Reform and Innovation on Production Internship Course of Remote Sensing based on the Training of Excellent Engineers

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Abstract: The Engineer Excellence Program is one of the focuses of China's talent development in the new era, mainly cultivating talents with outstanding technical innovation ability and good at solving complex engineering problems. Harbin Institute of Technology is one of the first 10 pilot universities of the excellent engineers, in order to realize the development of talent cultivation in the direction of Engineer Excellence, the production internship course is reformed with the remote sensing science and technology major as the carrier. The current situation of remote sensing production internship and the problems existed are analyzed in-depth, and the three aspects of internship idea reform, internship content reform and internship mode reform are explored. It also explores the specific program for the reform of production internship course of remote sensing science and technology major from those three aspects, which provides reference for the cultivation of excellent engineers in remote sensing major in the new era.

Keywords: excellent engineers; remote sensing; production internship; curriculum reform; school-enterprise association;

1 Introduction

Engineering education cannot be separated from engineering practice, and the cultivation of engineering talents should be integrated with the development of the times. In this regard, in 2022, China's Ministry of Education and the State-owned Assets Supervision and Administration Commission of the State Council issued *the Notice on Supporting Some Universities and Central Enterprises to Pilot the Construction of National Colleges of Excellence for Engineers*, which put forward “three fundamental changes” in the cultivation of engineering talents: the fundamental shift of engineering education from single discipline specialty and independence to cross-discipline and deep integration of schools and enterprises, the fundamental shift of cultivation goal from emphasizing on theoretical teaching to emphasizing on engineering innovation ability, and the fundamental shift of evaluation standard from thesis-only and awards-only to examining the actual contribution of innovation.

Harbin Institute of Technology (HIT) is one of the first 10 pilot universities of the excellent engineers. On September 9, 2023, Elite Engineers School of Harbin Institute of Technology (HIT) was officially inaugurated. The construction and development of the college is based on the need of cultivating talents with outstanding technical innovation ability and good at solving

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complex engineering problems, which are urgently needed by the country in the new era, focusing on the layout of talent cultivation of Harbin Institute of Technology in the new hundred years and the orientation of social service of industry, academia, research and application, with the aim of strengthening the practical education of postgraduates in engineering innovation, enhancing the ability of students to serve the development of the industry, It also aims to break through the barriers of interdisciplinary and inter-college cultivation of professional degree students, improve the employment quality of professional degree students, promote high-quality university-enterprise cooperation, create a new situation of high-level talent cultivation through integration of industry and education, and build a new system of excellent professional degree graduate education.

In order to cooperate with the development of talent cultivation in the direction of engineers of excellence in our university, the authors take remote sensing science and technology majors and related students as a hand, and take production internship courses of remote sensing majors as the main body to carry out experiments and innovations of curricular reforms oriented to the cultivation of excellent engineers.

2 Engineer education and talent development background

Remote sensing, as an important technical means of collecting Earth data and information on its changes, has been widely applied worldwide, and its advantages of synchronized, real-time observation over large areas can be used in various fields such as navigation, agriculture, meteorology, resources and the environment. After decades of development, remote sensing has become an advanced space exploration technology, which has promoted the training of talents in related fields. Many countries have attached importance to training professionals in remote sensing. In China, remote sensing courses have been set up in undergraduate and postgraduate education in institutions of higher learning since the end of the last century, and have now become one of the key courses in geography and other related disciplines.

Remote sensing is a profession with strong engineering and practicality, and it is necessary to combine theory and practice to master the content of remote sensing courses. Therefore, internship is an important part of remote sensing course, and it is also the main channel for students to master theoretical knowledge and cultivate analyzing and applying ability, so it is especially important to set up reasonable teaching content of internship. Production internship mainly teaches students to master the process of generating remote sensing data and the basic process of remote sensing image interpretation and processing, and completes the transition from knowledge reserve to practical application.

At present, for the cultivation goal of excellent engineers, remote sensing production internship still has some deficiencies in the curriculum: 1) Lack of coherence with the previous courses in the cultivation. As the remote sensing production internship is taught in the first semester of the fourth year, the previous professional courses have been basically finished, and since the previous professional courses are taught by different teachers and independently carry out on-line practice, it is difficult to directly correlate these courses with the production internship; (2) there is still a lack of some necessary professional knowledge before the internship. Remote sensing professional production internship requires students to practice the whole process of remote sensing data from the principle of generation, data acquisition, basic processing, and

practical application processing, so the knowledge reserve is high, but the pre-course training can't achieve all the knowledge coverage; 3) There is a big gap between the teaching mode and teaching methods and the talent cultivation goal of practical innovation. In the process of practical teaching, the instructor usually spends a lot of energy to review the basic principles and fundamental knowledge of remote sensing, then demonstrates the operation process and experimental results through commercial software, and finally arranges similar experimental tasks for students to verify. Although students get some exercise in hands-on ability, they generally lack innovative thinking.

3 Reform of internship thoughts guided by the cultivation of outstanding engineers

Remote sensing production internship is the last comprehensive internship course offered to undergraduates majoring in remote sensing science and technology during their college years. According to the cultivation objectives of remote sensing, students are required to consolidate the theory of the whole process of remote sensing technology and master the main methods of remote sensing application. Combined with the requirements for the cultivation of outstanding engineers and the needs of remote sensing industry, the reform idea of remote sensing comprehensive internship is to take students as the center, improve their engineering application ability, research and innovation ability, design and development ability and team cooperation ability through the reform of teaching content and innovation of teaching mode. In order to realize this reform idea, the objective of remote sensing comprehensive internship course is to cultivate talents with "strong hands-on, strong application, strong research and strong cooperation".

4 Reform of internship content guided by the cultivation of outstanding engineers

The content reform of remote sensing production internship guided by the cultivation of outstanding engineers mainly includes three aspects: 1) the internship content covers the whole process of remote sensing engineering processing; 2) oriented by practical application, the internship content reform combining engineering and application is realized through the two practical training contents of vehicle target detection of infrared remote sensing by drone and crop deciphering of multi-spectral remote sensing by drone; 3) Through the university-enterprise alliance, we can realize the training of engineering and innovation ability through the integration of industry-academia-research.

4.1 Engineering Reform of Internship Content

The engineering reform of internship content is mainly realized in three aspects, namely, UAV remote sensing system design and assembly practice, UAV remote sensing data acquisition practice [1] and ENVI-based optical image correction, alignment and stitching experiment.

(1) UAV remote sensing system design and assembly practice

Through students' disassembly and assembly of the UAV remote sensing imaging system and teachers' explanation of the composition of the UAV system, students can master in detail the composition of the modules of the UAV remote sensing imaging system (UAV, UAV battery pack, remote sensing sensor, sensor bracket and gimbal, remote sensing data storage module, communication module between the UAV and control handle, communication module between the UAV and the sensors, tablet computer used for line planning, UAV flight control handle, offline data processing computer) and the data flow production and transmission process, so that the students have the basic cognitive and processing ability of common UAV problems;

(2) UAV remote sensing data acquisition practice (sensor parameterization, route planning and flight practice)

The students can master the complete process of UAV remote sensing data acquisition mainly through the explanation and exercise of examples, including: 1) According to the typical remote sensing observation requirements, estimate the size of the observation area from the map, set the flight width, flight height and flight sorts between the flight route and parallel routes according to the flight distance limit of the UAV, and set the final flight route on the tablet computer; 2) Adjust the sensor shooting parameters according to the weather conditions and the characteristics of the target to be observed; 3) Calculate the single shooting range of the UAV according to the height of the UAV and the resolution of the sensor, and calculate the minimum shooting frequency for complete coverage of the observed area, and set the sensor shooting mode accordingly; 4) Verify the various indexes of the UAV and the sensor, and start the flight test after there is no error, and pay attention to letting the students master the basic flight control operation of the UAV; 5) According to the set routes and parameters, complete the complete flight and data collection of the UAV; 6) Remove the storage module of the UAV, read and demonstrate the captured data on the computer through the supporting software, and export the relevant data.

(3) ENVI-based optical image correction, alignment and stitching experiment. This experiment mainly allows students to master how to use ENVI software to extract our common remote sensing image products from multiple base data captured by UAVs. The practical content includes correction of infrared or multi-spectral images (atmospheric correction, spectral correction, ortho-correction), alignment between adjacent captured images (selection of alignment points and alignment algorithms), and image stitching (merging duplicate regions, multi-image unification). This part mainly practices the rules of model selection, the image of parameters and the basis of setting in each process.

4.2 Reform of Combining Engineering and Practical Application

As for the reform of combining engineering and application, two contents of practical training on vehicle target detection based on infrared remote sensing by UAV and practical training on intelligent interpretation of crops based on multi-spectral remote sensing by UAV have been designed.

(1) Practical training on vehicle target detection based on infrared remote sensing by UAV

Vehicle target detection experiment based on UAV infrared remote sensing is a comprehensive practical training for UAV remote sensing application, which mainly cultivates the

comprehensive ability of students to solve the actual remote sensing problems (vehicle monitoring) by utilizing the infrared remote sensing equipment carried by UAV. Experiencing the complete process of comprehensive practical training, students systematically master the hardware system design, sensor use, UAV flight, data processing [2], data characterization and interpretation capabilities required for UAV remote sensing monitoring. In addition to using the previous practical content, this part also adds the content of vehicle target detection based on infrared thermal sensitivity, mainly experimenting with how to choose the appropriate target detection model and algorithmic parameter optimization methods to achieve high-precision positioning of vehicle targets.

(2) Intelligent Crop Interpretation Training Based on UAV Multispectral Remote Sensing

Crop Intelligent Interpretation Experiment Based on UAV Multi-spectral Remote Sensing is the second comprehensive practical training of UAV remote sensing application, which mainly cultivates the comprehensive ability of students to solve the actual remote sensing problems (agricultural utilization) by utilizing the multi-spectral remote sensing equipment carried by UAV. Experiencing the complete process of comprehensive practical training, students systematically master the hardware system design, sensor use, drone flight, data processing, intelligent analysis and interpretation of data features required for UAV remote sensing monitoring. In addition to utilizing the previous, practical content, this part also adds the content of agricultural remote sensing analysis based on multispectral strong feature interpretation characteristics, mainly selecting appropriate intelligent classification models and parameter optimization methods to achieve high-precision interpretation of crops.

4.3 Reform of joint training between schools and enterprises

Colleges and universities are rich in scientific research and teaching advantages, and science and technology can only be transformed into productive forces to truly promote social progress and development. Enterprises have advantages in production technology, which is the main place to realize engineering application, industrialization of technical achievements and social production. Combining the production technology advantages of enterprises and establishing production-teaching consortium is an important way to strengthen the cultivation of engineering ability and innovation ability [3].

In this regard, remote sensing production internship will cooperate with Shanghai Huace Navigation Technology Co., Ltd. to jointly train students, mainly including: visiting enterprise remote sensing application production base, experiencing the production process, so that the students have the most practical experience of remote sensing engineering applications; talk with enterprise engineering and technical personnel to communicate with technical problems in production applications and project development, to exercise students' expression and communication skills; invite enterprises with rich practical experience and high-level engineering and technical personnel as part-time teachers to the school to give lectures, introducing advanced engineering and technical methods in remote sensing production practice, the latest application results and engineering talent training concepts into the laboratory teaching, and to make the students deeply grasp the method of engineering service to the society [4].

5 Innovation of internship mode guided by the cultivation of outstanding engineers

The key to the reform of production internship course for the cultivation of excellent engineers is to deepen the reform of experimental teaching mode and improve the quality of experimental teaching. The reform of experimental teaching mode needs to realize three changes: from indoctrination classroom to inspiration classroom, from knowledge classroom to ability classroom, and from period classroom to question mark classroom, so as to achieve the student-oriented and cultivate the spirit of active learning [5]. To this end, remote sensing production internship is oriented to engineering project design and the cultivation of engineering application ability, and through the practical experience and overall training of systematically completing a project, students can comprehensively cultivate the active learning ability, design and development ability, system application ability and group cooperation ability. Remote sensing production internship combines the concept of cultivation of outstanding engineers with flipped classroom to innovate the teaching mode, and the engineering reform and research reform of the experimental teaching content are all organized according to this innovative teaching mode, which involves two keys: one is that the knowledge, software operation skills and data processing methods involved in each internship task are all assigned to the students to complete by themselves outside the classroom by means of courseware; and the other is that the in-class teaching of each internship task is mainly task-driven and problem-inspired, and 4 closely-connected and layer-by-layer experimental teaching links are set up for research and conceptualization, independent design, development and implementation, and operation and application, so that students can be cultivated as a whole through the practical training of project and team work, and dispersed knowledge and application skills are systematically strung together in the form of a complete chain of knowledge clusters.

6 Conclusions

With the goal of cultivating outstanding engineers in remote sensing, we reform and innovate the most representative production internship course of remote sensing, take the entry point of cultivating the four talents of "strong hands-on, strong application, strong research and strong cooperation" as the starting point, and carry out the reform of the internship idea, internship content and internship mode of remote sensing, and deepen the engineering skills of students through the practice of the whole process of remote sensing data processing and the joint cultivation mode of school-enterprise [6]. We reform the idea, content and mode of remote sensing production internship, and deepen students' engineering skills by practicing the whole process of remote sensing data processing and school-enterprise joint training mode. Ultimately, it will realize the improvement of students' comprehensive application ability and practical innovation ability, so as to improve the cultivation quality of outstanding engineers specialized in remote sensing science and technology in our university.

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