

UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

A New Lab Initiative at CMIX:
tiny Machine Learning and EMBEDDED
COMPUTING (tML-EC) Lab

Title

Dr. Sercan Aygun

Name of Submitter
(Faculty or Staff Only)

**School of Computing and
Informatics**

Organization

Title: A New Lab Initiative at CMIX: tiny Machine Learning and EEmbedded Computing (tML-EC) Lab Date: July 15, 2024

Name (Contact Person): Dr. Sercan Aygun

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Department/College/Org: School of Computing and Informatics, College of Sciences

ABSTRACT (250 words or less):

This grant proposal seeks funding for the inaugural initiative of establishing the tiny Machine Learning and Embedded Computing (tML-EC) lab at Oliver Hall, Room 355, under the leadership of Assistant Professor Sercan Aygun. Currently, the lab is equipped with basic amenities such as tables, chairs, computing devices, and office essentials generously provided by the department. With two recent PhD students and three undergraduate students from diverse backgrounds already involved, the lab has initiated its activities, notably hosting the 2024 Summer Internship program supported by university's Informatics Research Institute (IRI) support. We aim to expand our technical infrastructure to bolster our capabilities in the upcoming fiscal year 2024-2025. This includes acquiring experimental tools crucial for both ongoing student projects and future endeavors, including the practical components of the CMPS 422-499 Machine Learning course. Dr. Aygun, who has previously taught this course with a dynamic and contemporary syllabus, intends to introduce a graduate-level course on "Machine Learning Systems" in the near future. The proposed equipment, such as a powerful server machine, computers, application-oriented controllers/embedded cards, development platforms, sensors, and related gadgets, will enhance the lab's research capabilities and support advanced coursework. By securing this funding, we aim to establish a robust foundation for the tML-EC lab, facilitating innovative research opportunities and academic growth among our students and faculty.

Description of the Proposal

This funding proposal aims to establish and equip the tiny Machine Learning and Embedded Computing (tML-EC) Lab (<https://www.sercanaygun.com/tml-ec-lab>), starting in the fiscal year 2024-2025. Assistant Professor Sercan Aygun, along with two PhD students and three undergraduate students, will actively utilize the requested equipment for research purposes and to enhance the experimental component of the CMPS 422-499 Machine Learning course. The equipment will also be available for use by other faculty members. Assistant Professor Shuvalaxmi Dass, who specializes in security and teaches INFX 422 Ethical Hacking, INFX 301 Computational Thinking, and INFX 629 Cyber Physical System Security, will collaborate on system-level security applications using the requested equipment. Dr. Ali Mokhtari, an expert in cloud systems who teaches CMPS 413 Computer Communication & Networks, INFX 210 Human-Computer Interaction, and INFX 451 Unix System Administration, will involve in server-related machine learning application development with the new equipment. For doctoral-level collaboration, a PhD student, Goktug Ayar, from Professor Martin Margala's research group will use the equipment for our ongoing research in *Hyperdimensional Computing*, which recently won the Best Poster Award at the GLSVLSI'24 Conference [1].

a. Purpose of Grant and Impact

① *Purpose*: The tiny Machine Learning and Embedded Computing (tML-EC) is a newly established, dynamic lab. The emphasis on "tiny" in the lab's theme reflects a cutting-edge and forward-looking concept focused on emerging computing paradigms. This involves the cooperative use of software and hardware to create lightweight and power-efficient machine learning systems. From a pool of over 60 applicants, two PhD students have recently been selected to work in tML-EC Lab. The research is active; one of the PhD students, Austin J. Bryant, has already had his first paper accepted at the prestigious "Embedded Systems Week" conference. The primary goal of this grant is to enhance the lab's equipment to support the research endeavors of its members. Another key objective is to strengthen the practical component of the Machine Learning course. Dr. Sercan Aygun maintains close contact with Professor Vijay Janapa Reddi from Harvard University, the founder of the *tiny Machine Learning Systems* field. Machine Learning Systems require equipment for both local and remote operations, such as edge processing and cloud processing. Dr. Aygun is a collaborator on the Machine Learning Systems book (led by Prof. Reddi https://harvard-edge.github.io/cs249r_book/), which includes numerous interesting applications. This book will be one of the course books for CMPS 422-499 Machine Learning course. Some of the equipment referenced in this book is included in this grant request, which will help enhance the course taught by Dr. Aygun and foster collaborations with other faculty members.

② *Impact*: While research labs under the supervision of professors may sometimes seem exclusive to their members, our goal is to foster a vibrant and inclusive environment at the tML-EC lab. We aim to make it a public research space by inviting students from diverse backgrounds to engage in research and discussions. Therefore, we plan to open our lab doors to students enrolled in the CMPS 422-499 course taught by Dr. Sercan Aygun. This course has seen increasing demand each semester (Fall 2023: 12 students, Spring 2024: 15 students, Fall 2024: 22 students as of July 11, 2024). With student enrollment now exceeding 20, we believe it is time to integrate real engineering applications into the course projects using actual devices. This funding will significantly enhance the educational quality of the course, as Machine Learning (ML) and Artificial Intelligence (AI) are critical subjects in computer science departments. Providing students with real devices for their term projects will yield impactful outcomes, improving their hands-on experience and understanding. Additionally, it will serve as a departmental

model for transferring research know-how to course-driven objectives, benefiting both the students and the broader academic community.

b. Projected lifetime of enhancement

The equipment purchased under this grant proposal will support ongoing and planned projects for approximately 5-7 years.

c. Person(s) responsible

i. Implementation

Dr. Sercan Aygun will be responsible for the organization and implementation of all steps related to the requested instruments.

ii. Installation

The installation of the equipment will be overseen by Senior System Administrator Troy Leger.

iii. Operation

The operational aspects of this project will be managed by two PhD students, Abu Kaisar Mohammad Masum and Austin Bryant, who are actively working in the tML-EC lab. Dr. Ali Mokhtari will also assist with the operational side of the equipment.

iv. Training

For proper usage of each piece of equipment, Dr. Sercan Aygun and PhD student Abu Kaisar Mohammad Masum will be responsible for training. We have planned internal weekly Friday meetings in the tML-EC lab and inter-lab meetings with Assistant Professor Shuvalaxmi Dass for potential collaborations. The tML-EC lab has previously collaborated with Professor Martin Margala's research group, making the lab facilities accessible to related students. For all collaborators and their students, Dr. Sercan Aygun and PhD student Abu Kaisar Mohammad Masum will organize training sessions.

v. STEP Plan Alignment

This grant proposal targets several key aims of the STEP plan, aligning with three main points: **① A new lab initiation** tML-EC Lab focuses on both hardware and software for "tiny" architectures, distinct from previous initiatives. It will support the current Machine Learning course curriculum, thus aligning with the objective to "*Create, deploy, and maintain effective learning environments that facilitate multiple instructional and learning styles.*" By transitioning from theory to application-oriented learning environments, this proposal targets diverse learning styles. Implementing machine learning concepts in real hardware environments with resource constraints will be highly beneficial for research and industry applications. **② Collaboration with other faculty members** This aligns with the STEP plan's goal of fostering a "*collaborative, diverse team that strives to acquire the most innovative technology for students to utilize while navigating their educational experience.*" The tML-EC lab targets hardware-oriented systems for machine learning using emerging computing technologies and includes diverse interdisciplinary fields for collaboration. During the use of this grant, the facilities will be open to all faculty, staff, and students within the School of Computing and Informatics. We plan a "STEP Grant Announcement Day" to showcase the funded equipment to all faculty members and students. **③ Enhancing the Curriculum and Introducing a New Course** This aligns with the STEP plan's vision to "*advance the quality and effectiveness of the teaching/learning process.*" Currently, our department

does not offer a Machine Learning Systems course. We believe that introducing such a course involving **Systems** would significantly enhance the educational variety at our R1 institution. Exemplary courses like Harvard University's "Tiny Machine Learning" (<https://scholar.harvard.edu/vijay-janapa-reddi/classes/cs249r-tinyml>) serve as a model, covering hardware machine learning systems—a niche but rapidly growing field. For example, in summer 2024, six students in the tML-EC lab collaborated with IRI to develop an intelligent mobile application for scene understanding, targeting housekeeping/cleaning companies. This autonomous Android application processes real-time camera input using the device's Graphics Processing Unit (GPU) to understand scene objects, place bounding boxes, and provide conversational AI responses (similar to Gemini or ChatGPT). This challenging task, enabled by tiny machine learning approaches, resulted in a functional app. Our plan is to extend these efforts, collaborate with cloud systems, address security challenges, and develop a lighter-weight language model, the Ultra Lightweight Language Model (ULLM).

d. Purpose and Justification for each of the Items Listed in the Budget Proposal

The following table lists the requested items and the purpose and the justification for each:

Item	Purpose & Justification	Unit Price
Laptop x2	To control all development platforms by two PhD students. Robotics application development and embedded projects will be controlled by these PCs.	\$3,469.00
Workstation x1	A server to be used for cloud applications. Dr. Mokhtari will do collaborative research on this device to measure sustainability.	\$5,033.53
Drone Dev. Kit x1	Aerial Machine Learning Applications will be assigned using this development kit.	\$2,999.99
Robot Dev. Kit x1	Mobile Robot Machine Learning Applications will be assigned using this development kit.	\$5,773.95
Mobile Phone x2	Android-based large language model development platform will be used for the on-going project and security-related research by other faculty member collaborations	\$310.00
Embedded Dev. Platform x2	Tiny Machine Learning Development platform	\$60.00
USB Power Meter x1	Tiny Machine Learning Applications requires the power meter for efficiency check	\$59.99
Sensor Package x1	Camera and other types of sensors (like EEG, biosensors) needed for tiny applications	\$3000.00

Budget Proposal

1. **Equipment** \$ (Please see the Table in previous page)

\$3,469.00 x2
\$5,033.53
\$2,999.99
\$5,773.95
\$310.00 x2
\$60.00 x2
\$59.99
\$3000.00

\$24,545.46 (for some, taxes are not included)

2. **Software** \$0

3. **Supplies** \$0

4. **Maintenance** \$0

5. **Personnel** \$0

6. **Other** \$0

TOTAL: **\$24,545.46**

References

[1] Alaaddin Goktug Ayar, **Sercan Aygun**, M. Hassan Najafi, and Martin Margala. 2024. Word2HyperVec: From Word Embeddings to Hypervectors for Hyperdimensional Computing. In Proceedings of the Great Lakes Symposium on VLSI 2024 (GLSVLSI '24). Association for Computing Machinery, New York, NY, USA, 355–356. <https://doi.org/10.1145/3649476.3658795>

Requested Equipment

ThinkPad X1 Carbon Gen 12 (14" Intel) Laptop ★★

Models

Features

Tech Specs

Ports & Slots



ThinkPad X1 Carbon Gen 12
Intel (14") - Eclipse black with
Classic black top cover

\$3,469.00

Add To Cart



Player: Three Prime - White



- 1 +

\$4,199.00

CPU: Intel i9-14900KF
GPU: NVIDIA® GeForce RTX™ 4090
Memory: 128GB (4 x 32GB) DDR5 6000 Mhz
Storage: 1TB NVMe M.2 SSD
Storage: 2TB NVMe M.2 SSD x2
Motherboard: Z790
Cooler: NZXT Kraken 280
Power: 1000W Gold
Case: NZXT H9 Elite
Software: Windows 11 Home



Player: Three Prime
White

\$4,199.00



Extend Protection Plan
379.00
Extend.IsExtendWarranty: true

\$379.00

Discount code or gift card

Apply

Subtotal	\$4,578.00
Shipping	\$75.00 FREE
FREE GROUND SHIPPING	
Estimated taxes	\$455.53
Total	USD \$5,033.53



Leo Rover v1.8 (Assembled)

FICTIONLAB | SKU: RBC-Kel-03
Manufacturer #: LeoRover-Assembled



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