Announcer:

Welcome to the Michigan Minds Podcast, a quick and informative analysis of today's top issues from University of Michigan faculty.

Interviewer:

Thank you both so much for joining us on Michigan Minds today. I'm very excited to learn more about your research project, so I want to jump right in and get started. Could you each please introduce yourself, sharing your name and your title, and tell us a little bit about where your research focuses.

Carol Menassa:

Good morning, everyone. My name's Carol Menassa. I'm a professor in civil and environmental engineering. My research is on human-building and built environment interaction. We explore methods and ways to make the built environment safe and healthy for occupants and users of the built environment. We have mainly three main tracks: one track that looks at office workers and their wellbeing and health, one track that looks at construction workers and trying to eliminate the burden, physical burden of doing construction work. Also helping them be more productive and healthy. And finally, with this project, we are looking at the intersection of people with physical disabilities and their interaction with the built environment.

Interviewer:

Thank you.

Vineet Kamat:

Morning, everyone. My name is Vineet Kamat, and I'm also a professor of civil and environmental engineering and also have a joint appointment in electrical engineering and computer science. My main area of research is in automation and robotics with general applications in the construction, operation, and maintenance of the built environment, as well as human interaction and experience within the built environment.

Interviewer:

Fantastic, thank you. I'm really excited to talk with you both today about a project in which you are the lead PIs looking at long-term solutions for people who use wheelchairs for mobility. And this project recently received a grant from the National Science Foundation. So can you start us off by telling us about the goals of this project?

Carol Menassa:

I guess the goal of the project is basically to enable independent mobility in people with physical disabilities. And what we mean, independent mobility here is taking into consideration their preferences as well as giving them control over their mobility needs. So when we talk about navigation and maneuvering in the end-to-end mobility spectrum, we are interested not only in providing automatic or automated navigation and maneuvering, but giving them control and providing them with what they need. So basically, looking at their preference, the historical use of the system, their preferences and enabling them to navigate themselves as independently as possible to their destination and final location.

Vineet Kamat:

I think to what Carol said, I'll just add that, at an overarching level, the main goal of this project is to improve the overall experience of people with physical disabilities in the built environment. So generally speaking, I think a large body of researchers agree that in terms of innovations that directly serve people with physical disabilities, one major breakthrough that happened in America was the ADA, but that was several decades ago. Since then, most innovations that support people with physical disabilities have been sporadic, maybe focused more on changing building codes, focused more on developing better wheelchairs. But what we are trying to do in this particular project is be able to use the innovations and technological advancements in communications and robotics to be able to fundamentally change how people who use mobility devices such as wheelchairs interact with the environment and are able to more independently meet their end-to-end mobility needs.

Interviewer:

Thank you. So what led the two of you to collaborate on this project?

Vineet Kamat:

I think we have been working in automation and robotic technologies together for a long time. As Carol mentioned, her primary expertise was in human-building interaction and finding ways to improve human experience within the built environment. And independently, my own research was focused on automation and robotics primarily, with applications to construction and operation of the built environment. At an informal gathering, we ended up having a conversation with one of our colleagues, Clive D'Souza, who is a co-principal investigator on this project now, and he's at University of Pittsburgh. And he worked exclusively in his career with people with physical disabilities, and he primarily was interested again in coming up with ergonomic solutions to improve their experience within the built environment. So when the three minds and three areas of expertise came together, I think it naturally evolved that there is an opportunity to bring together expertise in working with people with physical disabilities, bring together Carol's expertise working to improve the human experience in the built environment, and the type of work that my own lab did in automation and robotics. And that's how the project was conceived and came together.

Interviewer:

Fantastic. Thank you. A great example of interdisciplinary work. This is a really broad question, but can you explain how you will conduct the study?

Carol Menassa:

The way we plan to conduct the study, we're turning to a participatory design process. And what this means is that the design of the end-to-end mobility system that we are proposing will be motivated and directed by the individuals who are going to use it. So to achieve this, what we are going to do is our project will start by recruiting a cohort of people with physical disabilities through several of our collaborators, like Ann Arbor Center for Independent Living and Michigan Vet and Hire Vet. And then we will work with this cohort and let them report to us on a daily basis how their experience with the current mobility systems that they use. And then based on that, we will have also meetings with them and try to understand in more depth what are their needs in an end-to-end mobility system that would make them independent and also less reliable on caregivers and maybe family members who help them. So our approach would start like this.

We will then develop the technology or improve on the technology that we already have. And based on that, the next step would be to start testing the technology with the individuals. And in terms of that, we have a two-pronged approach to testing. The first one would be in laboratory settings, so a much more controlled environment in terms of the path planning for navigation and the maneuvering tasks. And then as a result of this testing, we will improve again the end-to-end mobility system. The cohort, the eventual cohort who has been with us will continue to provide feedback and input. And then as a last stage, we will do several routes around the Ann Arbor-Ypsilanti area and do actual testing on real buses and getting people from one location to another.

Vineet Kamat:

I think I'll add to what Carol said, is that the participatory design process, I think, is one of the key components of this work. So generally speaking, our approach has two directions. One is the technological direction. And typically, some research projects in the past have been guilty of going too far along the technological route without involving the potential end users of the technology or the system that the group is working on. In our case, the participation of the cohort of users, potential end users, will stay with the research team throughout its duration, is one of the key components that, I think, will bring a lot of value to our team.

So there are two distinct parts. One would be the technological track, and the other would be the social engagement component. And they're clearly not independent of each other. They are completely moving in parallel and supporting each other. So the first phase will involve gathering data, understanding needs, and using the participatory design process to generate requirements for technology development. And while those steps are moving in parallel, we hope to, at every stage, test it out and get additional feedback from our cohort of users. And we believe that this two-pronged approach positions this project for success much better than if they were independent.

Carol Menassa:

In addition to involving the cohort, the people who are going to use the mobility system we are proposing, we will also have several interviews, focus groups, interviews and surveys with the immediate caregivers of the users of the end-to-end mobility system. And just to understand the effect of having a more user-friendly, if you want, end-to-end mobility system for the people with physical disabilities, what effect would that have on the direct caregivers as well as health professionals who support them in the community?

Interviewer:

Thank you. Can you discuss why it's necessary to examine both indoor and outdoor environments and how you'll navigate that process and the different complexities that those environments present?

Vineet Kamat:

Yeah, sure. So when we talk about end-to-end mobility, the typical scenarios may include a person who uses a mobility device starting their journey maybe in their home or where they are in a particular building at a given time. And then their destination could be a specific room in another building that potentially may be an unknown environment, a place that they have not been before. So the motivating example we typically use is a person starts at their home and maybe wants to go to a very specific clinic or room in a building as large as the University of Michigan Hospital or the VA Hospital.

So the components of this journey include going from their home to maybe the nearest transit point, which is a familiar environment, then boarding the bus. And maybe the bus directly goes to the nearest bus stop at their destination, or it might go to an intermediate transit point, like Blake Center, and a person has to switch buses. And once at the nearest bus stop at their destination, they need to get to the building entrance where they're visiting. And bear in mind, it may not be the main entrance. It could be an entrance that is accessible in this case. And once inside the building, maybe it is where the most complexity is introduced, because now you have a very large building that may not have been visited by the person before. And anyone visiting that building, like for example the Michigan Hospital, we know that we need some time to find out where we are going and how the building is laid out. And with having navigated or maneuvered that part of the journey, maybe the person reaches where they want to be.

So as you can imagine in this example, there are several portions of this journey that involve both indoor and outdoor environments, and yet the person who is on this journey is going through two fundamental functions. They're either navigating from point A to point B or intermediate points, or within any of these navigation steps, they're trying to maneuver and get themselves into the best position so that they can take the next steps. So these two fundamental ideas, navigation and maneuvering, can span both indoor and outdoor environments, and that is why we need to treat these two things kind of together or make no assumptions about when we are indoors and when we are outdoors and that the switches are continuous and have to be smooth.

Carol Menassa:

I would add that another important aspect of this process is, even though you might provide a path maybe using Google Maps in outdoor environments, there is an example that maybe the accessible ramp or sidewalk is blocked due to construction, maybe blocked due to ice that hasn't been cleaned yet. So you would need to provide immediate assistance to the individual so they can find the next best route for them. Similarly, in an indoor environment, you might route them towards an elevator. Maybe it's being cleaned. Maybe it's not operating that day. And maybe that's the route they know, but finding out that the closest elevator is not working would require some assistance for them to find the next-best elevator for them to reach their destination. So an important aspect of this is how we can provide... learn in real time what the situation is and provide them... If we get to a point where the route that we are giving them is not accessible, how we can provide immediate assistance and alternative routes to get them where they need to go.

Vineet Kamat:

One quick thing, if I might add, it might be contextual to the listeners and our audience, is we haven't had an opportunity yet to define what we mean by navigation and what we mean by maneuvering in this context. So navigation in the context of this project is being able to figure out a path to go from point A to point B or any intermediate set of waypoints, whereas maneuvering is the kind of small steps we take to situate ourselves in a confined space. And maneuvering usually is an issue that needs to be addressed because people with physical disabilities often find themselves having to maneuver under time and space constraints.

So for example, as Carol mentioned, they may be at a situation where they're stopped for an elevator and the elevator door opens. There are three or four people already inside, and now we know they're all waiting and would like to continue their elevator journey. So under this circumstance, I have now to make a three-point turn and reverse into that elevator. So this is like a maneuvering situation under a time and space constraint. Similarly, maybe a bus comes and stops at my stop. The ramp comes down, and I know that there are people waiting. I want to get along with my journey. The others want to get along with their journey. Yet, I have to now climb that ramp and very quickly spin the wheelchair around, park it in a given situation within the bus. So this is another maneuvering situation.

Once I get off a bus, I now have to figure out what are turn-by-turn directions to get from the bus stop to the door of a building. That is more of a navigation situation. So if we draw a parallel between... A car using a GPS is navigation. Sometimes if you find a parking spot and ask the car to self-park, that's maneuvering. So this is the analogy that we usually use in our research to describe what is navigation and what is maneuvering. So the indoor and outdoor spaces also are connected because when a person wants to go from point A to point B, there are several navigation and maneuvering steps along the way that have to be considered as interconnected to each other to improve the end-to-end experience. And I think that hopefully establishes what the main context of the work is.

Interviewer:

Yes, thank you so much for clarifying that. Why is a study such as this vital to the community, and how will it help create more welcoming environments?

Carol Menassa:

Our research shows that there are around 4.3 million people with physical disabilities or individuals who use wheelchairs for their day-to-day activities. And this number is expected to grow at the 7% to 10% rate for a year, given improvements in health systems and the aging of the population. So one important aspect of this research is how we can provide these individuals with opportunities and independence to seamlessly remain part of the community, allow them to still be able to be employed, be active members in social events and things like that. One important aspect of this is enabling the individuals themselves to be part of the community and feel independent. But also, the other important aspect is reducing the burden on their caregivers. And that, as well, makes things better for their caregivers and reducing cost on the healthcare system as well.

Vineet Kamat:

Yeah, I think those are very good points. I'll just add to that, that mobility, I think, is a key determinant to an individual's prospects, be it in education, be it in finding good jobs, be it in their ability to socialize. And therefore, lack of mobility is not only detrimental to the prospects of the individual who is affected, but also to society because then the society is deprived of all the contributions that such individuals could make. And as we talk about being inclusive and making a city welcoming to all of its residents, there is in recent times increased focus on things such as adding bike lanes and making a city bike friendly, or a walking trail, adding walking trails to make it walk friendly and things like that.

As technology becomes more accessible and cities strive to become smart cities, I think the time now is correct to be able to think of making the city more inclusive and accessible to a large segment of our society: people with physical disabilities who use mobility devices of various types for their end-to-end connectivity. So I think within this context, it is very important to take advantage of our expertise and the general status of the technology that can enable such innovations to make our environments more accessible, more friendly for independent mobility, reducing the burden on the caregiver community, and at the same time, providing all the other opportunities that would otherwise have been inaccessible.

Carol Menassa:

And I think I would like to add that even though our focus is going to be on people who use wheelchairs for their mobility needs, we hope that this project will set the stage or the things we are going to learn from this project will set the stage for us to develop or build on the results of this research for other individuals who would need such an end-to-end mobility system. So for example, talking about people who are blind. This can be another or the next step in our research.

Vineet Kamat:

Yeah, I think that's a very good point. People with visual impairments is another segment of society that also, I think, would significantly benefit from some of the aspects of this work at a later time. The needs of users in that group are a little bit different than the needs of people with physical disabilities who may use mobility equipment, but many of the underlying ideas related to connectivity and information-sharing within a mobility context are the same for both the groups. So I think there is quite a bit of scalability opportunities in the project as well.

Interviewer:

Thank you. And you're working with some local organizations to facilitate these studies. Can you share why that's an important element to a project such as this?

Vineet Kamat:

Yeah, sure. I think as we mentioned in the beginning, a participatory design process is the cornerstone of this project. And when we talk about receiving input, the context is not only the potential end users but also other stakeholders in this end-to-end mobility ecosystem. And that would include caregivers. That would include healthcare organizations. That would include the city that provides infrastructure. That would include the transportation agencies that provide the buses and other modes of transportation. That could include the manufacturers of wheelchairs and mobility devices. So each of these stakeholders plays a unique role in what they can contribute towards improving the experience of people with physical disabilities.

So with this understanding, our project team has tried to assemble a team of experts who has experience in each of these sub-disciplines. So with that goal in mind, we have partnered with the University of Michigan Health System or Michigan Medicine Wheelchair Seating Service, which is a unit within the UM hospitals that outfit custom wheelchairs to meet the unique mobility needs of each individual that comes as a patient to their facility.

We are also participating with the VA hospital system because there are several patients in their care who may have physical disabilities, many of them encountered during times of war as former service members. And they also represent a group that is very active and willing to participate in a project like this. So that is another important team member for us. There is also the Ann Arbor Center for Independent Living, which is a community center that serves the needs of people with physical disabilities. And they also are a partner in this project because they have experience working with several individuals related to meeting their mobility needs and are also conveniently located close to our university so that we can collaborate with them more closely, and they can provide us with opportunities to interact with their members and give input to the various activities as well.

Carol Menassa:

In terms of community engagement, I think for this project, the institutions and organizations that Vineet mentioned are essential, I think, to the success of our project. So the objective is that this project would lead to benefits and be useful to the end stakeholders, and the only way to do that and ensure that we are doing that is through engaging the immediate individuals who will use it, but also who will benefit and be able to provide us with the knowledge and expertise of what actually happens in the field, for us to be able to provide a beneficial end product.

In addition to the institutions that Vineet mentioned, we have also several collaborators that come from multidisciplinary backgrounds. Our colleague Clive D'Souza at University of Pittsburgh, he's a human factors expert and has been working for several years now with people's physical disabilities, particularly designing accessible buses and ramps for them. Our colleague Patrick Carrington at Carnegie Mellon University, he's an expert in mental model formation. What we mean by that is the interaction between the individual and any technology, so understanding that trust relationship that happens. For any individual to use even a phone or any device, they need to develop trust that this system is providing them with the services they're looking for. So his expertise is at the center of measuring trust, especially in people with physical disabilities and interaction with technologies.

And our colleague Chien-fei Chen, she's at University of Tennessee. She's a social scientist and will be helping us in terms of understanding the social, economic, psychological factors associated with the, first of all, the navigation and maneuvering parts independent of our system. But also once our system is implemented and tested, what are the implications or what are the issues that we need to be aware of as well?

Interviewer:

Thank you. I like to ask every expert who graciously gives us their time on Michigan Minds this question as we near the end of the podcast, and sometimes it's very difficult to come up with just one thing. But I like to ask if you could share one, or one each, a takeaway that you hope everyone listening has from this information. What do you want them to remember from everything that you've shared with us today?

Vineet Kamat:

I think as we mentioned earlier in this talk, engaging with the potential end users and other stakeholders in this ecosystem of mobility is a high priority for our project. And what I'd like the audience to take away from this podcast is that this is an excellent example where our vision aligns with the vision of our college, and that is people-first engineering. And if we try to understand what are the full dimensions of people-first engineering, we'll see that it involves not only taking input from potential stakeholders and end users, but also deeply engaging with them throughout the research and development process, because eventually that will lead to better outcomes and better deliverables and also will give us the opportunity to magnify the impact of our research and its products to have a larger impact on the intended end users as well as society at large.

Carol Menassa:

The main takeaway, I guess, is the idea of end-to-end mobility and the challenges associated with it for people with physical disabilities is important and significant, and it's very important to look at solutions to this problem mainly to enable independence, to enable reduced cost. And when I say cost, it doesn't necessarily mean economic cost, but also social burden on themselves and their caregivers. Another important aspect from this research is the engagement of the stakeholders from time zero in the project is important to us. And finally, I think getting feedback from the community, since we are going to start publishing and sharing the results of our research. Getting feedback and input from the community is, again, very important to us. So that's part, I guess, of the process that we are excited about for this project, is the way we are doing the research itself is very exciting for us.

Interviewer:

It's a wonderful example of public-engagement work, which is part of the reason I'm so happy that I got to meet both of you today and speak with both of you. Before we wrap up, are there any final thoughts or anything additional that you would like to share?

Vineet Kamat:

I think as researchers, one thing we wanted to add is this is also a unique and somewhat new experience for us because, as academicians, there is usually a tendency to forge a hammer and hope that somebody out there wants it and this will be useful to others. But I think as the culture in research and emphasis on including stakeholders and participants in the research process continues to improve for the better, we are also already learning and experiencing that this results in us defining the research objectives much better and in a more clear way and all the intermediate milestones. And potentially, the end product will also have a much higher chance of being useful and being actually deployed for its intended use. So I think this team approach is something that is quite unique to this project in terms of the breadth of stakeholders and the duration for which they're going to stay with our project. And that is something we are quite excited about.

Carol Menassa:

I would like to add two things. First, in addition to the research and the research approach that we have talked a lot about in this interview, I think one important aspect of the project is also education and involving a diverse set of students and undergraduate researchers, graduate researchers, in the research project and making an impact on their education and their careers as well. So a significant part of our work would also look into how the results of our research can be integrated in the different classes that we teach, at least in the Co-PIs' different departments and how we can benefit from the results of this research to educate students. But also, the involvement of graduate students, undergraduate students in the actual research activities is an essential component of our research. And finally, I think I would like to thank the National Science Foundation, particularly the Smart and Connected Communities program, for their trust in our project and for supporting us financially to be able to achieve the vision of this project.

Interviewer:

Thank you both so much for joining us today. We really appreciate your time and all the information that you've shared with us. Thank you.

Vineet Kamat:

Sure. Thank you.

Carol Menassa:

Thank you.

Announcer:

Thank you for listening to the Michigan Minds Podcast, a production of the University of Michigan. Join the conversation on social media with #UMichImpact.