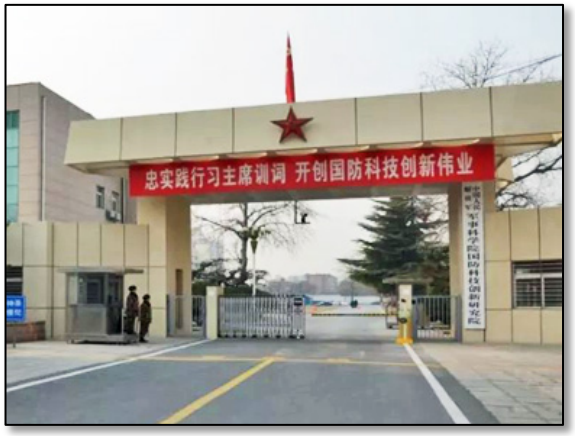
Profiling China's AI Developers:

The PLA's Artificial Intelligence Research Center

Summary

China's People's Liberation Army (PLA) established its own Artificial Intelligence Research Center (AIRC) in 2017 to conduct research on AI-enabled weapons systems for the military. The AIRC was set up as a component of the new National Innovation Institute of Defense Technology (NIIDT) and is probably based on the NIIDT compound in Beijing.

Entrance to NIIDT compound



Source: wemp.app

While the specific projects under way in AIRC are undoubtedly classified, the general nature of their work can be deduced by identifying its researchers, their academic backgrounds, and the research topics in their recently published academic papers. Those AIRC researchers that are most active (based on volume of published research) include the personnel listed below with the themes of their most recent work:

- **Dai Huadong (AIRC Director)**: robot operating systems and unmanned systems task management
- **Yi Xiaodong (Deputy Director)**: robot operating systems and swarm robot task planning
- **Kou Guang**: network security situational awareness and attack prediction
- **Peng Jinlin**: intelligent UAV (unmanned aerial vehicle) swarm networks and intelligent anti-jamming relay communications
- **Wang Yanzhen**: swarm robot task planning and communications systems
- **Wang Zhiyuan**: deep learning framework for robot operating systems
- **Zhang Bo**: communications systems for UAV swarms and robot surveillance systems.

Taken together, the identified themes clearly indicate that development of AI-enabled UAV swarm robots is a central research focus for this institute. It is likely that AIRC is developing the AI software and communications for such systems while its sister organization in NIIDT, the Unmanned Systems Technology Research Center, is working on the unmanned platforms themselves.

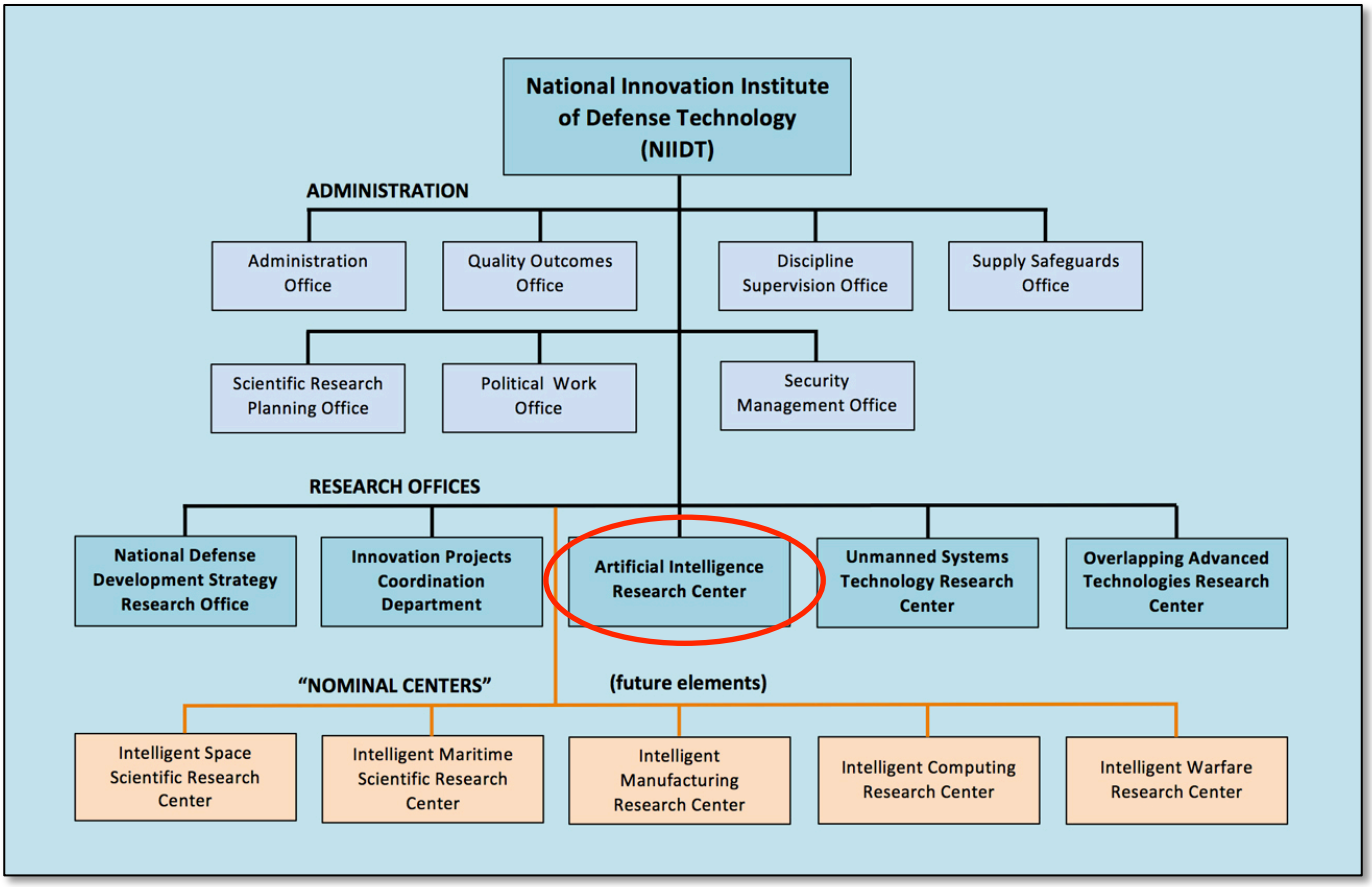
Sources

To provide some insight into the nature of work in the AIRC, this report has focused on the academic research papers and journal articles written by AIRC personnel. These are available at online Chinese repositories of academic work as well as at some international repositories. The identities of AIRC researchers and their biographic data come from these same repositories as well as Chinese university websites, online patent repositories, scholar tracking websites, and Chinese-language general media.

AIRC as a Component of NIIDT

Official postings have stated that NIIDT was established on September 30, 2017, as a scientific research organization subordinate to the Academy of Military Sciences (AMS). It is primarily focused on national defense S&T development strategy, device innovation, and basic technology research tasks. As described in official sources, NIIDT has seven administrative offices that are part of the headquarters and five offices divide the research work into main topics: development strategy, project coordination, artificial intelligence, unmanned systems, and "overlapping" technologies (see chart below).

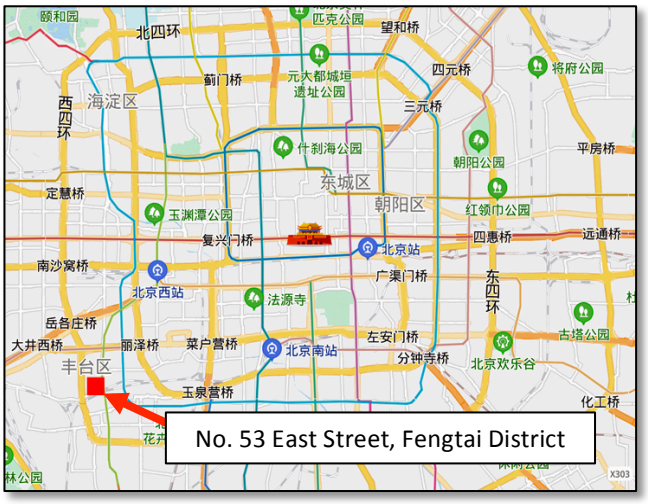
Organizational structure of NIIDT



The main elements for conducting military research are the Artificial Intelligence Research Center (AIRC), the Unmanned Systems Technology Research Center, and the Overlapping Advanced Technologies Research Center. This report will focus on the programs within AIRC.

Multiple references identify the address for NIIDT as No. 53 East Street, Fengtai District, Beijing. This address corresponds to a compound in southwest Beijing between the Third and Fourth Ring Roads (see map). The only street address identified in online materials specifically for AIRC was the same No. 53 East Street address. While the data on the location for AIRC is limited, it appears that this component of NIIDT is based within the NIIDT compound.

Beijing City map



Source: baidu.com

Identified AIRC Researchers

The search for AIRC personnel identified seven researchers that appear to be their most productive employees if judged by the volume of their published academic work. None of the information found identifies these as military personnel, although several of them attended military universities and are likely commissioned officers. All of the researchers in this set hold doctoral degrees, and many have worked before on the staff of the PLA's National University of Defense Technology (NUDT). Brief sketches of each of these appear below.

Dai Huadong

Source: sohu.com

Dai Huadong (戴华东) is the current Director of the NIIDT Artificial Intelligence Research Center. He previously served as a software engineering instructor at the National University of Defense Technology. During his tenure at NUDT from 2002 to 2017, he published more than 30 papers on standard computer topics such as memory management, operating systems, virtual machine operations, and cloud services. During this same period, Dai Huadong filed for more than 50 patents. His inventions deal with memory storage and management, virtual machine operations, system access and data protection, and the Kylin operating system.

He appears to have transferred to the AIRC in 2018. He was credited in Chinese sources as having served first as AIRC's Deputy Chief Engineer for daily operations, working on development of the Kylin operating system. (Kylin is the Chinese indigenous operating system developed at NIIDT that was started in 2001 and funded by National 863 High Technology Program.) He was also described as playing "a prominent role in China's autonomous controllable information systems development."

His published papers since joining AIRC have discussed **machine learning and recognition training**. He has patented processes and inventions since arriving at AIRC that have centered on **unmanned systems task management** and **asynchronous communications**. He was also involved in the development of **"micROS" (morphable intelligent collective Robot Operating System)** and was noted n 2018 and 2019 giving lectures on micROS in China.

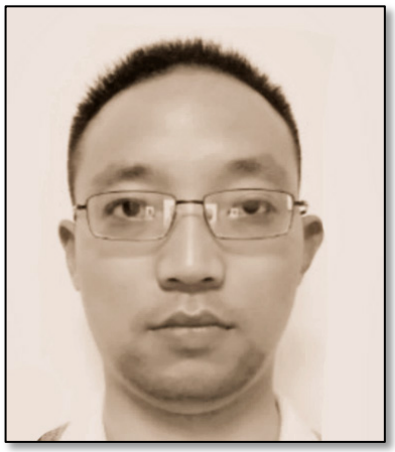
Yi Xiaodong

Source: caa.org.cn

Yi Xiaodong (易晓东) is the Deputy Director of the Artificial Intelligence Research Center. He was born in 1978. He has long been involved in research in the fields of high performance computing, intelligent computing, collective robot operating systems, cloud computing, and big data. He is the primary designer of the security subsystems and virtual machine subsystems of the Kylin operating system, and he credited with the invention of the Ubuntu-Kylin open source operating system. He also holds the position of Chief Scientist of National Defense Technology Innovation under the CMC Committee on Science and Technology. He has been a speaker several times at the Xiangshan Science Symposium and at international academic conferences. He is a visiting scholar at Dresden Polytechnic University in Germany.

Papers published by Yi Xiaodong indicate he was on the staff of the National University of Defense Technology (NUDT) since at least 2012. His work on robot operating systems, dating to at least 2016, identify his place of work as NUDT's State Key Lab for High-Performance Computing. His research topics while there include autonomous navigation of robots in large-scale environments and fault-tolerant cooperative multi-robot systems. From 2017 through 2019 he gave presentations at several Chinese forums on swarm intelligence robot operating systems and specifically the "micROS" operating system developed at AIRC. During his time at AIRC since 2018, his published work has addressed the **micROS robot operating system, swarm robot task planning, and communications connectivity for multiple unmanned aerial vehicles**.

Kou Guang



Source: Journal on Communications

Kou Guang (寇广) is an associate research fellow at AIRC. He was born in 1983 and received his undergraduate degree in network security from Changsha University of Science and Technology in 2004. He attended the PLA Information Engineering University (PLAIEU) from 2011 to 2016 and received a doctorate in cyberspace security from this military university. He has been working at AIRC since January 2018. One source stated that he was also an associate professor of Tianjin University.

His work at PLAIEU focused on network security and threat evaluation. One paper of note from 2016 was entitled "Using Deep Learning For Detecting BotClouds," indicating he was trying to develop AI tools for network security well before arriving at AIRC. Paper credits indicate he was also associated with the Key Lab for Information Assurance Technology in Beijing from 2016 to 2018 while still tied to PLAIEU. The papers published since he started at AIRC have addressed **network security situational awareness** and **attack prediction**.

Peng Jinlin

Source: ieeexplore.ieee.org

Peng Jinlin is a researcher at AIRC. He received his undergraduate degree in electromechanical engineering from the Beijing Institute of Technology and a doctorate degree in electrical engineering from the University of Leeds, UK. He has worked as a postdoctoral researcher in the Department of Electronic Engineering at Tsinghua University in Beijing.

Peng Jinlin's research interests have included wireless network protocols, ad hoc networks, signal processing in wireless communications, and machine learning. His publication topics have also included autonomous aerial vehicles (UAV's), collective robot systems, control engineering computing, aerospace communications, and artificial intelligence. His published work while at AIRC has focused on **intelligent UAV swarm networks, communications in UAV swarms,** and **intelligent anti-jamming relay communications**.

Wang Yanzhen (王彦臻) is an associate research fellow at AIRC. He received his bachelor's, master's, and doctoral degrees in computer science from NUDT's College of Computer Science. While studying for his doctorate, he attended Canada's Simon Fraser

University College of Computer Science for 17 months, working on digital geometric processing and 3D shape analysis research. He was also identified at NUDT's State Key Lab for Parallel and Distributed Processing in 2008. After staying at NUDT in a teaching position, Wang Yanzhen also traveled to the UK and worked at Manchester University's Biotechnology Research Institute as a visiting researcher for 18 months, working on virtual reality and computer graphics research.

Wang Yanzhen

Source: crad.ict.ac.cn

Wang Yanzhen is identified in his recent published works as associated with both AIRC and NUDT's State Key Lab of High-Performance Computing. By 2016 he was working at NUDT on robot operating systems. His published work while at AIRC has been about **swarm robot task planning and communications systems**. He is a co-author with Dai Huadong and Yi Xiaodong on the 2019 paper on the deep learning framework for the **micROS Robot Operating System**.

Wang Zhiyuan (王之元), also an associate research fellow at AIRC, is credited with work on robot operating systems, collective intelligence operating systems, machine learning, and related technologies. She studied in the NUDT State Key Lab For High Performance Computing from 2006 to 2011 and received her doctorate there. She stayed on at NUDT's Computer Science Department after receiving her PhD. She has reportedly participated in more than ten key projects for either the National Natural Sciences Foundation or the Central Military Committee's Science and Technology Committee.

Wang Zhiyuan

Source: crad.ict.ac.cn

Starting in about 2016, her written work began to concentrate on robot operating systems, specifically the Alliance-ROS system and the micROS system that she described in a paper co-authored with AIRC lead researchers Dai Huadong and Yi Xiaodong while they were all at NUDT. Her most recent work since arriving at AIRC was on the **deep learning framework for micROS**. While working at AIRC in Beijing, she was also associated with the Tianjin Artificial Intelligence Civil-Military Fusion Innovation Center, which has a cooperative relationship with AIRC.

Zhang Bo

Source: ieeexplore.ieee.org

Zhang Bo (张博) is an associate research fellow at AIRC, and his current association is made clear from his email address: bo.zhang.airc@outlook.com. In 2015 he received a doctorate in electronics and electrical engineering from the UK's Southampton University Electronics and Computer Science College. He has written extensively on wireless communications and signal processing and spoken at several major international communications conferences. One profile described him as a principal investigator on three national foundation granted projects. He was also guest editor for special IEEE publications of collective robotics communications. Zhang Bo's published work from 2017-2019 has focused on **communications systems for UAV swarms**, including investigation of **anti-jamming communications, robot surveillance systems**, and **reinforcement learning** in the development of robot swarm communications.

Sample AIRC Published Research

Insight on work specifics can be gained from recent selected articles and abstracts by AIRC personnel, many of which discuss swarm robots or swarm UAV research. Some samples are shown below (AIRC authors in **bold**):

Research On Multi-UAV Communication Connectivity Maintenance Based On Dynamic Programming
Wu Yunlong, **Zhang Bo**, Ren Xiaoguang, **Wang Yanzhen**, **Yi Xiaodong**
Scientia Sinica (Technologica), 2020, Volume 5
Abstract:
With the continuous development of unmanned aerial vehicle (UAV) technology and its falling cost, UAV's have been widely used in important fields such as agriculture, industry, security, and the military. In operation, UAV's often need to maintain communication connectivity with ground stations. However, in the case of long distance or shadowing, the quality of the wireless channels will be seriously degraded, which will affect the communication connectivity. To solve this problem, this paper considers deploying multiple UAVs as communication relays. In this paper, we select the long-term channel capacity as the optimization objective and propose two planning methods for UAV relays based on dynamic programming (DP): CMMP-AT and CMMP-OBO. The CMMP-AT method emphasizes the deployment of all relay UAV's at the beginning of the task. This method is simpler to implement, but the computational complexity is intolerable. The CMMP-OBO method proposes to deploy relay UAVs one by one according to the task requirements. Although the CMMP-OBO method may lose performance, it has a lower computational complexity and better scalability and can save more motion energy.

Swarm Robot Task Planning Based on Air and Ground Coordination for Disaster Search and Rescue
Li Minglong, Yang Wenjing, **Yi Xiaodong**, **Wang Yanzhen**, Wang Ji
Journal of Mechanical Engineering, 2019, Volume 55
Abstract:
A novel method of swarm robot task planning based on air and ground coordination is proposed for earthquake search and rescue. A surveillance aircraft gets the positions of the damaged buildings and passes this information to the UAV swarm. The UAV swarm uses a decentralized method to plan the searching paths based on this information. They get the positions and number of the injured people, and pass this information to the unmanned vehicles. The vehicles rescue the people according to it. A method of communication-maintain-based auction (CMBA) is provided for the UAV planning, considering the UAV features including that they are cheap, small and easy to be deployed massively. A planning method for the unmanned vehicles is provided, which is a centralized approach of adaptive-feedback-based adjustment-GA (AFBA-GA).

Parallel Learning Architecture of micROS Powering the Ability of Life-Long Autonomous Learning
Dai Huadong, Yi Xiaodong, Wang Yanzhen, Wang Zhiyuan, Yang Xuejun
Journal of Computer Research and Development, 2019, Volume 56
Abstract:
As the most important infrastructure of robotic platforms, the robot operating system is playing an important role to improve autonomy and intelligence of robots and unmanned systems. In this paper, a parallel learning architecture of micROS supporting life-long autonomous learning is presented. It is built to power a wide variety of robots with the ability of contextual adaptation. In addition, two core concepts guiding the design of micROS are also presented. One concept is the actor, which is the control abstraction of robot behaviors. The other concept is the semantic situation abstracting the dataflow in micROS. Some important techniques including collective behavior control and ad hoc wireless networks are also described in this paper.

Two aspects of this last paper stand out. First, of the 29 references cited in the report, only 4 were by Chinese authors. The great majority of the work that this analysis was built upon was by researchers from other countries such as the United States, Russia, Germany, Belgium, France, and Japan. This indicates that at that time, these scholars were still drawing primarily on foreign sources in their development of these artificial intelligence applications for China.

Second, this paper was identified as a work by AIRC researchers, but one author listed is Yang Xuejun (杨学军), who in 2019 was no research contemporary but the Director of the Academy of Military Sciences and a lieutenant general. Yang Xuejun entered the PLA in 1979. He received his doctorate in computer science and technology from NUDT in 1991. He stayed on at NUDT as a professor in the Computer Department and held

several other positions at this school. During the 1980's and 1990's he worked on development of the Yinhe (Galaxy) series of satellites, and later on design of the Tianhe-1 supercomputer. He was promoted to the rank of major general in 2014, and became the NUDT President in 2011. In the China military restructure of AMS conducted in 2017, he was appointed by Xi Jinping as Director, which put NIIDT (and thus AIRC) directly under his control.

Yang Xuejun

Source: ucxinwen.com

What does it mean that he is listed as co-author of this paper? Yang Xuejun has in fact had a long relationship with these AIRC personnel. Besides being their superior at NUDT, he co-authored another article with several of these authors on micROS in 2016 (when NUDT President). He also appears in the credits for a paper on memory allocation with Dai Huadong in 2013 and a paper on parallel computing with Wang Zhiyuan in 2012. Actually, the relationships at NUDT between Yang Xuejun and future AIRC personnel go back at least to 2006, when Yang co-authored two articles with Yi Xiaodong.

His inclusion as an author in several papers suggests that Yang Xuejun has acted as a mentor for this set of researchers during their time at NUDT, and that he has maintained this relationship since their move to AIRC. Since Yang Xuejun is now the Director of AMS, he is certainly in a position to offer continued support to these researchers and to AIRC as a whole.

Comments

The set of seven researchers identified above is likely a small segment of those employed by AIRC; they are just the ones whose work has been published in some volume. The full scope of AI research at this institute is not clear from the open source material available. However, the themes identified in this body of published works clearly indicate that development of AI-enabled swarm UAV robot systems is a central task for AIRC. There are likely many other tasks being worked, but the majority of identified researchers and their published research are contributing to swarm robot development.

The weaponization of such systems is not discussed in these works, and in at least one case the swarm is tasked with reconnaissance, not attack. However, other sources have shown Chinese interest in wide area surveillance, target identification, and direct attack by swarm UAV's.[1] Since AIRC is now apparently the primary military AI development

[1] See, for example, CETC's demo video, at www.youtube.com/watch?v=p1eWmE3draU.

entity, and AIRC is focusing on AI-enabled swarm UAV's, it seems likely that the nature of their AI research is directed at development of AI weapons, even if such systems are not mentioned publicly at present.

Within NIIDT, AIRC has a sister organization, the Unmanned Systems Technology Research Center. Given the themes identified in AIRC research work, it is likely that deep learning, AI software, and swarm robot communications networks fall under AIRC's purview, and unmanned systems hardware and airframe development are being carried out in parallel by this Unmanned Systems Center.