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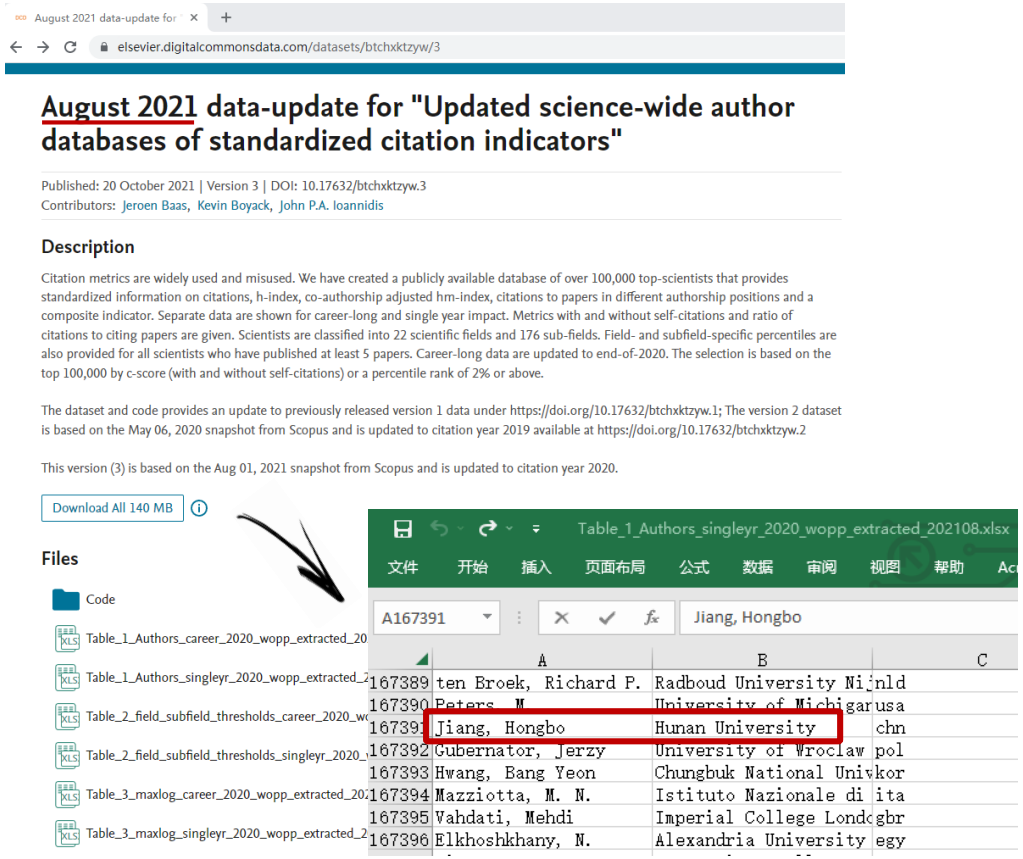

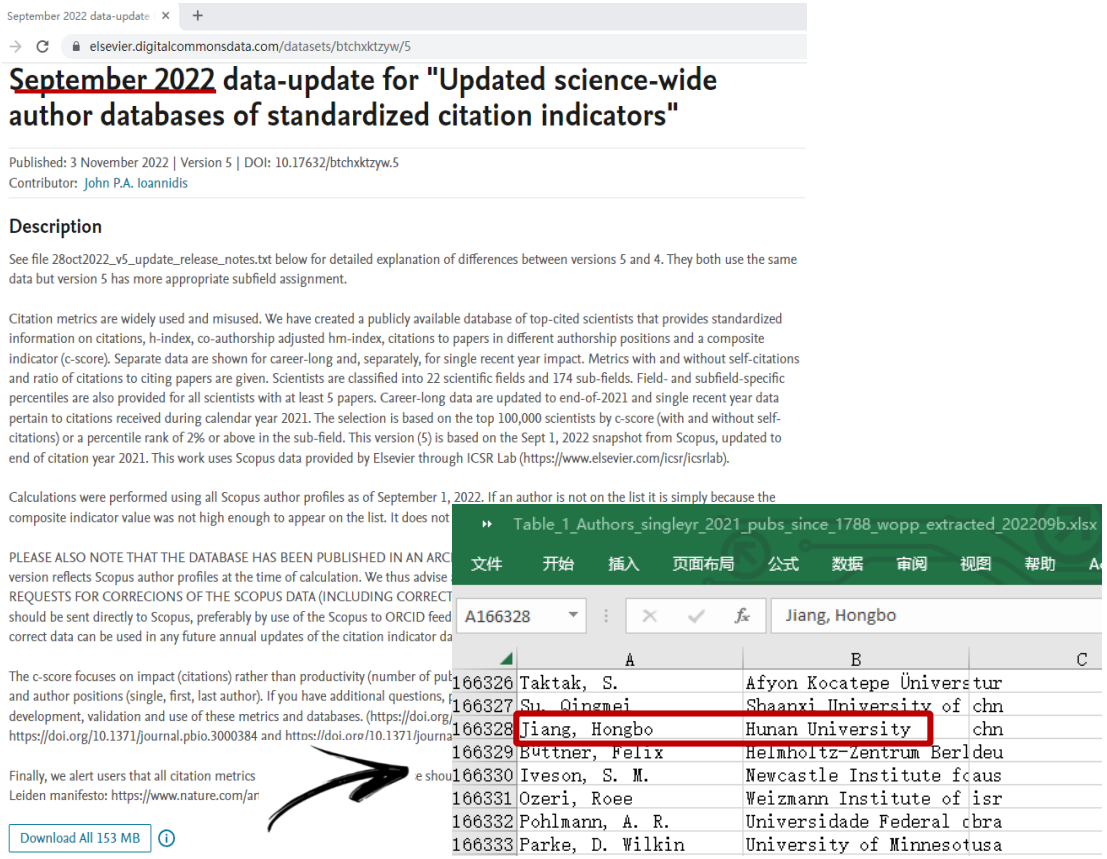

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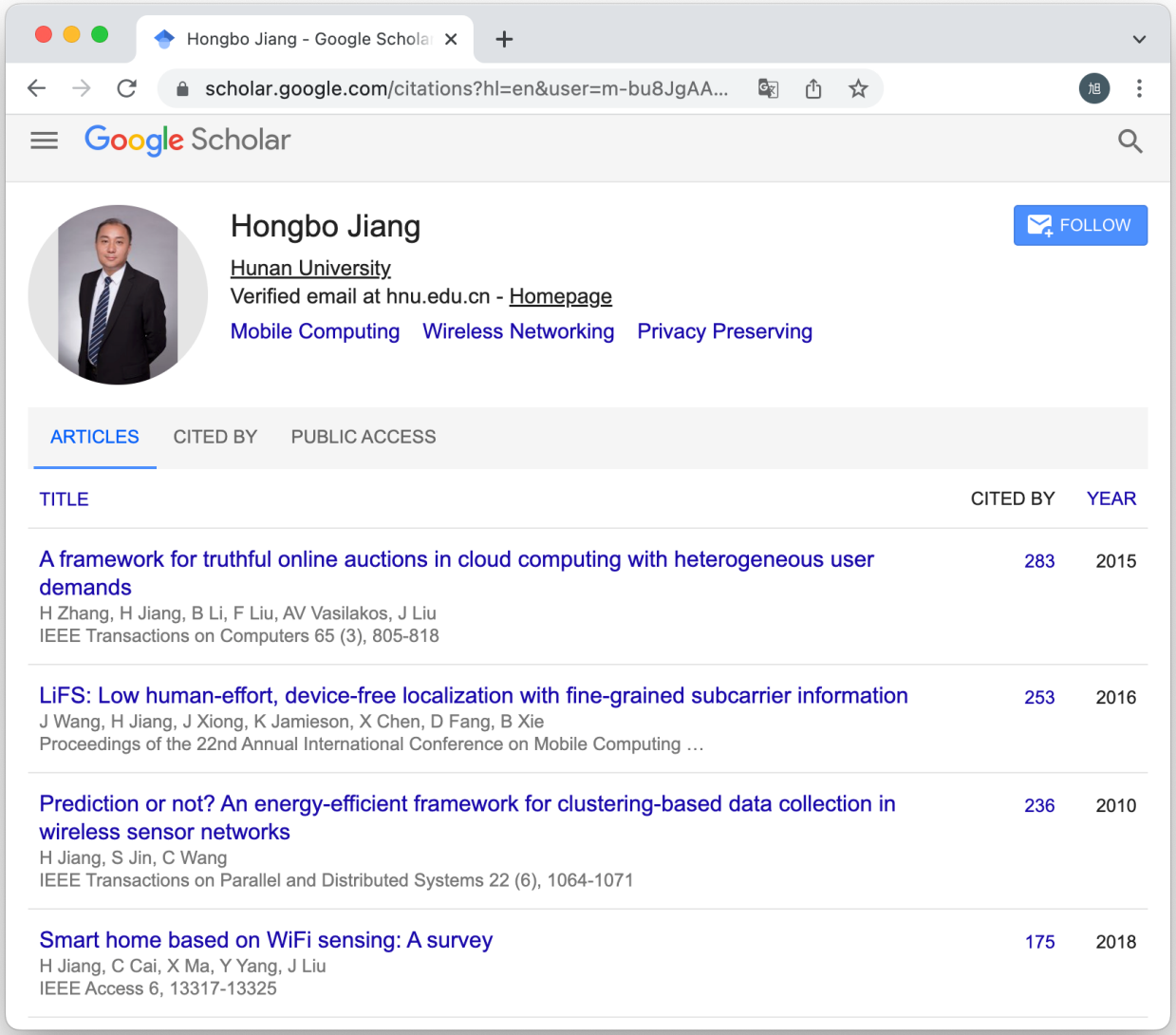

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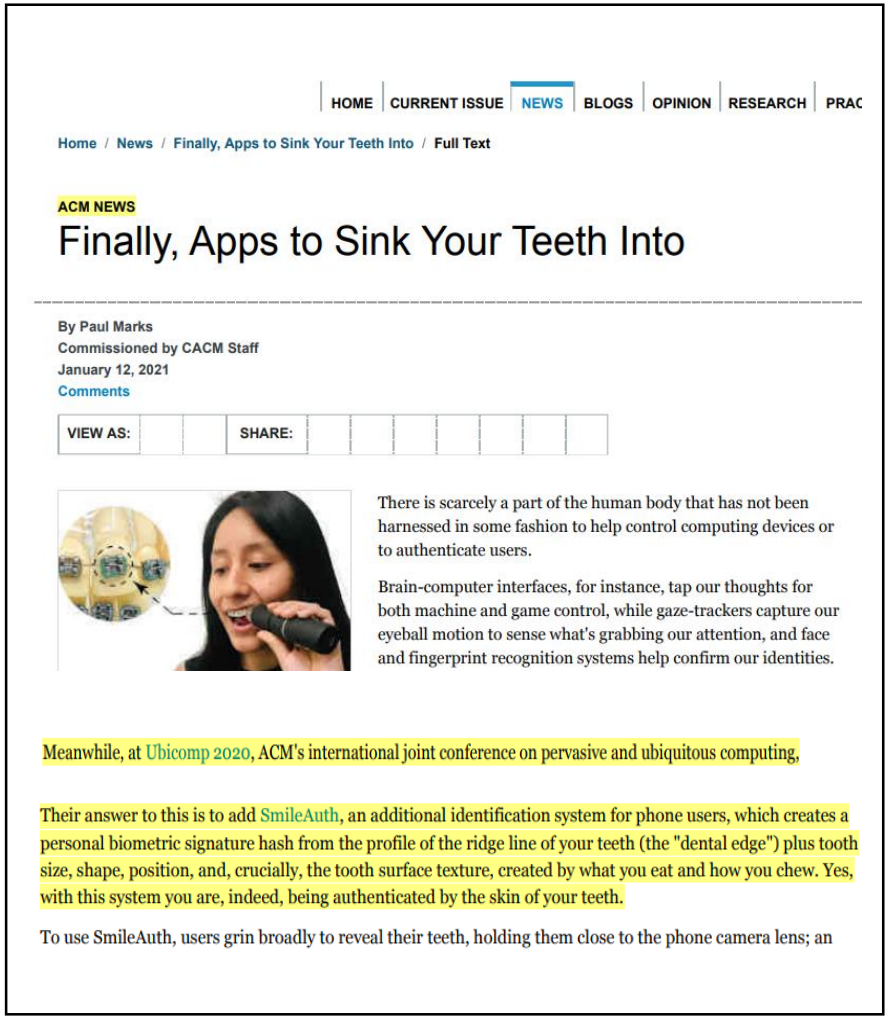
ACM NEWS

https://cacm.acm.org/news/249831-finally-apps-to-sink-your-teeth-into/fulltext



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ACM NEWS

Finally, Apps to Sink Your Teeth Into

By Paul Marks
Commissioned by CACM Staff
January 12, 2021
Comments

VIEW AS: SHARE:

There is scarcely a part of the human body that has not been harnessed in some fashion to help control computing devices or to authenticate users.

Brain-computer interfaces, for instance, tap our thoughts for both machine and game control, while gaze-trackers capture our eyeball motion to sense what's grabbing our attention, and face and fingerprint recognition systems help confirm our identities.

Meanwhile, at Ubicomp 2020, ACM's international joint conference on pervasive and ubiquitous computing,

Their answer to this is to add SmileAuth, an additional identification system for phone users, which creates a personal biometric signature hash from the profile of the ridge line of your teeth (the "dental edge") plus tooth size, shape, position, and, crucially, the tooth surface texture, created by what you eat and how you chew. Yes, with this system you are, indeed, being authenticated by the skin of your teeth.

To use SmileAuth, users grin broadly to reveal their teeth, holding them close to the phone camera lens; an

- **国际计算机学会《ACM NEWS》在2021年将申请人成果“新型物联网终端用户认证感知模型SmileAuth（UBICOMP 2020，代表作2）”作为全球开创性研究成果之一进行了重点报道**

- 评价该项成果**支撑了物联网泛在感知的新兴应用场景**，已开展了大规模的实际测试“are now in cooperation with local companies to test the system in a larger population”，并**有望转化为实际产品**“SmileAuth could see light of day as an actual product”

UBICOMP 2018

8-12 October 2018 SINGAPORE

Duet: Estimating User Position and Identity in Smart Homes Using Intermittent and Incomplete RF-Data

DEEPAK VASISHT, ANUBHAV JAIN, CHEN-YU HSU, ZACHARY KABELAC, DINA KATABI,
Massachusetts Institute of Technology

Although past work on RF-based indoor localization has delivered important advances, it typically makes assumptions that hinder its adoption in smart home applications. Most localization systems assume that users carry their phones on them at home, an assumption that has been proven highly inaccurate in past measurements. The few localization systems that do not require the user to carry a device on her, cannot tell the identity of the person; yet identification is essential to most smart home applications. This paper focuses on addressing these issues so that smart homes can benefit from recent advances in indoor localization.

We introduce Duet, a multi-modal system that takes as input measurements from both device-based and device-free localization. Duet introduces a new framework that combines probabilistic inference with first order logic to reason about the users' most likely locations and identities in light of the measurements. We implement Duet and compare it with a baseline that uses state-of-art WiFi-based localization. The results of two weeks of monitoring in two smart environments show that Duet accurately localizes and identifies the users for 94% and 96% of the time in the two places. In contrast, the baseline is accurate 17% and 42% respectively.

CCS Concepts: • **Human-centered computing** → *Ubiquitous and mobile computing systems and tools;*

Additional Key Words and Phrases: RF-based Indoor Positioning, Multi-modal Sensor System

ACM Reference Format:
Deepak Vasisht, Anubhav Jain, Chen-yu Hsu, Zachary Kabelac, Dina Katabi. 2018. Duet: Estimating User Position and Identity in Smart Homes Using Intermittent and Incomplete RF-Data. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 2, 2, Article 84 (June 2018), 21 pages. https://doi.org/10.1145/3214287

Second, RF-based localization systems assume that the RF signal along the direct line-of-sight to the user is not completely blocked. Although recent systems ([17, 34, 40]) can successfully localize in the presence of multipath, they fundamentally require the presence of the signal along the direct path. Yet, typical home structures may completely block the signal along the direct line of sight from the user to the receiver. TV screens, mirrors, HVAC are all metallic bodies that block RF signals. Thick structures such as pillars and in-wall plumbing can have the same effect. The blocking effect is further exacerbated by that, homes tend to have a single access point, unlike the enterprise where each location is covered by several access points. Once that single line-of-sight is blocked, there is no way to localize the user.

Some past work [3, 4, 35] has demonstrated device-free-localization, which can track a person using the RF signal reflected off her body. Such systems eliminate the need for having the user carry her phone, but they introduce their own challenges. First, they exacerbate the blocking problem. Since they rely purely on weak, low-power RF reflections off people's bodies, they are more likely to be blocked by home structures like TV, mirrors, HVAC, etc. Further, even when not blocked, they have a limited reach due to their lower power (100x lower power than Wi-Fi [3]). Second, device-free localization lacks the notion of identity. These systems are unable to identify who is sitting on the TV couch and who is cooking in the kitchen; they may end up tuning the TV to the wrong channel or making the temperature too high for the person in the kitchen.

This paper introduces Duet, a location tracking system that is customized for the smart home. In contrast to past work, which has focused on new signal processing algorithms to infer physical location from radio signals, Duet focuses on addressing the above practical problems so that smart home applications can benefit from existing indoor localization algorithms.

Dina Katabi

美国工程院院士，ACM Fellow

ACM计算奖获得者

美国麻省理工学院教授

在其发表的UBICOMP 2018论文中**以申请人的泛在感知研究成果作为他们系统设计的基础**，并引用该成果说明了射频信号特征与无需终端设备的被动感知之间的关联现象“出 has demonstrated device-free…using the RF signal reflected off her body. Such systems eliminate the need for having the user carry her phone”。

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[35] Ju Wang, Hongbo Jiang, Jie Xiong, Kyle Jamieson, Xiaojiang Chen, Dingyi Fang, and Binbin Xie. 2016. LiFS: Low Human-effort, Device-free Localization with Fine-grained Subcarrier Information *(MobiCom)*.

UBICOMP 2018

8-12 October 2018 SINGAPORE

Training-Free Human Vitality Monitoring Using Commodity Wi-Fi Devices

XIANG LI and DAQING ZHANG*, Peking University, China
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Device-free sensing using ubiquitous Wi-Fi signals has recently attracted lots of attention. Among the sensed information, two important basic contexts are (i) whether a target is still or not and (ii) where the target is located. Continuous monitoring of these contexts provides us with rich datasets to obtain important high-level semantics of the target such as living habits, physical conditions and emotions. However, even to obtain these two basic contexts, offline training and calibration are needed in traditional methods, limiting the real-life adoption of the proposed sensing systems. In this paper, using the commodity Wi-Fi infrastructure, we propose a training-free human vitality sensing platform, WiVit. It could capture these two contexts together with the target's movements speed information in real-time without any human effort in offline training or calibration. Based on our extensive experiments in three typical indoor environments, the precision of activity detection is higher than 98% and the area detection accuracy is close to 100%. Moreover, we implement a short-term activity recognition system on our platform to recognize 4 types of actions, and we can reach an average accuracy of 94.2%. We also take a feasibility study of monitoring long-term activities of daily living to show our platform's potential applications in practice.

CCS Concepts: • **Human-centered computing → Ubiquitous and mobile computing systems and tools**;

Additional Key Words and Phrases: Wi-Fi, Device-free, Training-free, Human vitality

ACM Reference Format:
Xiang Li, Daqing Zhang, Jie Xiong, Yue Zhang, Shengjie Li, Yasha Wang, and Hong Mei. 2018. Training-Free Human Vitality Monitoring Using Commodity Wi-Fi Devices. *Proc. ACM Interact. Mob. Wearable Ubiquitous Technol.* 2, 3, Article 121 (September 2018), 25 pages. https://doi.org/10.1145/3264931

applications. Therefore, Wi-Fi has been considered particularly promising for ubiquitous indoor human sensing.

In the last few years, a lot of Wi-Fi based device-free human sensing applications have been proposed, such as indoor localization [20, 38, 50], activity recognition [39, 42], intrusion detection [19] and respiration monitoring [22, 35, 54], etc. For most of these applications, capturing the human vitality information (i.e. the human is *still* or *non-still* and in which area the human is staying) is essential. For example, respiration sensing with Wi-Fi needs to know when the target is still and then to monitor the respiration because body movements severely interfere with the fine-grained respiration sensing. On the contrary, activity recognition needs to know when the human is non-still and then to segment and recognize different activities. Moreover, a specific type of human activity usually takes place in a particular area, such as sleeping activity takes place in the bedroom and eating activity usually happens at the dining table. Thus, for activity recognition, knowing the rough area information can significantly help reduce the training size and increase the sensing accuracy. Furthermore, the long-term vitality information can be employed to infer a lot of useful high-level semantics about the target. For example, frequent toilet visits and a very short sleep during the night different from the target's usual routine are signs for medical attentions.

In this paper, we use *vitality* to represent the information including in which area the target is staying and whether the target is still or non-still. Although some approaches have been proposed to detect when the human is non-still or locate the human target in the indoor environment based on the Wi-Fi signal, there are several limitations preventing us from applying these approaches to obtain the human vitality information in practice. Existing systems usually detect whether the human target is non-still based on the variance or correlation of Wi-Fi signal in time domain [19, 28, 39, 42, 47]. These methods require significant amount of human efforts in offline training and calibration to learn the difference between static environment (i.e. the target is still) and dynamic environment (i.e. the target is non-still). To locate the target, most of existing systems employ fingerprint-based solutions [1, 38, 48], which require labor-intensive offline training to build the fingerprint database for localization. Angle-of-Arrival (AoA) based device-free localization solutions [20, 21] require careful phase calibration to remove the random phase offset between two RF ports during startup. To the best of our knowledge, there is still no such a platform which could detect when the target is non-still and in which area the

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张大庆

欧洲科学院院士、
IEEE Fellow

认为申请人成果LiFS[申请人文章]能提高网络环境视距传播时位置估计的精度，并 **论证了不规则区域的位置信息与组网连接特征之间的作用机制。**

and dynamic environment (i.e. the target is non-still). To locate the target, most of existing systems employ fingerprint-based solutions [1, 38, 48], which require labor-intensive offline training to build the fingerprint database for localization. Angle-of-Arrival (AoA) based device-free localization solutions [20, 21] require careful

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IEEE Transactions on Wireless Communications

A Unified Framework for Pushing in Two-Tier Heterogeneous Networks With mmWave Hotspots

Zhanyuan Xie, Wei Chen, *Senior Member, IEEE*, and H. Vincent Poor, *Life Fellow, IEEE*

***Abstract*—Millimeter-wave (mmWave) communications have attracted substantial attention due to their potential to provide very large bandwidths. Unfortunately, the propagation of millimeter waves suffers from severe path loss and blocking, which limits the coverage of mmWave communication systems. To overcome this, mmWave hotspot empowered two-tier heterogeneous networks are expected to play an important role in the sixth generation (6G) systems. When the deployment of mmWave hotspots is not dense enough, or even sparse, assuring the quality of service (QoS) for mobile users becomes rather challenging. In this paper, we investigate pushing in two-tier heterogeneous networks with mmWave hotspots, in which popular content items are cached by a mobile user when they can be served by a mmWave hotspot. To this end, a unified framework is presented to analyze and optimize the effective throughput of pushing. Based on the effective throughput analysis, pushing policies with different mobility models and/or mmWave hotspot distributions are presented. Both theoretical and numerical results demonstrate the substantial caching gain due to user mobility in mmWave hotspot empowered two-tier networks.**

***Index Terms*—Wireless pushing and caching, mmWave hotspots, two-tier heterogeneous networks, effective throughput, mobility, Poisson point process, Markov chain, matching.**

I. Introduction

With the rapid development of smartphones, more and more high-data-rate applications, e.g., virtual reality streaming and cloud gaming [2], have stimulated a rapidly increasing network traffic in the emerging sixth-generation mobile systems (6G), which will create significant challenges for conventional communication technologies. To address these challenges, novel communication technologies, e.g., millimeter-wave (mmWave) technology [3] and artificial intelligence empowered technologies [4], have been proposed.

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MmWave frequencies between 30 and 300 GHz offer the promise of further communication gains via spatial multiplexing and beamforming [5]. In this way, it is regarded as one of the promising technologies to be used for outdoor point-to-point backhaul links and indoor high-data-rate wireless applications, e.g., high-resolution multimedia streaming [6]. As a result, mmWave communications has attracted substantial attention from academia and industry recently [7]. The fundamentals of beamforming and multiple-input multiple-output (MIMO) spatial multiplexing for mmWave wireless communications are presented in [8]. Spatially sparse precoding in mmWave systems is studied with large antenna arrays in [9]. Fozi, Sharafat, and Bennis present an efficient method for mmWave beamforming based on deep reinforcement learning in MIMO systems to maximize the network's energy efficiency subject to the QoS constraint in [10]. MmWave MIMO channel characteristics, including blockage effects, path loss, and coverage range, are studied in [11]. Moreover, Bai and Heath present a general framework to evaluate the coverage and rate performance in mmWave cellular networks in [12] by leveraging concepts from stochastic geometry.

When applying mmWave communication technology, the coverage of mmWave signals is limited since the propagation of millimeter waves suffers from severe path loss and blocking. Furthermore, mmWave hotspots cannot be deployed in all areas due to the high construction and maintenance costs. To address these challenges, heterogeneous networks (HetNets) have been proposed for capacity improvement [13]. A-tier downlink heterogeneous cellular networks are modeled and analyzed in [14]. An energy-efficient framework for heterogeneous small cell networks was presented in [15] with guaranteed throughput and outage probability when a large number of MUs and IoT nodes need to be served. Through a network-wide utility maximization problem, a novel scheme for user association with load balancing is presented for HetNets in [16]. By this means, the quality of service (QoS) for mobile users is improved when the

H. Vincent Poor

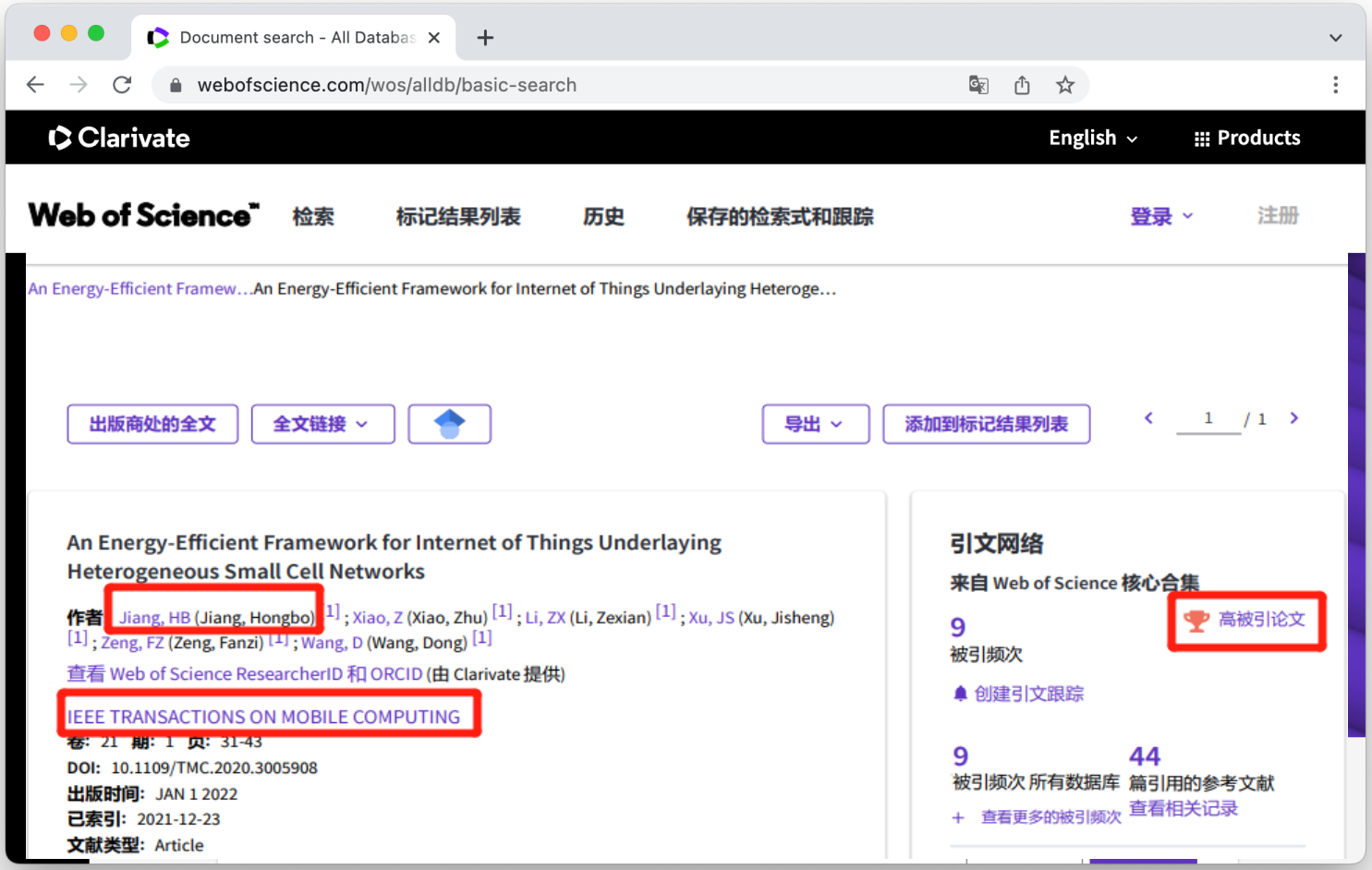
美国国家工程院士、美国国家科学院院士、IEEE Life Fellow、IEEE亚历山大•格雷厄姆•贝尔奖章获得者、普林斯顿大学教授

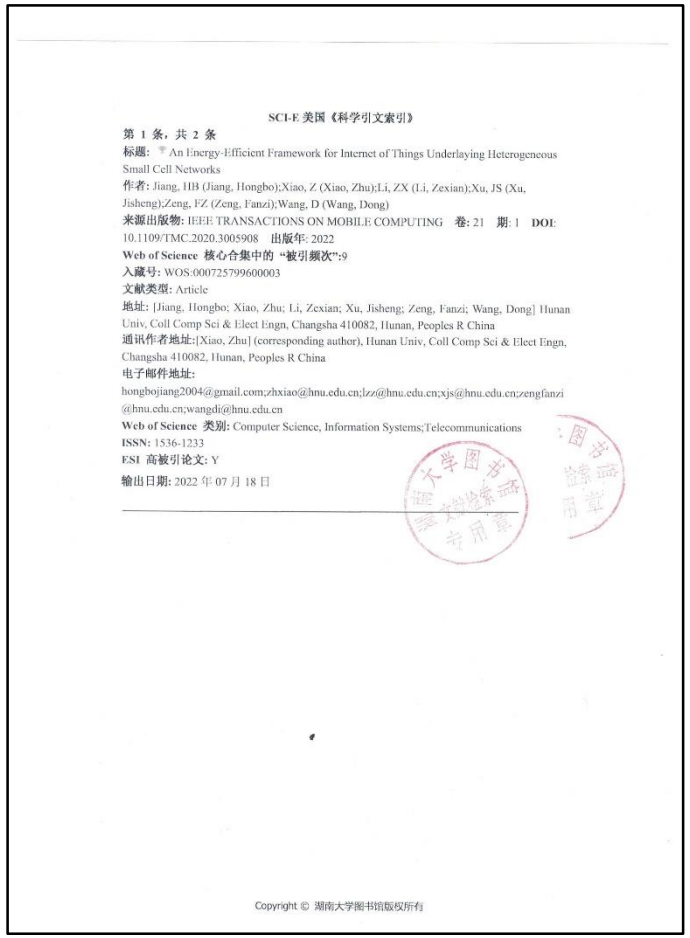
在其TWC论文中高度评价了能耗效率优先的物联网组网连接理论模型（TMC 2022，代表作4），并指出该模型能够在**海量物联网终端和移动终端共同接入时保障系统吞吐量的需求。**

eled and analyzed in [14]. An energy-efficient framework for heterogeneous small cell networks was presented in [15] with guaranteed throughput and outage probability when a large number of MUs and IoT nodes need to be served.

[15] H. Jiang, Z. Xiao, Z. Li, J. Xu, F. Zeng, and D. Wang, "An energy-efficient framework for Internet of Things underlaying heterogeneous small cell networks," *IEEE Trans. Mobile Comput.*, vol. 21, no. 1, pp. 31–43, Jan. 2022.

代表作4 —— *IEEE TMC 2022* 论文“An Energy-Efficient Framework for Internet of Things underlaying Heterogeneous Small cell Networks” 入选ESI高被引论文

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第 1 条，共 2 条

标题: An Energy-Efficient Framework for Internet of Things Underlaying Heterogeneous Small Cell Networks

作者: Jiang, HB (Jiang, Hongbo);Xiao, Z (Xiao, Zhu);Li, ZX (Li, Zexian);Xu, JS (Xu, Jisheng);Zeng, FZ (Zeng, Fanzi);Wang, D (Wang, Dong)

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3.1肯定性评价附件 - 第7页

IEEE Transactions on Mobile Computing

MOTO: Mobility-Aware Online Task Offloading with Adaptive Load Balancing in Small-Cell MEC

Sijing Duan, *Student Member, IEEE*, Feng Lyu, *Senior Member, IEEE*, Huaqing Wu, *Member, IEEE*, Wenxiong Chen, *Member, IEEE*, Huali Lu, *Student Member, IEEE*, Zhe Dong, *Student Member, IEEE*, and Xuemin (Sherman) Shen, *Fellow, IEEE*

Abstract—Mobile edge computing is a promising computing paradigm enabling mobile devices to offload computation-intensive tasks to nearby edge servers. However, within small-cell networks, the user mobilities can result in uneven spatio-temporal loads, which have not been well studied by considering adaptive load balancing, thus limiting the system performance. Motivated by the data analytics and observations on a real-world user association dataset in a large-scale WiFi system, in this paper, we investigate the mobility-aware online task offloading problem with adaptive load balancing to minimize the total computation costs. However, the problem is intractable directly without prior knowledge of future user mobility behaviors and spatio-temporal computation loads of edge servers. To tackle this challenge, we transform and decompose the original task offloading optimization problem into two sub-problems, i.e., task offloading control (*ToC*) and server grouping (*SeG*). Then, we devise an online control scheme, named *MOTO* (i.e., Mobility-aware Online Task Offloading), which consists of two components, i.e., Long Short Term Memory based algorithm and Dueling Double DQN based algorithm, to efficiently solve the *ToC* and *SeG* sub-problems, respectively. Extensive trace-driven experiments are carried out and the results demonstrate the effectiveness of *MOTO* in reducing computational costs of mobile devices and achieving load balancing when compared to the state-of-the-art benchmarks.

Index Terms—Mobile edge computing, load balance, mobility-aware task offloading, reinforcement learning

1 Introduction

The proliferation of smart mobile devices (MDs) has brought rich convenience to our lives. However, the limited on-board energy and computing power of MDs have impeded the performance improvement for computation-intensive services, e.g., augmented/virtual reality and autonomous driving [2]–[4]. Mobile edge computing (MEC) is a promising paradigm to alleviate the computing burdens of MDs by deploying servers at the network edge [5]–[7]. With MEC, users can obtain high-quality computing services with low latency. Recently, integrating MEC with small-cell networks has drawn much attention considering the high-throughput performance of small-cell networks. By de-

Table 1: Comparison with some related works.

Reference	Small cell MEC	Mobility-aware	Data-driven approach	Task offloading	Load balancing	DL-based method
Thananjeyan et al. [9]	No	Yes	No	Yes	No	No
Hu et al. [10]	No	Yes	No	Yes	No	No
Jing et al. [11]	Yes	No	No	Yes	No	No
Dai et al. [12]	No	No	Yes	Yes	No	Yes
Qian et al. [13]	No	No	Yes	Yes	No	Yes
Yang et al. [14]	Yes	No	No	Yes	No	No
Yang et al. [15]	Yes	No	No	Yes	No	No
Huang et al. [16]	Yes	No	No	Yes	No	Yes
Yang et al. [17]	No	No	No	Yes	No	Yes
Li et al. [18]	No	No	No	Yes	Yes	No
Wu et al. [19]	No	No	No	Yes	Yes	Yes
Liu et al. [20]	No	No	No	No	Yes	Yes
Hasan et al. [21]	Yes	No	No	No	Yes	No
Hu et al. [22]	Yes	No	No	No	Yes	No
Mohammad et al. [23]	Yes	No	No	No	Yes	No
Tang et al. [24]	No	No	No	Yes	No	Yes
Zhang et al. [25]	No	No	No	Yes	Yes	No
Yang et al. [26]	No	No	No	No	Yes	Yes
This paper	Yes	Yes	Yes	Yes	Yes	Yes

imize the overall energy consumption while ensuring the latency requirements, the authors of [16] focus on the joint design of computation offloading and interference coordination in small cell networks. Furthermore, the joint optimization of task offloading and resource allocation strategies are investigated in MEC systems, aiming to achieve the trade-off between energy efficiency and service delay [10], [27]–[30]. However, the user mobility issue and load balancing are not considered in those offloading-related researches. On the other hand, there have been some works focusing on load balancing problems. For example, an optimization problem considering load balancing and task offloading is studied in MEC networks [18]. In [19], [20], load balancing solutions are proposed in vehicular MEC systems and problem, we then formulate a task offloading optimization (*TOO*) problem, which is intractable directly since the future user mobility behaviors and the spatio-temporal computation loads of MEC servers are unavailable in advance. To this end, we transform and decompose the original problem into two sub-problems, i.e., Task offloading Control (*ToC*) and Server Grouping (*SeG*) with load balancing. Afterwards, we propose an online control scheme, named *MOTO* (i.e., Mobility-aware Online Task Offloading), to solve the two sub-problems. Particularly, *MOTO* consists of two components, i.e., Long short term memory (LSTM)-based algorithm and Dueling Double DQN (D3QN)-based algorithm, respectively solving the *ToC* and *SeG* sub-problems. Finally, we implement our proposed *MOTO* scheme and conduct

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高度评价任务卸载和资源分配协同优化的成果（TMC 2022，代表作3），在其发表于TMC论文中指出该成果能够 **有效地满足网络协同计算的能量效率与时延约束的需求。**

tion in small cell networks. Furthermore, the joint optimization of task offloading and resource allocation strategies are investigated in MEC systems, aiming to achieve the trade-off between energy efficiency and service delay [10], [27]–[30]. However, the user mobility issue and load balancing

[27] H. Jiang, X. Dai, Z. Xiao, and A. K. Iyengar, "Joint task offloading and resource allocation for energy-constrained mobile edge computing," *IEEE Transactions on Mobile Computing*, 2022.

IEEE Communications Surveys & Tutorials

Privacy-Preserving Content Dissemination for Vehicular Social Networks: Challenges and Solutions

Xiaojie Wang, Zhaolong Ning, MengChu Zhou, *Fellow, IEEE*, Xiping Hu, Lei Wang, Yan Zhang, *Senior Member, IEEE*, Fei Richard Yu, *Fellow, IEEE*, and Bin Hu, *Senior Member*

***Abstract*—Vehicular social networks (VSNs), viewed as the integration of traditional vehicular networks and social networks, are promising communication platforms based on the development of intelligent vehicles and deployment of intelligent transportation systems. Passengers can obtain information by searching over Internet or querying vehicles in proximity through intra-vehicle equipment. Hence, the performance of content dissemination in VSNs heavily relies on inter-vehicle communication and human behaviors. However, privacy preservation always conflicts with the usability of individual information in VSNs. The highly dynamic topology and increasing kinds of participants lead to potential threats for communication security and individual privacy. Therefore, the privacy-preserving solutions for content dissemination in VSNs have become extremely challenging, and numerous researches have been conducted recently. Compared with related surveys, this article provides the unique characteristics of privacy-preserving requirements and solutions for content dissemination in VSNs. It focuses on: 1) a comprehensive overview of content dissemination in VSNs; 2) the privacy issues and potential attacks related to content dissemination; and 3) the corresponding solutions based on privacy consideration. First, the characteristics of VSNs, content dissemination and its solutions in VSNs are revealed. Second, the privacy issues for content dissemination in the current VSN architecture are analyzed and classified according to their features. Various privacy-preserving content dissemination schemes, attempting to resist distinct attacks, are also discussed. Finally, the research challenges and open issues are summarized.**

***Index Terms*—Vehicular social networks, content dissemination, potential attacks, individual privacy, attack resistance.**

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the ID of an RSU that sends the packet to the vehicle, b) *VAM* is the authentication message, c) t is the generation time of the packet, d) *RSS* is the RSS value of the packet, e) C_p is the ciphertext of the transmission power p, and f) *LOC* is the GPS location of the vehicle when it receives the packet.

Location information can also be useful for detecting the vehicular rogue APs in VSNs [154]. In this scheme, users can distinguish a rogue AP from a normal one based on the RSS value of the received messages. Each AP needs to broadcast its GPS location, which leads to location forgery for vehicular rogue APs to avoid detection. A detection algorithm is also designed to validate the reported locations by employing RSS values. The inputs of the algorithm contain the reported locations of APs, the RSS of the beacon and the location of the vehicle. Based on the reported locations of APs and the vehicle's own location, the distance between the AP and

I. Introduction

VEHICULAR Ad Hoc Networks (VANETs) have attracted significant attention in both research and industrial com-

The most important application for location cloaking is to protect the location privacy for an LBS query. For example, to resist the location-dependent attack in an LBS query, a privacy-preserving algorithm based on location cloaking is proposed in [156]. For a requesting user preparing to query for LBS, this scheme focuses on generating a cloaked region, which contains many other users to meet the privacy requirements. It contains four steps: first, it identifies as many candidate user sets as possible; second, the smallest circle is found among these candidate user sets; third, a safe cloaking region is generated by finding the largest candidate user set satisfying the smallest circle bound; at last, update the sub-candidate user set in a timely fashion. Similar to [156], a privacy preserving scheme is proposed to protect location privacy for LBS in vehicular transportation systems [157]. Point of interest is provided for drivers' queries by making use of transportation informa-

Mengchu Zhou

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新泽西理工学院杰出教授

F. Richard Yu

加拿大工程院院士、IEEE Fellow
加拿大卡尔顿大学教授

在其IEEE COMST论文中高度评价了用户信息与位置依赖计算模型（ToN 2018，代表作7），并认为 **该成果为当前主要研究思路提供了启发和依据。**

timely fashion. Similar to [156], a privacy preserving scheme is proposed to protect location privacy for LBS in vehicular transportation systems [157]. Point of interest is provided for drivers' queries by making use of transportation information on roads. However, the location cloaking approach may

[156] H. Jiang, P. Zhao, and C. Wang, "RobLoP: Towards robust privacy preserving against location dependent attacks in continuous LBS queries," *IEEE/ACM Trans. Netw.*, vol. 26, no. 2, pp. 1018–1032, Apr. 2018.

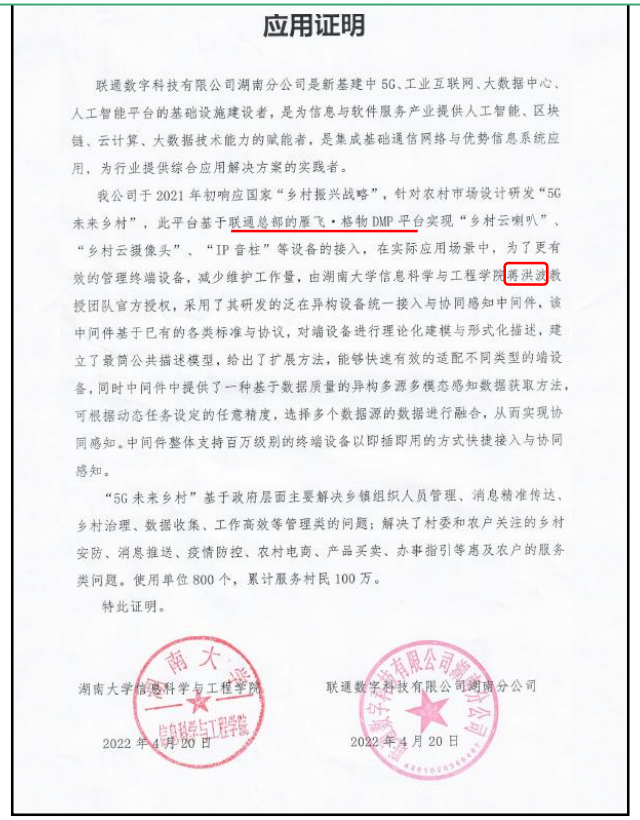
3.1肯定性评价附件 - 第9页

- 申请人成果支持了中国联通的雁飞·格物DMP物联网平台，**实现百万级终端实体设备的快捷接入及协同感知**。
- 申请人**在物联网领域的关键技术成果**支撑了中联重科环境的环卫流程监控运维平台的建设，并入选了“2020年湖南省工业互联网平台”。

2020年湖南省省级工业互联网平台建设计划

序号	平台名称	牵头申报单位	市州
1	蓝思自研工业互联网云平台	蓝思科技股份有限公司	长沙
2	博世长沙工业大数据分析平台	博世汽车部件（长沙）有限公司	长沙
3	环卫装备远程监控运维大数据平台	（盈峰环境） 长沙中联重科环境产业有限公司	长沙
4	绿色智慧能源管理平台	远大空调有限公司	长沙
5	电能计量产品智能制造工业互联网平台	威胜集团有限公司	长沙
6	智慧工业园区综合化管理平台	威胜信息技术股份有限公司	长沙

入选湖南省省级 工业互联网平台



应用证明

联通数字科技有限公司湖南分公司是新基建中 5G、工业互联网、大数据中心、人工智能平台的基础设施建设者，是为信息与软件服务产业提供人工智能、区块链、云计算、大数据技术能力的赋能者，是集成基础通信网络与优势信息系统应用，为行业提供综合应用解决方案的实践者。

我公司于 2021 年初响应国家“乡村振兴战略”，针对农村市场设计研发“5G 未来乡村”，此平台基于联通总部的雁飞·格物 DMP 平台实现“乡村云喇叭”、“乡村云猫像头”、“IP 音柱”等设备的接入，在实际应用场景中，为了更有效的管理终端设备，减少维护工作量，由湖南大学信息科学与工程学院蒋洪波教授团队官方授权，采用了其研发的泛在异构设备统一接入与协同感知中间件，该中间件基于已有的各类标准与协议，对端设备进行理论化建模与形式化描述，建立了最简公共描述模型，给出了扩展方法，能够快速有效的适配不同类型的端设备，同时中间件中提供了一种基于数据质量的异构多源多模态感知数据获取方法，可根据动态任务设定的任意精度，选择多个数据源的数据进行融合，从而实现协同感知。中间件整体支持百万级别的终端设备以即插即用的方式快捷接入与协同感知。

“5G 未来乡村”基于政府层面主要解决乡镇组织人员管理、消息精准传达、乡村治理、数据收集、工作高效等管理类的问题；解决了村委和农户关注的乡村安防、消息推送、疫情防控、农村电商、产品买卖、办事指引等惠及农户的服务类问题。使用单位 800 个，累计服务村民 100 万。

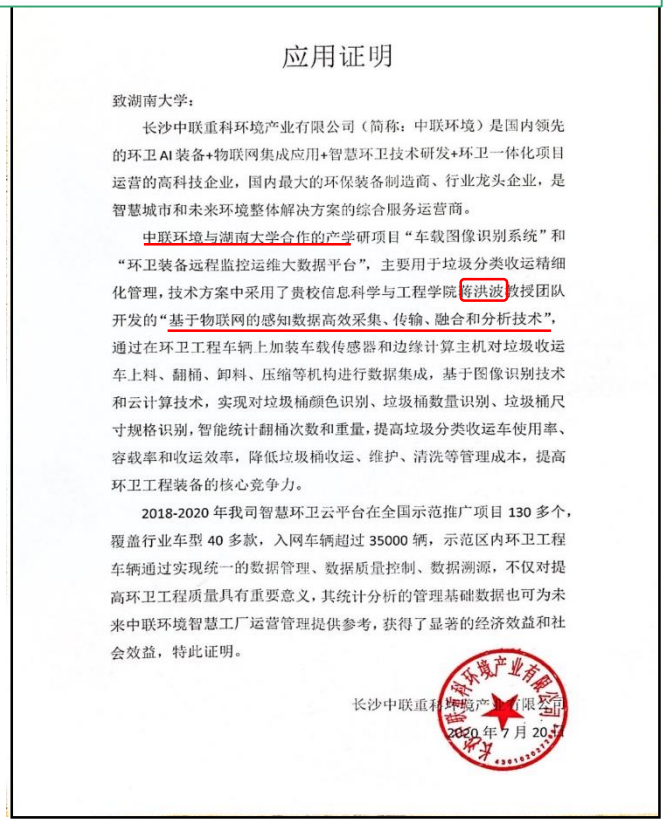
特此证明。

湖南大学信息科学与工程学院

2022 年 4 月 20 日

联通数字科技有限公司湖南分公司

2022 年 4 月 20 日



应用证明

致湖南大学：

长沙中联重科环境产业有限公司（简称：中联环境）是国内领先的环卫 AI 装备+物联网集成应用+智慧环卫技术研发+环卫一体化项目运营的高科技企业，国内最大的环保装备制造商、行业龙头企业，是智慧城市和未来环境整体解决方案的综合服务运营商。

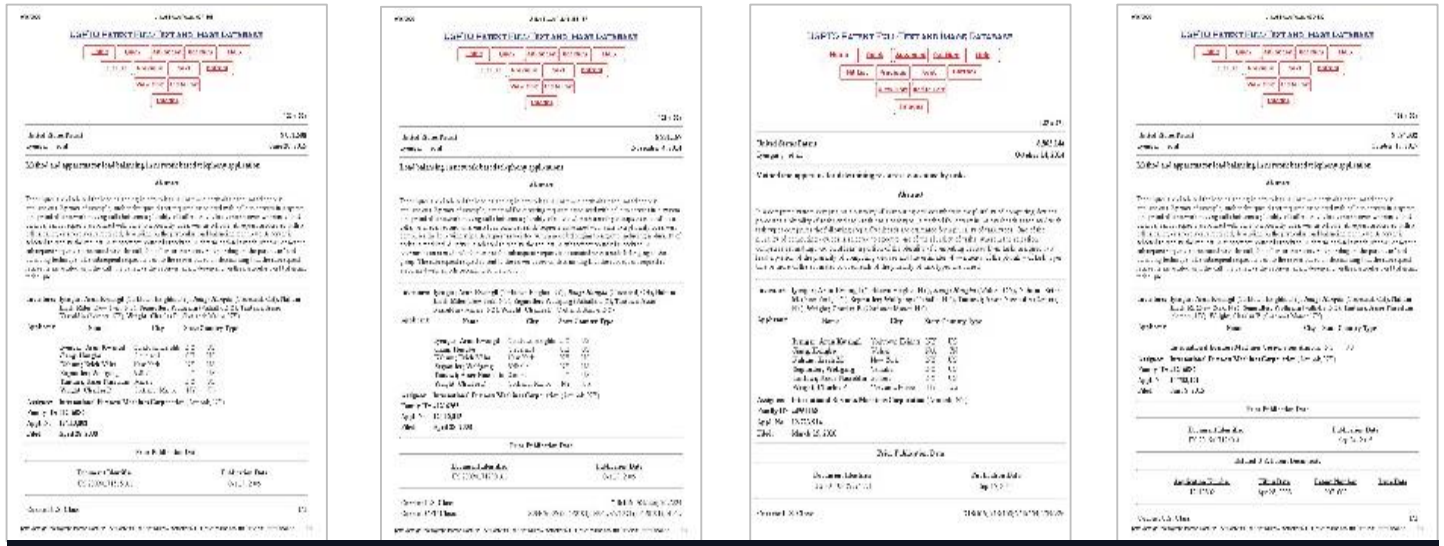
中联环境与湖南大学合作的产学研项目“车载图像识别系统”和“环卫装备远程监控运维大数据平台”，主要用于垃圾分类收运精细化管理，技术方案中采用了贵校信息科学与工程学院蒋洪波教授团队开发的“基于物联网的感知数据高效采集、传输、融合和分析技术”，通过在环卫工程车辆上加装车载传感器和边缘计算主机对垃圾收运车上料、翻桶、卸料、压缩等机构进行数据集成，基于图像识别技术和云计算技术，实现对垃圾桶颜色识别、垃圾桶数量识别、垃圾桶尺寸规格识别，智能统计翻桶次数和重量，提高垃圾分类收运车使用率、容载率和收运效率，降低垃圾桶收运、维护、清洗等管理成本，提高环卫工程装备的核心竞争力。

2018-2020 年我司智慧环卫云平台在全国示范推广项目 130 多个，覆盖行业车型 40 多款，入网车辆超过 35000 辆，示范区内环卫工程车辆通过实现统一的数据管理、数据质量控制、数据溯源，不仅对提高环卫工程质量具有重要意义，其统计分析的管理基础数据也可为未来中联环境智慧工厂运营管理提供参考，获得了显著的经济效益和社会效益，特此证明。

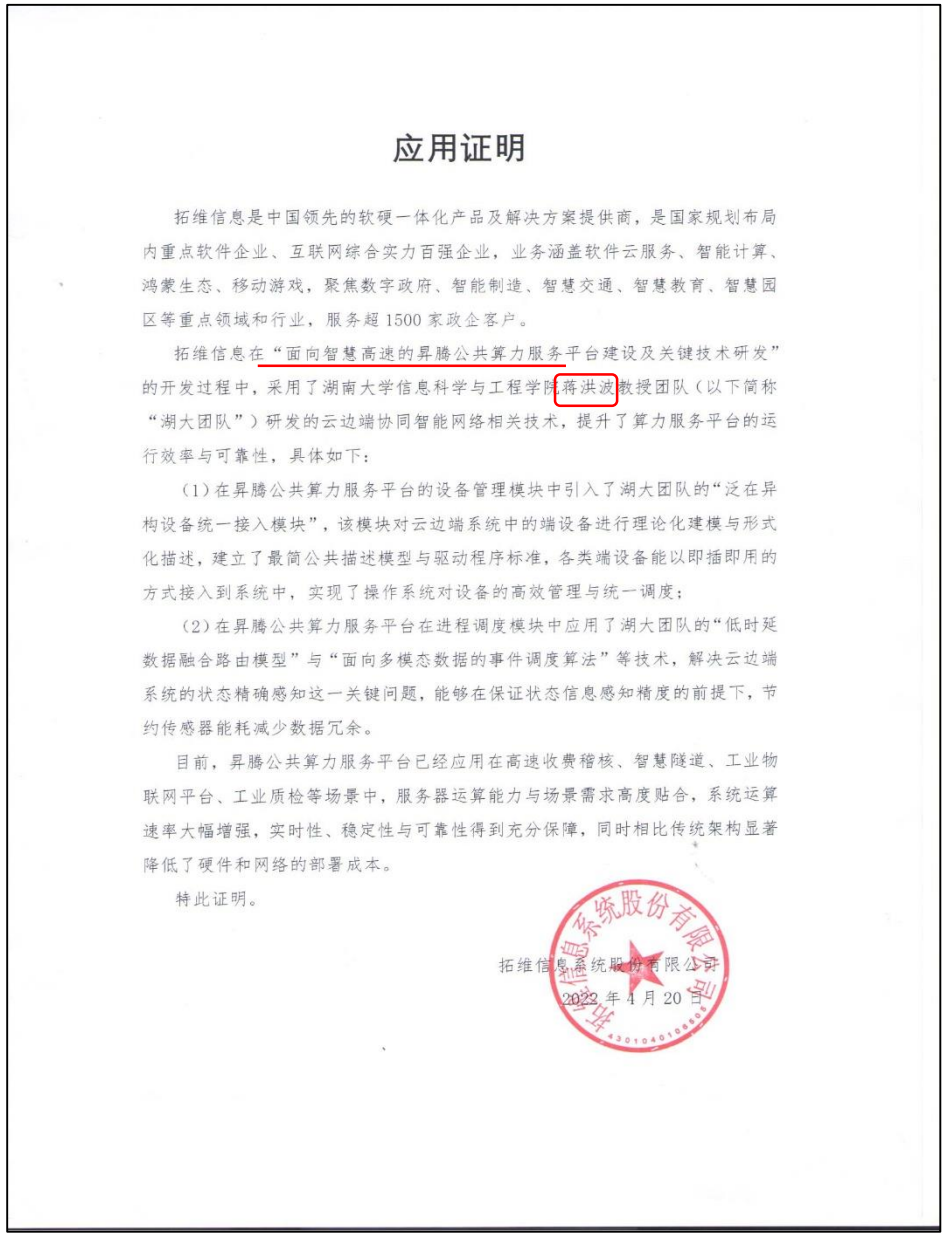
长沙中联重科环境产业有限公司

2020 年 7 月 20 日

- 申请人 **基于资源智能均衡分配的负载均衡关键技术** 已集成到IBM WebSphere Application Server（WAS）开发环境的负载均衡器（Load Balancer for IBM WAS）中。
- 申请人 **在云边端协同智能网络相关技术** 已应用于拓维信息公司的昇腾公共算力服务平台中，有效提升了平台运行效率和可靠性。



申请人与IBM合作获美国发明专利4项



应用证明

拓维信息是中国领先的软硬一体化产品及解决方案提供商，是国家规划布局内重点软件企业、互联网综合实力百强企业，业务涵盖软件云服务、智能计算、鸿蒙生态、移动游戏，聚焦数字政府、智能制造、智慧交通、智慧教育、智慧园区等重点领域和行业，服务超1500家政企客户。

拓维信息在“面向智慧高速的昇腾公共算力服务平台建设及关键技术研发”的开发过程中，采用了湖南大学信息科学与工程学院蒋洪波教授团队（以下简称“湖大团队”）研发的云边端协同智能网络相关技术，提升了算力服务平台的运行效率与可靠性，具体如下：

（1）在昇腾公共算力服务平台的设备管理模块中引入了湖大团队的“泛在异构设备统一接入模块”，该模块对云边端系统中的端设备进行理论化建模与形式化描述，建立了最简公共描述模型与驱动程序标准，各类端设备能以即插即用的方式接入到系统中，实现了操作系统对设备的高效管理与统一调度；

（2）在昇腾公共算力服务平台在进程调度模块中应用了湖大团队的“低时延数据融合路由模型”与“面向多模态数据的事件调度算法”等技术，解决云边端系统的状态精确感知这一关键问题，能够在保证状态信息感知精度的前提下，节约传感器能耗减少数据冗余。

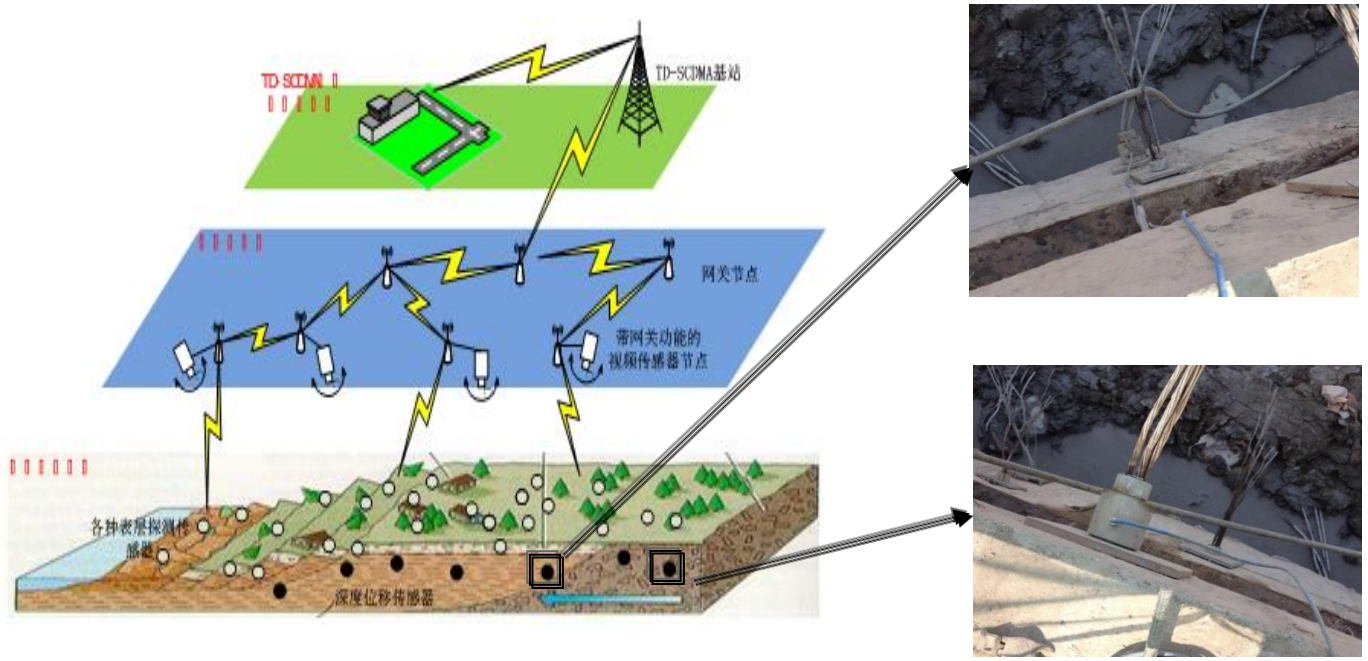
目前，昇腾公共算力服务平台已经应用在高速收费稽核、智慧隧道、工业物联网平台、工业质检等场景中，服务器运算能力与场景需求高度贴合，系统运算速率大幅增强，实时性、稳定性与可靠性得到充分保障，同时相比传统架构显著降低了硬件和网络的部署成本。

特此证明。

拓维信息系统股份有限公司

2022 年 4 月 20 日

- 申请人所提出的边界识别算法和传感数据预测模型的部分成果被湖北省高新技术企业武汉测度科技有限公司应用于地质灾害长期监测的传感网自组织组网。
- 在四川两个监测地区(雅安和绵竹汉旺)实际使用，取得了良好效果。



附表 1

应用证明

项目名称	面向物联网的大规模无线网络拓扑控制理论及方法	
应用单位	武汉测度科技有限公司	
单位注册地址	武汉洪山区保利花园 1-2-902	
应用起止时间	2008.12-2010.12	
经济效益（万元）		
自 然 年	新增销售额	新增利润
2013 年		
2014 年		
2015 年		
累 计		

所列经济效益的有关说明及计算依据：

具体应用情况：华中科技大学电子信息与通信学院蒋洪波教授研究出的"边界识别算法和传感数据预测模型"的部分成果已在我单位"面向地质灾害的长期监测系统"中成功运用。该成果应用于地质灾害长期监测的传感器自组织网络，并在四川两个监测地区（雅安和绵竹汉旺）实际使用，取得了良好效果，特此证明。

应用单位法定代表人签名：王威

2016年 01月26日

应用单位盖章

年 月 日

注：专用项目如无经济效益，可不填经济效益相关栏目。

31

- 申请人团队研发的**云边端协同目标检测算法**，满足了**桥隧作业过程中实时准确的环境感知与目标识别需求。**
- 申请人团队研发的**云边端协同计算优化技术**，实现了对疫情防控健康展示系统进行优化，能同时满足10万个以上的终端设备接入需求。

疫情防控健康信息展示系统

湖南省应对新冠肺炎疫情联防联控机制疫情防控组

感谢信

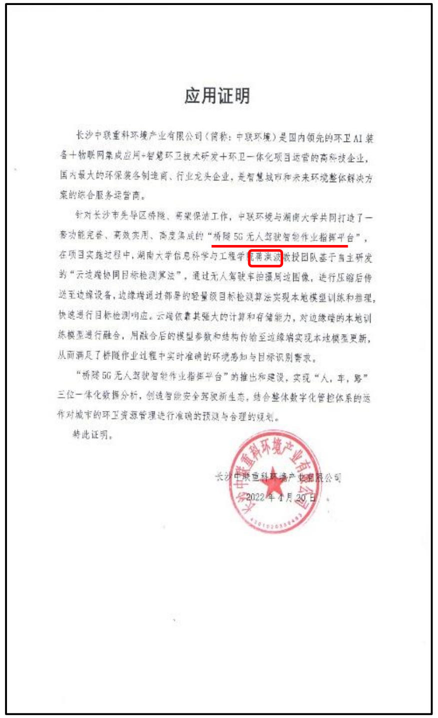
辛丑夏秋之交，新冠肺炎病毒德尔塔毒株首现罗家河游轮，破防魅力湘西剧场，继而全省七市州均现病例，破我省此前连续516日全省无本土病例之记录。一时硝烟再起，号令又鸣。应省委省政府领导指示，省应对新冠肺炎疫情联防联控机制防控组即时成立数据应急专班，汇各方英才，聚多源数据，对焦人、时、空要素，深加工大数据，大幅提升防控工作速度、精度与效度，高水平服务疫情排查防控和流行病学调查工作，为迅速阻断疫情传播、快速清零本土病例，坚决打赢本轮本土疫情防控阻击战发挥了重要作用。

期间，中国联合网络通信有限公司湖南分公司在风险人员温馨短信提醒、大数据综合分析、健康红黄码申诉等方面给予了技术和人员的强有力保障。

在此，谨致以此信，向中国联合网络通信有限公司湖南分公司全体同志表示敬意、慰问与感谢。

湖南省应对新冠肺炎疫情联防联控机制疫情防控组（代章）

2021年9月8日



应用证明

长沙中联重科环境产业有限公司（简称：中联环境）是国内领先的环卫AI装备十物联网集成应用+智慧环卫技术研发十环卫一体化项目运营的高科技企业，国内最大的环保装备制造商、行业龙头企业，是智慧城市和未来环境整体解决方案的综合服务运营商。

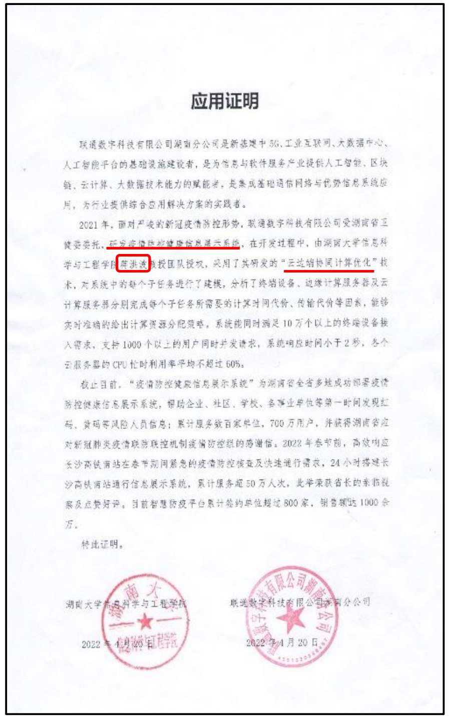
针对长沙市先导区桥隧、高架保洁工作，中联环境与湖南大学共同打造了一套功能完善、高效实用、高度集成的“桥隧5G无人驾驶智能作业指挥平台”，在项目实施过程中，湖南大学信息科学与工程学院蒋洪波教授团队基于自主研发的“云边端协同目标检测算法”，通过无人驾驶车拍摄周边图像，进行压缩后传送至边缘设备，边缘端通过部署的轻量级目标检测算法实现本地模型训练和推理，快速进行目标检测响应。云端依靠其强大的计算和存储能力，对边缘端的本地训练模型进行融合，用融合后的模型参数和结构传输至边缘端实现本地模型更新，从而满足了桥隧作业过程中实时准确的环境感知与目标识别需求。

“桥隧5G无人驾驶智能作业指挥平台”的推出和建设，实现“人，车，路”三位一体化数据分析，创造智能安全驾驶新生态，结合整体数字化管控体系的运作对城市的环卫资源管理进行准确的预测与合理的规划。

特此证明。

长沙中联重科环境产业有限公司

2022年4月20日



应用证明

联通数字科技有限公司湖南分公司是新基建中5G、工业互联网、大数据中心、人工智能平台的基础设施建设者，是为信息与软件服务产业提供人工智能、区块链、云计算、大数据技术能力的赋能者，是集成基础通信网络与优势信息系统应用，为行业提供综合应用解决方案的实践者。

2021年，面对严峻的新冠疫情防控形势，联通数字科技有限公司受湖南省卫健委委托，研发疫情防控健康信息展示系统，在开发过程中，由湖南大学信息科学与工程学院蒋洪波教授团队授权，采用了其研发的“云边端协同计算优化”技术，对系统中的每个子任务进行了建模，分析了终端设备、边缘计算服务器及云计算服务器分别完成每个子任务所需要的计算时间代价、传输代价等因素，能够实时准确的给出计算资源分配策略，系统能同时满足10万个以上的终端设备接入需求，支持1000个以上的用户同时并发请求，系统响应时间小于2秒，各个云服务器的CPU忙时利用率平均不超过60%。

截止目前，“疫情防控健康信息展示系统”为湖南省全省多地成功部署疫情防控健康信息展示系统，帮助企业、社区、学校、各事业单位等第一时间发现红码、黄码等风险人员信息；累计服务数百家单位，700万用户，并获得湖南省应对新冠肺炎疫情联防联控机制疫情防控组的感谢信。2022年春节前，高效响应长沙高铁南站在春节期间紧急的疫情防控核查及快速通行需求，24小时搭建长沙高铁南站通行信息展示系统，累计服务超50万人次，此举荣获省长的亲临视察及点赞好评。目前智慧防疫平台累计签约单位超过800家，销售额达1000余万。

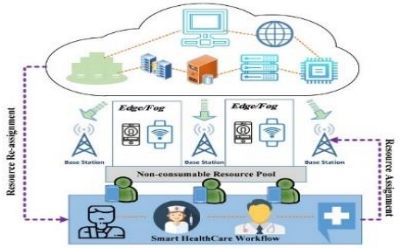
特此证明。

湖南大学信息科学与工程学院　　联通数字科技有限公司湖南分公司

2022年4月20日　　2022年4月20日

- 申请人团队开发了**“物联网智能感知与协同计算关键技术”**，推广应用于基于协同计算的糖网人工智能筛查系统，服务于国家脱贫攻坚和一带一路战略。
- 开展“一带一路-中国与斯里兰卡公益光明行”，成员受到斯里兰卡总统西里塞纳亲切接见。
- 已和中国健康促进基金会、湘雅附二医院、贵州疾控中心等签订了合作协议，被中国公益新闻网、人民网等报道。

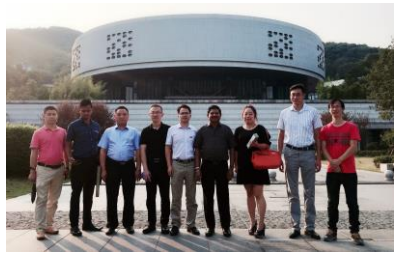
HuoEye移动端设备



协同计算应用平台

公益光明行

斯里兰卡总统接见



斯里兰卡卫生部长来访

各媒体广泛报道

应用证明

项目名称	基于协同计算的糖网人工智能筛查系统
应用单位	贵州省疾病预防控制中心
单位注册地址	贵州省贵阳市云岩区八鸽岩路 73 号
应用起止时间	2018 年 7 月 1 日-2021 年 6 月 30 日

经济效益（万元）

自 然 年	新增销售额	新增利润
2018 年-2021 年	\	\
累 计	\	\

所列经济效益的有关说明及计算依据：

无。

具体应用情况：

“基于协同计算的糖网人工智能筛查系统”服务于“健康扶贫”的理念，实现糖尿病性视网膜病变“早筛查、早防控、早介入、早治疗”的防控目的，技术方案中采用了湖南大学信息科学与工程学院荣辉桂、[illegible]等洪波教授团队开发的“物联网智能感知与协同计算关键技术”，通过在便携式眼底成像设备上加装高精度传感器，将拍摄的眼底相片实时传输到边缘服务器，通过深度学习模型进行糖尿病性视网膜病变分类预测，并给出辅诊建议，灵敏度和特异性等指标与国内外同类产品相当。目前该技术与我中心联合在贵州进行推广应用，相关项目已获贵州省科技厅 2020 年科技支撑项目资助和贵州省 2019 年地方标准立项，目前我中心已使用该系统累计开展筛查活动 10 余场，开展技术交流会 5 次，筛查 1000 余例，在贵州省黔南州福泉市开展 5000 例糖尿病患者筛查工作已在进行中。

应用单位盖章

2021 年 9 月 1 日

注：专用项目如无经济效益，可不填经济效益相关栏目。