View results

	Respondent		11:31
12	Nishant Garg		Time to complete

Instructions:

Please adhere to the session word counts. Project leads must attend one SSC working group meeting post step 1 application submission. If you have any questions about the application process, please contact the SSC at Sustainability-Committee@illinois.edu.

1. Have you attended a working group meeting and presented your project to the committee before this application? The SSC requires attendance at a working group meeting to remain eligible for SSC funding. If you have not attended a working group meeting, please do so and then continue the application.

   Linked below is our calendar with all of our working group meetings
   https://studentengagement.illinois.edu/student-sustainability/ssc/calendar/

   *

   ⦿ Yes

   ◯ No

2. Please enter the dates of the working group meetings you attended. As a reminder, the working group meetings are structured as followed:

   - Energy + Transportation and Infrastructure working group.
   - Food & Waste + Land, Air, and Water working group.
   - Education and Justice working group.

   *

Sep 27, Oct 11, Oct 25, Nov 8 (all in 2023) - Food & Waste Working Group Meetings

3. Project Name: *

Towards Zero Waste: Classification via Spectroscopy Enabled Computer Vision at Campus Waste Transfer Station

4. Total Funding Requested From the SSC. *

$161,200

5. Date of application. *

> 11/16/23

6. Project Lead Full Name: *

> Prof. Nishant Garg

7. Project Lead University Email Address. *

> nishantg@ilinois.edu

8. Project Abstract: (In less than 100 words, briefly describe the project.) *

> Waste management is a pressing issue at our campus, where we produce up to ~5,000 tons/year. This project aims to automate waste classification (and eventually sorting) by fusing image processing with Near-Infrared (NIR) spectroscopy into a specialized AI model. Targeted for implementation at the University's Waste Transfer Station, this initiative aligns with both the Illinois Climate Action Plan (iCAP) for Zero Waste and the State Waste Reduction Plan. By automating waste categorization, our AI model will offer precise, real-time analytics for more effective waste upcycling, all visualized through an intuitive analytics dashboard available to the entire campus community.

9. Project Category *

- ( ) Education & Justice
- ( ) Energy
- (●) Food & Waste
- ( ) Land, Air & Water
- ( ) Transportation & Infrastructure

10. Do you have a change in team members? *

- ( ) Yes
- (●) No

Project Questionnaire:

11. Any press releases or educational/promotional materials involving the project must acknowledge SSC funding. How will you bring awareness and publicize the project on campus? In addition to SSC, where will information about this project be reported? *

> The project and the related results will be shared and promoted through our CEE department and Grainger college websites, scientific conferences, and journal papers. Additionally, SSC's social media and networks will be leveraged. We plan to organize a tour/workshop with SSC to further engage the undergraduate and graduate campus community.

12. Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments affiliated directly or indirectly by the project. This includes any entity providing funding (immediate, future, ongoing, matching, in-kind, etc.) and any entities that benefit from this project.

Please attach letters of commitment or support below *

> Shawn Patterson, Transportation Manager, Facilities & Services
> Daphne Hulse, Zero Waste Coordinator, Facilities & Services

13. Please attach any letters of commitment or support here along with any other supplemental media that will support your application (presentations, pictures, etc.)

📄 Support Letter_Nishant Garg.pdf

14. How does this project impact environmental and social justice? 250 word max *

> This project profoundly impacts environmental sustainability at the University of Illinois Urbana-Champaign by transforming waste management into a high-efficiency, data-driven operation. By achieving an over 85% accuracy rate in waste classification, the project directly contributes to significantly reducing landfill waste. This aligns closely with the Illinois Climate Action Plan (iCAP) that aims for Zero Waste, thereby reducing the university's carbon footprint. The coupling of Near-Infrared (NIR) spectroscopy with AI-driven computer vision allows for comprehensive waste categorization, leading to more effective recycling and upcycling. This not only minimizes waste but also conserves raw materials and energy that would otherwise be spent on producing new items, thus reducing the overall carbon and water footprint. Additionally, by enabling a precise understanding of waste composition, the project opens pathways for converting specific waste types into biofuels, contributing to a circular economy and further reducing greenhouse gas emissions. Our innovation sets UIUC as a benchmark in sustainable waste management, with the potential to provide a scalable model for other academic institutions and communities. The resulting waste management dashboard will educate and engage the campus community in environmental stewardship, fostering a culture of sustainability.

15. Where is the project located, does it require Facilities and Services permissions? *

> The project will be located at Prof. Garg's laboratory within the Department of Civil and Environmental Engineering and the Waste Transfer Station of the University of Illinois Urbana-Champaign. For the second location, we are coordinating with Shawn Patterson and Daphne Hulse from Facilities and Services, and we will have full access for the duration of the project.

16. Is this project student led? *

- ◯ Yes
- ⦿ No

17. If applicable, have you received approval from Facilities & Services and/or site manager? *

- ⦿ Yes
- ◯ No
- ◯ N/A

18. Do you have a plan for ongoing funding beyond SSC? (SSC does not guarantee ongoing financial support) *

  ⦿ Yes

  ○ No

19. Beyond SSC, do you have sources contributing funding or support (ex. staff time, external grants, etc.) to this project? *

  ⦿ Yes

  ○ No

20. Have you applied for SSC funding previously? *

  ⦿ Yes

  ○ No

21. Project Timeline:
    (SSC funding agreements remain active for two years. List your project's proposed end date.) *

    Over two years, the project is structured into sequential phases, each with clearly defined objectives and deadlines. Initially, a Lab-Scale Classification System will be operational by Q1 2024. This will pave the way for constructing a Spectral Library by March 2024. By Q2, we will achieve Image-Based Waste Stream Classification, integrating it with spectroscopy data by August 2024 to form a cohesive Municipal Solid Waste (MSW) system. The latter half of 2024 focuses on system miniaturization and deployment at the Materials Recovery Facility by December. In 2025, the first quarter will be dedicated to accuracy refinement and system enhancements. The project will conclude with in-depth Techno-economic and Lifecycle Analyses by the end of Q2 2025.

22. Provide a detailed project description:
    (In 400 words or less, describe your project. What does your project hope to accomplish? What are your project's deliverables?) *

    This project aims to redefine waste management by developing an AI-driven waste characterization system that merges computer vision with Near-Infrared (NIR) spectroscopy. Initially conceived at a lab scale, the system targets conveyor belt speeds up to 20 cm/s and aspires for over 90% classification accuracy. It will be scaled to the University of Illinois Urbana-Champaign's Materials Recovery Facility, capable of handling 17-20 tons of waste daily. The core of this innovation lies in its ability to classify waste into six fundamental categories: paper, plastic, yard waste, food waste, metal, and glass. Utilizing deep learning algorithms fine-tuned for waste streams and coupled with NIR spectral data, the system promises precision-targeted waste classification. By the project's end, we aim to categorize approximately 10 tons of waste per day from various community streams with an accuracy exceeding 85-90%. This information will guide the conversion pathways for biofuels and bioproducts, contributing to lifecycle sustainability assessments. A final deliverable will be a sophisticated waste management dashboard offering detailed analytics and disposal guidelines. The first year will be structured into three main tasks, focusing on lab-scale image-based classification and hyperspectral sensor integration. The second year will concentrate on refining the system's accuracy and deploying the comprehensive waste management dashboard. This initiative stands as a groundbreaking venture in waste management, providing scalable, data-driven solutions for sustainable waste diversion and resource recovery.

23. Environmental Impact:
(In 200 words or less, how does your project increase environmental stewardship at UIUC? If applicable, what is the carbon, water, waste, and/or energy savings?) *

> This project profoundly impacts environmental sustainability at the University of Illinois Urbana-Champaign by transforming waste management into a high-efficiency, data-driven operation. By achieving an over 85% accuracy rate in waste classification, the project directly contributes to significantly reducing landfill waste. This aligns closely with the Illinois Climate Action Plan (iCAP) that aims for Zero Waste, thereby reducing the university's carbon footprint. The coupling of Near-Infrared (NIR) spectroscopy with AI-driven computer vision allows for comprehensive waste categorization, leading to more effective recycling and upcycling. This not only minimizes waste but also conserves raw materials and energy that would otherwise be spent on producing new items, thus reducing the overall carbon and water footprint. Additionally, by enabling a precise understanding of waste composition, the project opens pathways for converting specific waste types into biofuels, contributing to a circular economy and further reducing greenhouse gas emissions. Our innovation sets UIUC as a benchmark in sustainable waste management, with the potential to provide a scalable model for other academic institutions and communities. The resulting waste management dashboard will educate and engage the campus community in environmental stewardship, fostering a culture of sustainability.

24. iCAP Objective Correspondence:
(In 200 words or less, does your project aim to advance one or more of the Illinois Climate Action Plan's (iCAP) objectives? If so, how?)

A full list can be found here: https://icap.sustainability.illinois.edu/objectives

> This project directly advances iCAP's Key Objective 5.2 by implementing a cutting-edge waste classification system at UIUC's Materials Recovery Facility. By leveraging AI and Near-Infrared (NIR) spectroscopy, the project aims to achieve over 80% accuracy in real-time waste categorization. This technology will substantially decrease landfill contributions, well aligning with iCAP's goal to reduce landfill waste from 5,049 tons in FY19 to 4,544 tons or less in FY24. The high-accuracy classification will also enable more effective recycling and upcycling of materials, thereby contributing to iCAP's waste minimization and diversion targets. Furthermore, the project resonates with iCAP's Objective 5.3.1 by integrating a comprehensive waste management dashboard. This digital platform will act as a Zero Waste messaging campaign tool, educating the campus community on effective waste management practices. By providing real-time analytics on waste types and disposal methods, the dashboard fosters individual and collective environmental stewardship. This educational component will be a vital asset in achieving iCAP's goal of 10,000 "Use the Bin" pledges by FY24, ultimately driving UIUC toward a more sustainable, zero-waste future.

25. Student Impact:
(In 200 words or less, how will this project benefit students? How will students be involved with this project? What educational components are in your project?)
*

> This groundbreaking project not only elevates UIUC's sustainability but also improves the Materials Recovery Facility's efficiency, leading to substantial cost savings. These savings can be redirected to enhance student amenities and services, thereby enriching the campus experience. From an academic angle, six students will gain hands-on experience in cutting-edge technologies like AI and Near-Infrared spectroscopy over 24 months. Beyond technical skills, they will acquire proficiencies in project management and team collaboration. The project's reach extends globally, preparing students for waste management challenges that transcend local or national boundaries. It also fosters community engagement by offering students opportunities to lead sustainability workshops, thus fulfilling service-learning credits and cultivating a sense of social responsibility. For those with entrepreneurial aspirations, the project serves as a fertile ground for startup ventures or patent applications. Additionally, the project's success in waste reduction indirectly contributes to a healthier campus, positively affecting student wellness and academic performance. In summary, this project serves as a comprehensive educational platform, blending practical skills with global awareness, community engagement, and an enduring commitment to environmental responsibility, all while paving the way for future entrepreneurial endeavors.

Project Finances

26. See attached file, please be very descriptive and fill out the finalized budget and timeline Excel sheet, and submit it below.

https://studentengagement.illinois.edu/student-sustainability/ssc/docs/SSC-Supplemental-Budget-Timeline.xlsx
*

📄 SSC-Supplemental-Budget-Timeline_Nishant Garg.xlsx

27. Project Finance Manager.
    Must be a fulltime UIUC faculty or staff member** *

    Prof. Nishant Garg

28. Finance Project Manager Department *

    Civil and Environmental Engineering

29. Project Finance Manager University Email *

    nishantg@illinois.edu