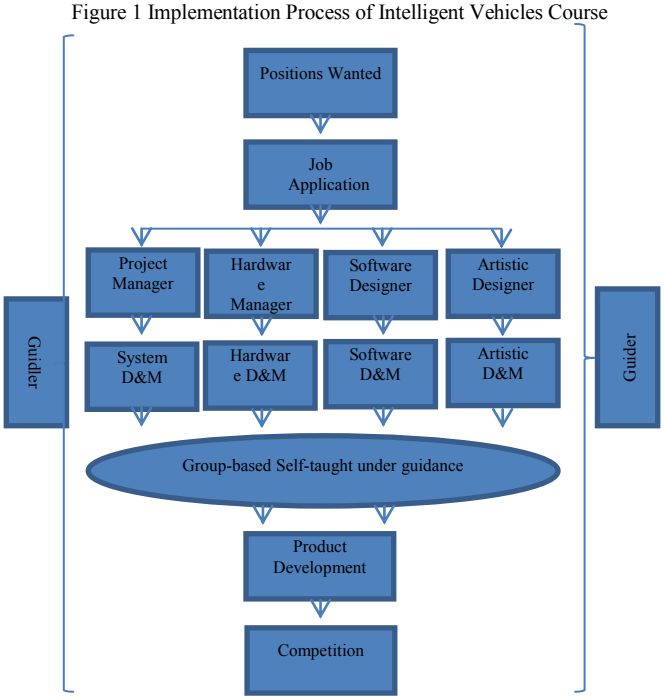
E. Implementation Process

As shown in Figure 1, job advertisements are posted to learners one month prior to the beginning of the course, recruiting talent based on needs of smart vehicles project. In this month, learners carry out relevant research according to their learning background and thus determine their pre-applied positions and applied materials. Then at the beginning of the course, learners start to apply a variety of positions, such as project managers, hardware designers, software designers, artistic designers and group members. Under teachers' guidance, based on team discussion, project manager formulates system design plan and project management plan, hardware designer draws up hardware design plan and hardware management plan, and software designer formulates software design plan and software management plan, and artistic designer creates car body and logo design plan and artistic management plan, team members also develop their own learning and work plan according to task allocation. Subsequently, under teachers' guidance, project team conducts development and iteration, and finally obtains expected products and organizes smart vehicles competition.

F. Course Schedule

This course lasts for two weeks with a total of 32 hours. The first week is artificial intelligence foundation, overall design and hardware development, the second week is software and algorithm design and development, the third week is artistic design and development, and the fourth week is paper writing. See 3.2 Course Schedule for details.

Figure 1 Implementation Process of Intelligent Vehicles Course



III. COURSE IMPLEMENTATION

A. Recruitment

Before start of the course, a task description and recruitment notice was given to senior high Grade 1 in Beijing 13 and NO.101 Senior High School to help teachers select candidates for the course. Recruitment notice as shown in Figure 2.

10 resumes were received, including 5 students applying for Agent-in-Chief and hardware agent, 2 for software agent, 2 for art agent. A hiring committee was formed by teachers to vote on competition and finally selected a 3-person group, including 1 Agent-in-Chief and hardware agent, 1 software agent and 1 art agent. Each agent is in charge of different

sub-tasks and learn together by listening to lectures, self-learning, discussion and doing experiments.

B. Course Schedule

Course Schedule is developed based on our artificial intelligence curriculum. The whole course lasts two weeks, in each week there are one or two days of class-learning and discussion, three or four days of self-learning and twice Q&A office hours.

The first week focused on basic courses for artificial intelligence and system hardware design, including two days classes and three days self-learning, covering beginning of artificial intelligence, projects management, beginning of software project, beginning of intelligent vehicles and vehicles electronics, hardware system design and management plan on hardware development.

The second week focused on basic courses for system software design, including two days classes and three days self-learning, covering software design, data structure and algorithm design, embedded software design, C language and software design, and management plan on software development.

The third week focused on artistic creativity and VR+3D development and design, including two days classes and three days self-learning, covering VR & Art development, 3D printing and Art Development, VR+3D Art design, and management plan on art development.

The forth week focused on paper searching and paper writing, including one day class and four days self-learning, covering literacy searching, paper reading, beginning of paper writing and management plan on paper writing.

Figure 2. Agents Wanted

Agents Wanted
Now recruit Agent-in-Chief, a software agent, a hardware agent and an art agent to complete design and development of a deep learning based intelligent surveillance car with binocular vision. This car requires beautiful and invisible, logo and car body needs to be designed with VR and produced with 3D printing using a variety of environmentally friendly materials. This car can integrate vision, ultrasound and other information to identify surrounding environment and then make comprehensive decision to ultimately achieve goals of monitoring surrounding environment and secret delivery of goods.
Agent-in-Chief: Project Management (System Design, people management, time management, process management, finance management)
Software Agent: Software and Algorithm design and develop management
Hardware Agent: Hardware design and develop management
Artistic Agent: Art design and develop management

The curriculum is smart car series artificial intelligence curriculum based on artificial intelligence curriculum we have developed for high school students, which includes four kinds of courses such as basic courses, professional courses, technical courses and electives. Basic courses are basic knowledge to learn project-based artificial intelligence course, such as AI Basics, Project Management and Software Engineering; Professional courses refer to professional basic knowledge required to complete specific AI projects, such as Intelligent Vehicles Basics and IV Electronics; Professional technical courses refer to technical foundation needed to complete specific AI projects, such as hardware design basis, software design basis, 3D printing technology, VR development technology, etc. Elective courses are to provide learners with better learning opportunities and learning environment.

C. Project Management

As shown in Table 1, under guidance, agents developed project management plan with Microsoft Projects.

Table 1 Management Plan

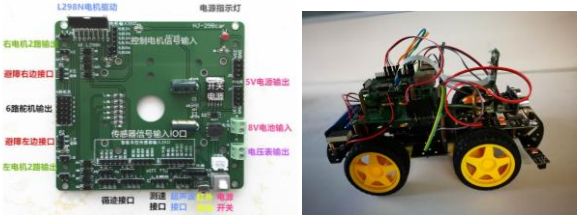
	29	30	31	1	2	3	4	5	6	7	8
Basics											
Hardware Design											
Software Design											
Art Design											
Summary											

D. Hardware Design

A pre-built four wheel drive (4WD) chassis is used as a base on which following hardware components are fit: Raspberry Pi (rev C) for GPU and CPU computations, Wi-Fi 802.11n dongle to connect to Pi remotely, Motor driver IC L293D which can control two motors, Ultrasonic sensor to detect obstacles, Pi camera, batteries to provide power.

The Raspberry Pi is a credit card-sized single-board computer. The BCM2835 Compute Module is an entirely different form factor and cannot be used standalone. In this project, we have used the model C Rev 3. It comprises of a 512 MB RAM model with two USB ports and a 10/100 Ethernet controller. It is the camera shipped along with Raspberry Pi which can be used to take high-definition videos as well as still photographs. Ultrasonic sensors evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. In this project, they are used to detect the distance of obstacles from the car.

Figure 3. Hardware Design



E. Software Environment

Software of Raspberry Pi Raspbian is a free operating system based on Debian (LINUX), which is available for free from the Raspberry Pi website. Python is a widely used general-purpose, high-level programming language. Its syntax allows the programmers to express concepts in fewer lines of code when compared with other languages like C, C++or java. The RPi.GPIO Python library allows you to easily configure and read-write the input/output pins on the Pi's GPIO header within a Python script. OPENCV (Open Source Computer

Vision) is a library of programming functions mainly aimed at real-time computer vision. It has over 2500optimized algorithms, including both a set of classical algorithms and the state of the art algorithms in Computer Vision, which can be

used for image processing, detection and face recognition, object identification, classification actions, traces, and other functions. In our project is used to detect the roads and guide the car on unknown roads. It is based on C++ but wrappers are available in python as well.

F. Autonomous Driving Training Environment

In this article, an autonomous driving training environment was built to realize convenient data collection as shown in Figure 4. While collecting training data, the car itself doesn't do all that much. It basically takes pictures and sends them to a GPU supported PC server and gets servo commands in return. The server is important to implement the autonomous driving functions. Firstly, it collects the images and driving information from the user manually driving the car around the track, by the default way via the web page interface delivered by the server. The mobile web page even has a live video view of what the car sees and a virtual joystick. The server records data from a person driving the car, then uses those images and joystick positions to train a Keras/TensorFlow neural network model in software. This happens quickly — full trip latency (car > server > car) takes about 1/10 second. Once trained, the model can be loaded on the car and the car should be able to drive like the manual driving style.

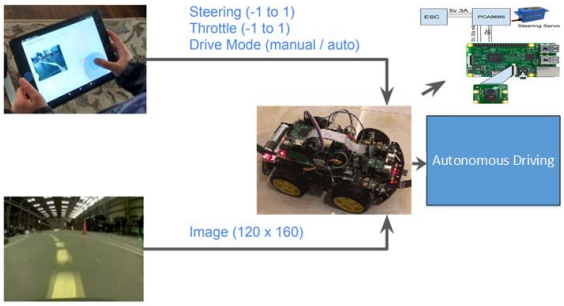


Figure 4. An Autonomous Driving Training Environment

G. Overall Algorithm

As shown in Figure 5, a model-based and feature-based combined lane detection was carried out, then a vehicle loop-based model was conducted 30 times per second and a large data set of road situation and steering angle of virtual joystick were got for training and testing.

Last, a 3 layer convolution network with one fully connected layer was applied to train or teach our car how to drive in different situations. Because of limitation of article length and this article's focus on course design, so this paper would lay out more details of algorithm.

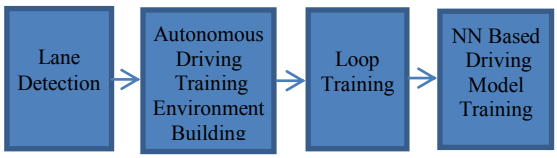


Figure 5.Integrated Video Cognitive Algorithm

H. VR based Art Design and 3D Printing

Under guidance, a "funny" emoji was made with some simple geometric figures by the 3DVR drawing software and was printed out as the logo of raspberry Pi car.

IV. CONCLUSION

Then based on review of this course on content, guider and learners, this paper sums up problems found in course implementation.

Course Content: Since this course is related to forefront artificial intelligence theories and technologies such as computer vision, neural network and deep learning, even though guiders tried to deliver these knowledge and technologies in various ways, it is found that learners can only understand 50%. So course needs to be gamified and curriculum content needs to be simplified. Therefore, we suggest that this intensive artificial intelligence curriculum should be dispersed into several semesters and introduced into the learners' daily lives to digest slowly, which may be the best way to learn.

Higher requirements for guiders' quality: Integrating science, technology, art, management and other aspects, this course puts forward high demands on qualities of guiders. We asked associate researchers in field of smart cars to conduct guidance and found out that they accomplished in guiding of science, technology and project management, but need to improve their artistic quality. Thus, STEAM concept put high demand on guiders, and there is urgent need for teachers training. Therefore, core curriculum should not be just Chinese, Math and English, while others are arranged in a casual manner. At regular intervals, different kinds of projects should be carried out by learners to develop their own ideas and experience project process.

Self-exploration learning model is welcomed by learners: In learners' active exploration, they were surprised to find that they were able to learn and master much original knowledge all by themselves. "I did not expect I can do it, and I did not expect learning is so much fun!" Just as Seymour Papert said, in this situation, real learning is happening! Real learning exists in self-exploration process when learners try to do something on their own, even make part of music or a funny toy. Therefore, we suggest that schools offer more self-exploration opportunity and return happiness and rights to learners.

Learners enjoy democratic learning atmosphere: In this atmosphere of equality, exploration, tolerance and autonomy,

learners fully demonstrate their strong drive and learning enthusiasm. In traditional education, from very beginning of learners' studies, teachers are considered to be authorities and they are considered to be passive recipients. Most sadly, this idea has been prevailing until today. Over time, enthusiasm of learners and self-confidence to learn will decline, thinking that they are a born mobile hard disk. Therefore, at school, by balancing authority with democracy as much as possible, under certain conditions, we try to let learners get immersed in learning atmosphere of equality and trust, and thus increase their internal drive and enthusiasm for learning.

Management brings challenge to learners: Although learners are often given a variety of tasks in their daily learning, less is management of synthetic factors. Since project management involves people, money, material, time, progress and other factors, and also there will be some contradictories, how to balance these contradictions to achieve goals within a given time is not only for learners but also for mature managers. In this project, learners found that due to unclear interface of tasks and insufficient communication resulted in task failures. As a result, there is a need to offer K-12 learners more project management training opportunities to gain not only knowledge and skills, but more importantly project management skills, communication skills and leadership skills.

Literature retrieval and bilingual paper reading, writing and analyzing ability need to be improved: In new IT era, learners do not need to remember piles and piles of knowledge, but need to learn how to acquire knowledge, so it is important that learners grasp a variety of literature retrieval methods and tools. After retrieval, then it comes to reading and analyzing to get effective information and come up with original ideas. And then comes to paper writing, which is how to express your ideas systematically and clearly. So more training on literature reading, analyzing and writing should be offered in school.

Introducing deep learning, computer vision, neural network, project management into project-based learning for high school students is a bold attempt, provides a new way to curriculum reform and teaching reform, and proposes a viable path to improve students' overall quality and help to realize new generation of learning revolution in China. However, follow-up work still needs to be continued from systematic setup of artificial intelligence curriculum, systematic training of teachers and comprehensive setting of learning environment so as to provide learners with an interesting, personalized and systematic learning environment.

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