FLORA FLOW

URBAN SENSING AND DATA REPORT

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PRODUCED BY:
JULIA QIAN
MENGYAO CHEN
XUYAN ZHAO
SOICHIRO HARADA

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ABOUT

WE'RE CURIOUS ABOUT THE OCCUPATION AND USAGE PATTERN OF THE PULICE SPACE, SO

HOW DO ENVIRONMENTAL CONDITIONS AND SPATIAL LAYOUT INFLUENCE SEATING BEHAVIOR AND SPACE UTILIZATION?

This project was initiated to understand seating behaviors and the impact of environmental factors on space usage.

Key observations include consistent occupancy of the site due to its moderate sunlight, making it a popular area during various weather conditions, particularly busy during weekday lunchtimes. We utilized non-intrusive ultrasonic sensors to monitor occupancy patterns without disturbing natural behaviors, providing insights into the effectiveness of the current seating arrangements.

An incident during sensor maintenance highlighted the delicate balance between effective monitoring and privacy concerns, underscoring the importance of ethical considerations in observational studies.

Our findings suggest opportunities for enhancing urban planning, such as the development of occupation-detecting furniture with integrated sensors to optimize space management and responsiveness to user needs.

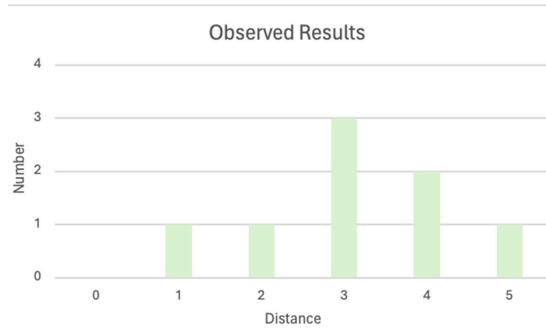
TO BEGIN WITH

"HOW FAR WILL HE SIT NEXT TO YOU?"

In New York, we see benches everywhere. While it is true that benches allow many people to sit on them at the same time, would people want to sit next to a stranger? Or would they intentionally sit apart from strangers? How far would they want to sit from you?

Our idea about this project comes from the weekly observation, a concept called "How far will he sit next to you?" We numbered each sits on the bench and tracked people's sitting behavior during that 10 minutes. During this observation, it was also very interesting to see that weather and temperature have a very drastic effect on the number of people sitting on the bench.

Originated from study of public benches, we picked site of the study within the university, focusing on the plaza in front of the engineering library, by making sensors to observe the characteristics and behaviors of students using the public space for a small period of time. This is the idea and origin of our project.



TO UNDERSTAND THE PUBLIC SPACE

Urban planning and design revolve around understanding the intricate dynamics that influence how people interact with their surroundings. Factors like geographical location, weather conditions, and the time of day all shape our experiences within the built environment.

Our focus is on a specific area within the Columbia campus, near the engineering library. During weekday lunch breaks and post-class hours from 11:00 am to 1:00 pm, we've observed a significant uptick in activity and foot traffic.

Through careful observation and analysis, we've uncovered a delicate balance between spatial layout and environmental conditions. Despite receiving moderate sunlight compared to other campus spots, this area maintains a consistent level of occupancy regardless of the weather.

Going beyond mere headcounts, our research delves deep into understanding behavioral patterns. That's why we use discreet, nonintrusive sensors, like the ultrasonic sensor, to capture the natural flow of activity without disturbing users.

HOW IS THIS SPACE UTILIZED

By establishing clear parameters for occupancy, we can decipher not only how long seats are occupied but also the preferred spots within the area. This insight allows us to gauge whether the existing furniture meets the needs of the users effectively.

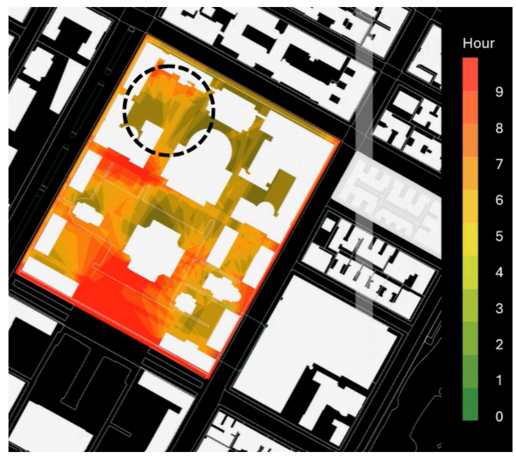
As we navigate this intersection of human behavior and urban design, armed with data-driven insights, we're not only unraveling the mysteries of space utilization but also laying the groundwork for future landscapes. Our journey doesn't stop at understanding usage patterns; it extends to ensuring that the space is equipped to meet the needs of its occupants efficiently.

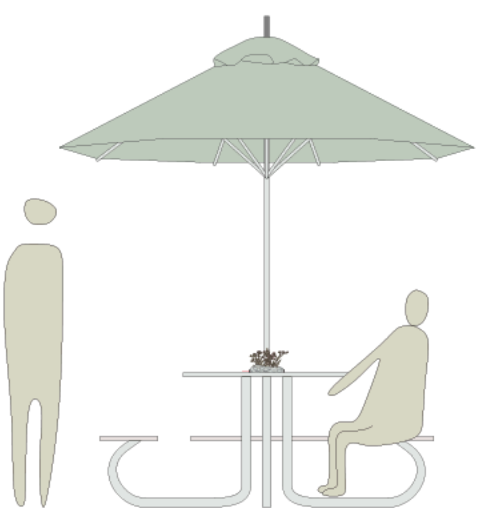
ON THE PLAZA

NEAR PUPIN HALL & ENGINEERING LIBRARY

The way people use their space will be influenced by many factors such as location, weather, time of the day, and illumination and shadow

On our site, the sun exposure is relatively mild most of the time, providing a less intense sunlight experience compared to other areas on campus. Here, we've observed a significant flow and usage of space, especially during weekday lunchtimes when classes conclude. It serves as an ideal spot for those coming from the engineering library to enjoy their lunch or to do some work in the pleasant weather.





WHAT IF PEOPLE NOTICED SENSOR

"IT MUST BE AWKWARD, BUT WE HAVE TO CHANGE THE BATTERY... OH FINE, THEY WALK AWAY, HAHA."

The incident where people suddenly noticed the sensor tracking their behavior in our detecting area shed light on a critical aspect of the balance between observation and intrusion. Initially, the sensor seamlessly blended into the environment, allowing us to gather valuable data on occupancy patterns without disrupting activities. However, when one of our team members needed to change the sensor's battery, individuals immediately became aware of being monitored and swiftly moved away.

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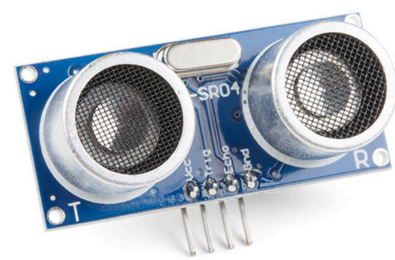
These observations reveal the complex interplay between technology, privacy, and urban life. They underscore the need for urban planners and policymakers to consider not just the functionality of “surveillance” tools but also their impact on individuals' rights and behaviors. Moving forward, it's crucial to foster open dialogue and collaboration between stakeholders to ensure that urban spaces are designed and managed in a way that respects the diverse needs and preferences of their inhabitants.

LOCAL INTERACTION

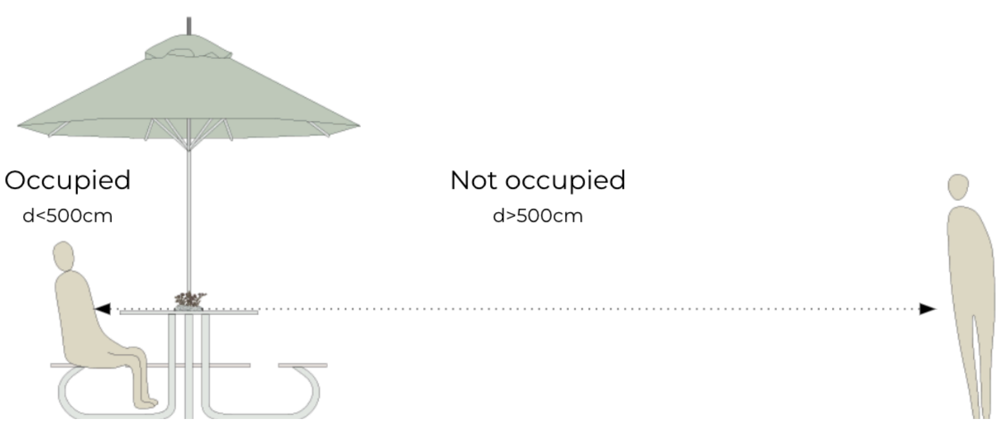


- Operating Voltage: 5V DC
- Operating Current: 15mA
- Measure Angle: 15°
- Ranging Distance: 2cm - 4m

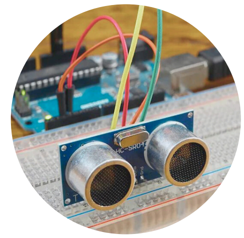
"HOW DOES THE SEAT BEING DEFINED OCCUPIED?"

In this scenario, we define "interactions" as strangers sitting on the seat we are observing. Since the monitoring distance of the ultrasonic sensor is 2cm-4m, we define the seat as "occupied" when the distance measured by the sensor is less than 500cm, and we define the seat as "not occupied" when the distance measured by the sensor is more than 500cm. That is when the sensor monitoring result is occupied, the sensor will have an interaction with the person sitting here, and when the monitoring result is not occupied, the interaction will disappear.

Due to the specificity of the observation (people often sit in a chair for long periods), so-called "interactions" do not occur very often. What is certain is that when a defined "interaction" occurs, it will be visualized in the data results.

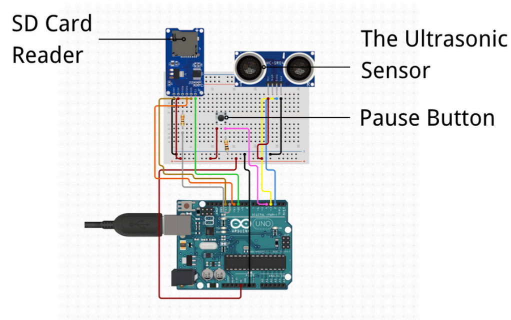


TECHNICAL USE

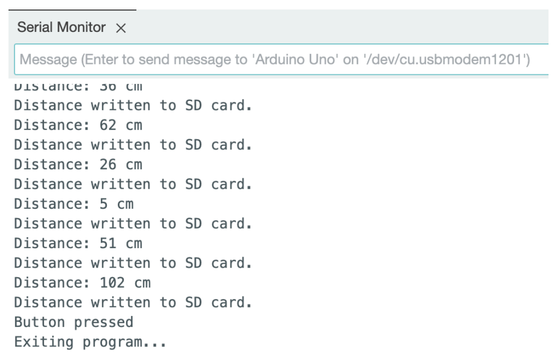


HOW DOES OUR SENSOR WORK?

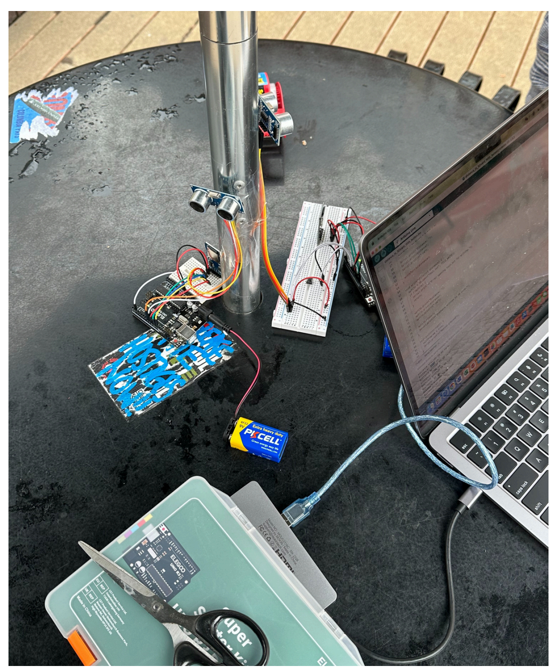
In the sensors part, our goal is to build a sensor that could observe human behavior, and at the same time, we needed to record the data measured by the sensor. With this clear goal of our sensor, we start to build a sketch on "the circuit" website. The ultrasonic sensor became our first choice because it can measure the distance of the object in front of us by ultrasonic method, and tell us whether someone is occupied or not with the change of distance value.



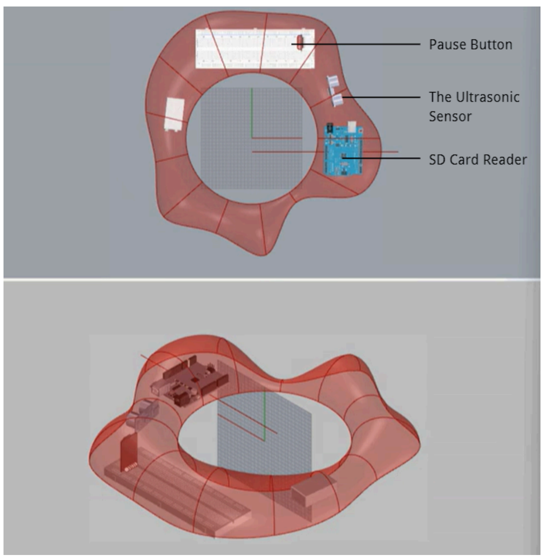
This sensor can be divided into three main parts, the first is an ultrasonic sensor to measure the distance of the object in front of it, and the second part is an SD card reader, which is used to send the data measured by the sensor back to the SD card so that we can use those data to do some analytics work later. The third part is a button which is used to terminate the program. It is also very important to press the button before removing the battery because it can significantly reduce the error or problem that might happen to the SD card.



Considering the special characteristics of the observed object, we set the refresh interval of the recorded data to 5s when programming this sensor, which can greatly reduce the situation of generating too much useless data because of the short time interval. Also, we ended up making two different sizes of sensors in order to match our different designs.



LET FLORA FLOW



The cover's design was carefully crafted with the help of 3D modeling software Rhino+Grasshopper to perfectly match the sensor's shape.

Eventually, we generated two typologies: a donut-shaped variant for tables with umbrellas, and another capable of holding a planter. To maintain aesthetic coherence, we spay painted the 3D printed model with black paint, ensuring the sensors blend seamlessly with the target table's color.

ON SITE TEST

In order to make our experiment work, we did the following things:

Only test on one table

Due to the complexity of the flow on our site, we decided to only place and test on one and the same table through out the test.

Test from Mon to Fri

Since the site is a campus scenario, we decide to only test on weekdays, so that there will actually have enough flow to show some occupation changes.

Manually recorded data

We also did record data including weather, occupation pattern by hand to compensate the limitation due to limited number of sensor.

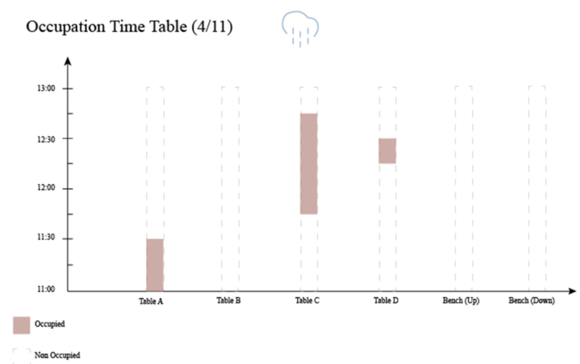
Also Included bad weather

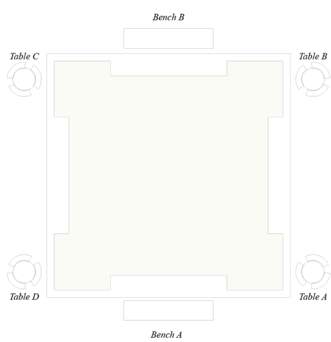
Though we do not expect to see many flow on bad weather, we still try to include the data collected on that day to make the result less biased.

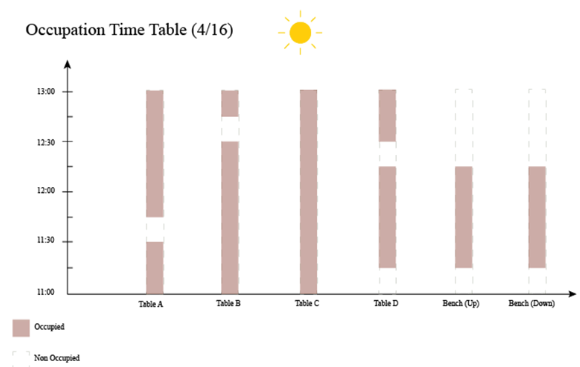
OUR OBSERVATION

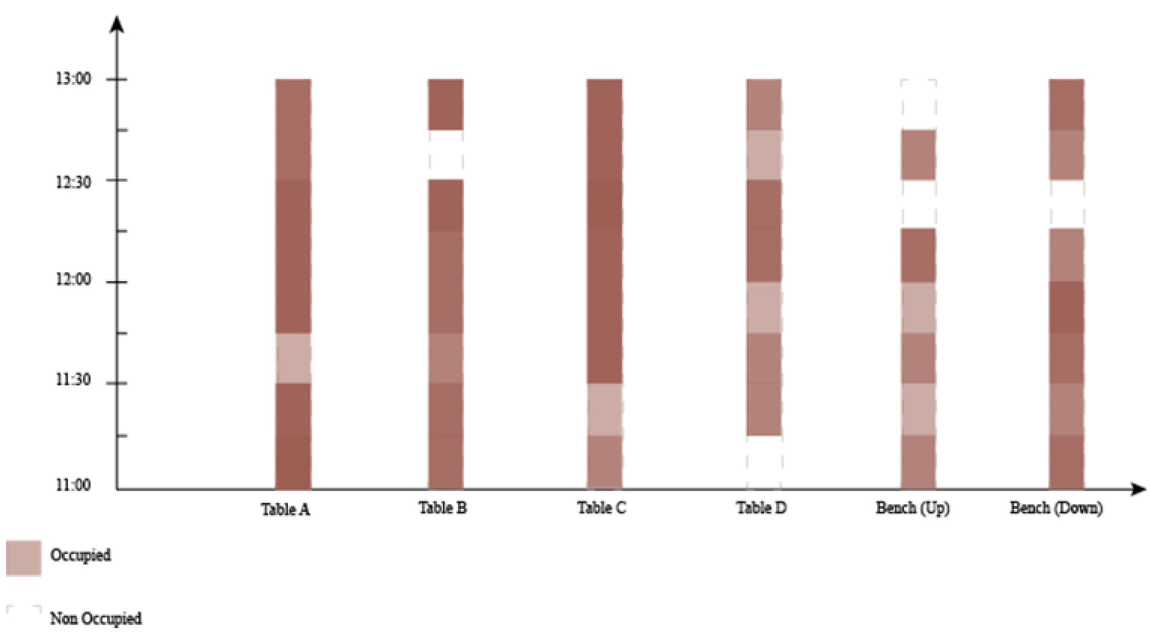
WHAT WE SEE AND DOCUMENTED BY HAND

Our manually collected data indicate that the place is mostly ignored on rainy days, specifically two benches with no umbrellas. According to the overlay, Tables A and C are the most popular seats, possibly because both are close to the building's entrance.

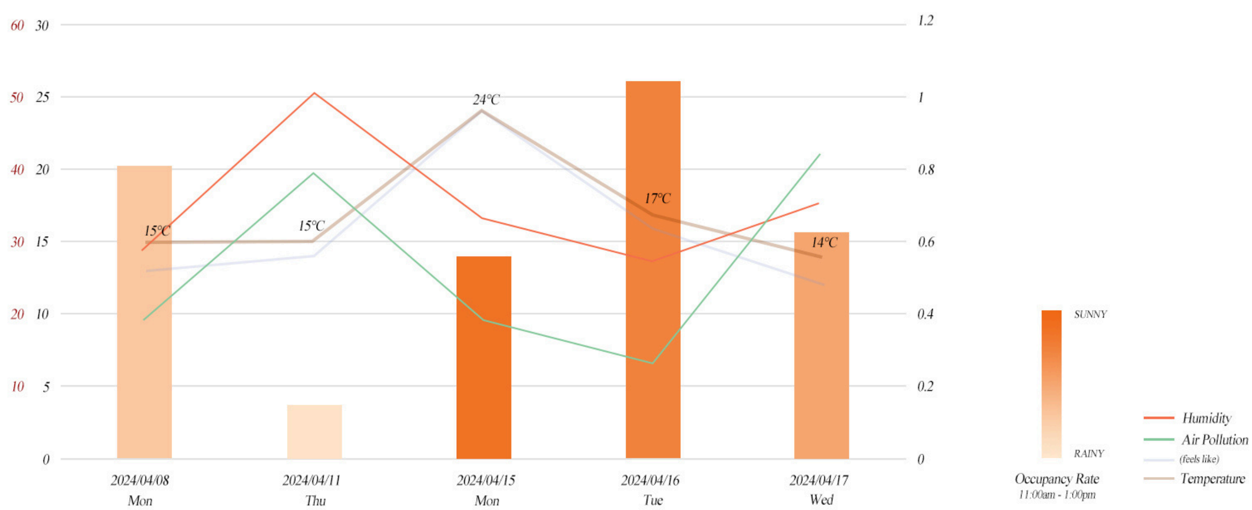








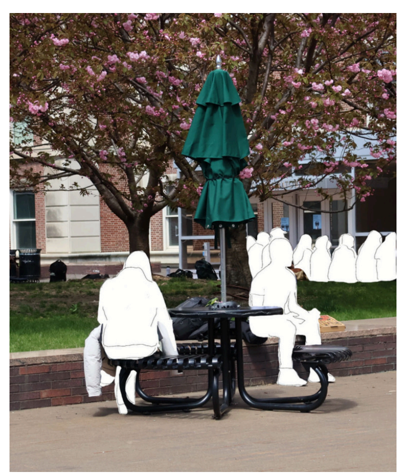
DATA VISUALIZATION



Data Source: Graphs combining field observations and sensor data from 11:00 am-13:00pm on five weekdays.

Diagram Description: The height of the bar indicates the average attendance of the four seats at different times of the day on five days. The color of the bar indicates the weather condition, the darker the color, the sunnier the weather. The temperature (℃), air pollution level, and humidity are expressed through the different colors of the dash lines.

Conclusion: Air quality and air humidity are directly proportional to occupancy, and too high or too low temperature affects occupancy.



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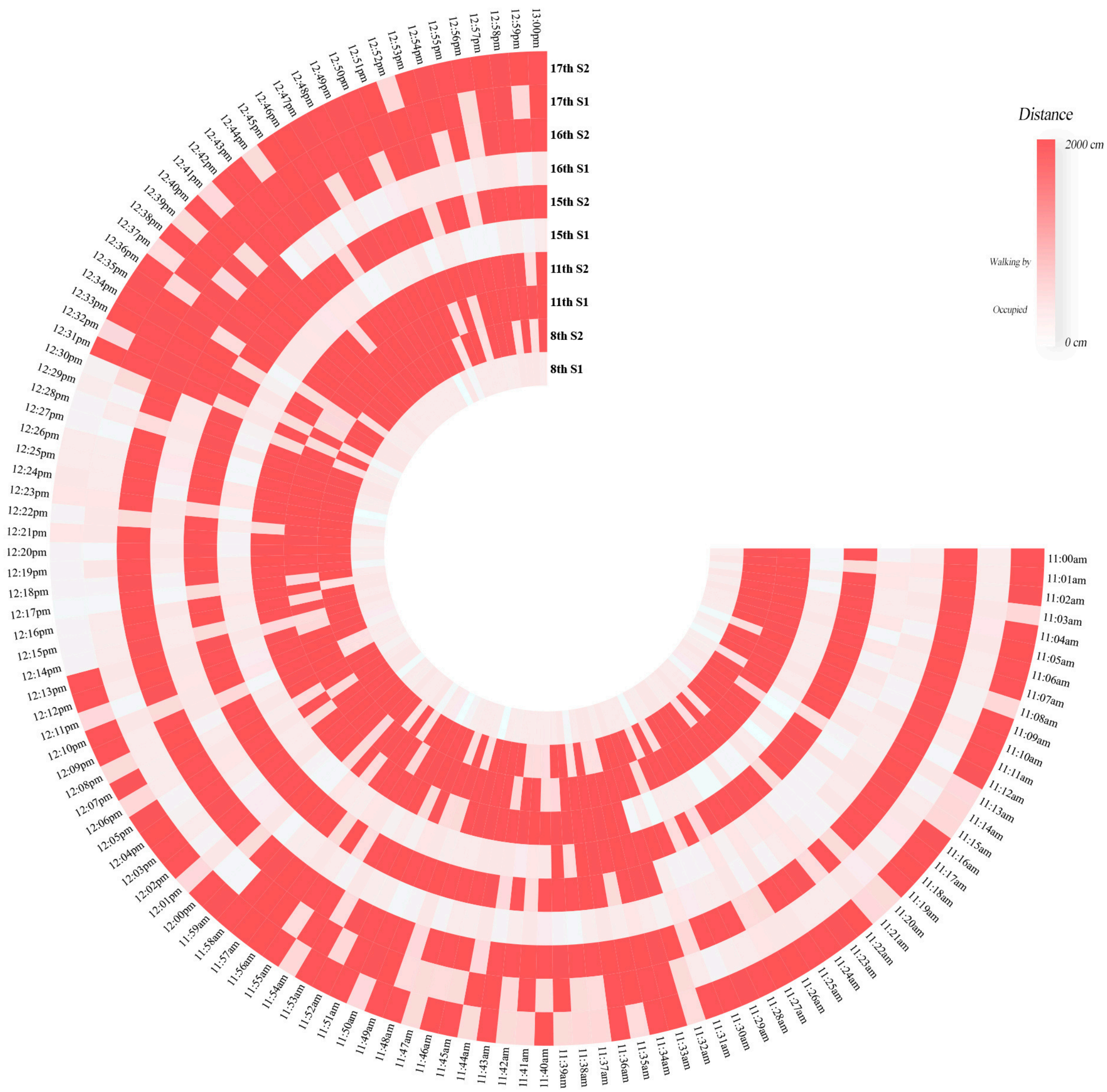
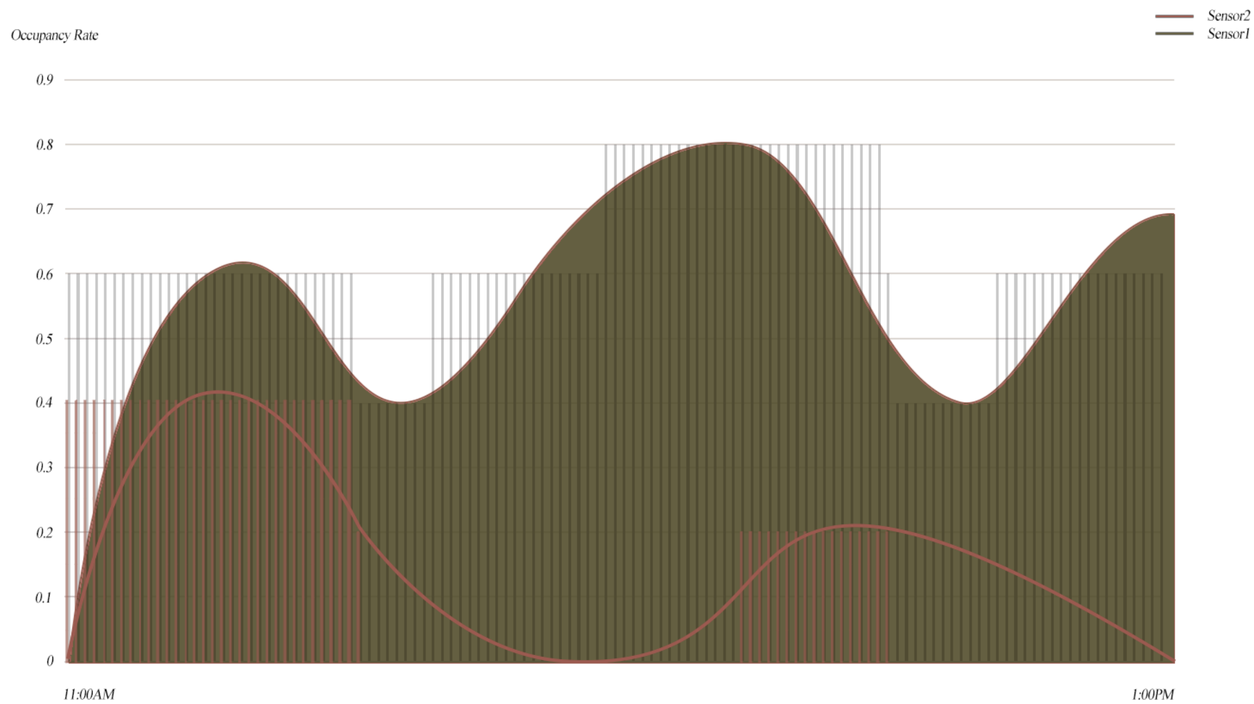


Based on distances collected by sensors.
Red means the seat is unoccupied (sensor distance >500), white means the seat is occupied (sensor distance <100), and pink means someone has passed by the sensor.

DATA VISUALIZATION



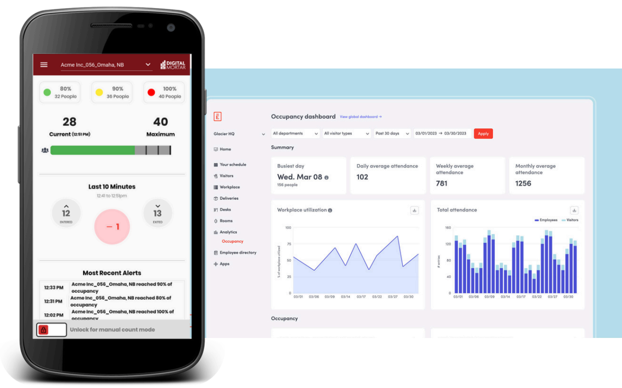
Data: Based on the data obtained from the sensors, distance >500 was defined as 0, and values less than 100 were defined as 1.

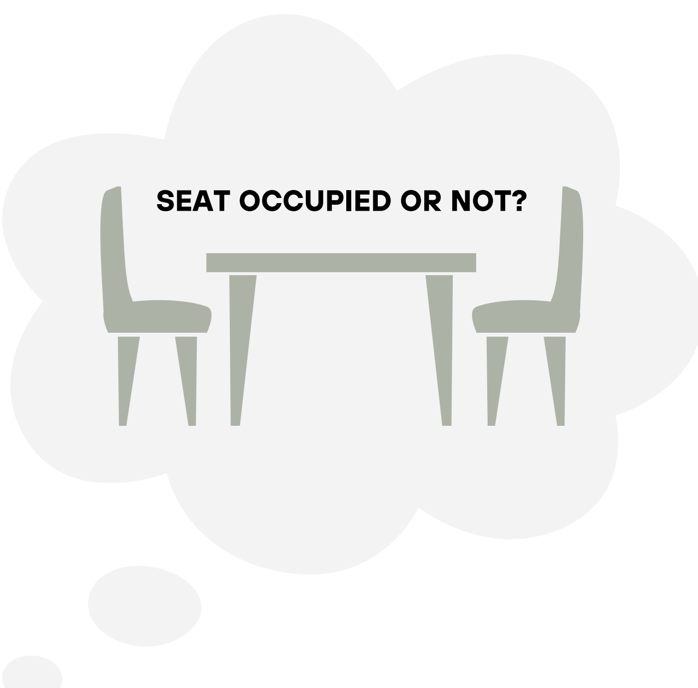
Diagram Description: The occupancy rate was calculated every three minutes and plotted as a bar graph. The histogram was fitted with a curve and plotted.
The dark green color represents sensor1, and the red-orange color represents sensor2.

Conclusion: It can be seen that the position of sensor1 is more popular and the occupation rate is higher.

Time	8-Apr		11-Apr		15-Apr		16-Apr		17-Apr	
	distance1	distance2	distance1	distance2	distance1	distance2	distance1	distance2	distance1	distance2
11:00am	55	1176	1186	21	1179	30	53	1180	46	1179
11:01am	61	1176	1186	25	156	66	68	1186	57	1180
11:02am	39	1188	1189	48	1180	66	47	1187	46	1176
11:03am	62	1180	1180	23	1176	52	63	1177	63	161
11:04am	45	1179	1176	51	1183	57	54	1183	65	1186
11:05am	58	1190	1189	51	1185	67	28	1181	58	1189
11:06am	56	1174	1181	60	1184	24	61	1189	52	1186
11:07am	57	1175	1179	47	1182	67	46	1187	54	1180
11:08am	49	1189	1176	54	1188	34	51	1185	36	160
11:09am	18	140	1190	48	1189	64	34	1184	38	1184
11:10am	48	1180	1181	53	1179	53	34	1176	67	1179
11:11am	35	1181	1176	60	1190	32	64	1186	47	1179
11:12am	12	1187	1179	54	1189	51	53	1179	21	1177
11:13am	45	127	1181	59	1184	62	49	1182	59	159
11:14am	49	1178	1181	20	145	31	49	1190	31	162
11:15am	61	1188	159	9	1182	23	61	1178	51	160
11:16am	54	1183	1183	62	1176	60	58	1184	63	1178
11:17am	50	1176	1185	48	1176	31	56	1186	65	1186
11:18am	23	1188	1183	10	1178	33	62	1180	37	1190
11:19am	56	1178	1182	55	1189	33	28	1183	58	1180
11:20am	53	112	1187	61	157	31	29	153	50	152
11:21am	59	1177	1185	24	1184	32	47	1186	61	158
11:22am	57	128	1186	22	1182	66	66	151	48	1189
11:23am	49	1184	1176	59	1176	67	52	1177	51	1177
11:24am	63	1177	1182	14	1182	48	28	1180	51	1183

FUTURE ENVISIONS





Imagine a city where the pervasive deployment of advanced sensor technology transforms the urban landscape, seamlessly blending into the fabric of everyday life while offering unparalleled insights into human behavior and space utilization. The enhancements we envision include better camouflage for sensors, enabling them to discreetly gather data without disrupting the natural flow of urban activity. With an array of sensors measuring not only occupancy but also environmental factors like temperature, humidity, and illumination... this expanded monitoring network could provide a comprehensive understanding of urban dynamics.

The vision also lies in the concept of occupation-detecting furniture, such as tables equipped with ultrasonic sensors discreetly positioned underneath. This innovation enables us to pinpoint precisely when and where spaces are occupied, empowering urban planners to optimize resource allocation and design more responsive environments. Beyond merely understanding how spaces are used, this technology will offer the potential to address broader questions about urban infrastructure, such as ensuring adequate provision of public furniture across urban spaces such as campus, plazas, parks, and so on.

The implications of this future are vast, offering both opportunities and challenges. On one hand,

FUTURE ENVISIONS

SECURITY & PRIVACY

the ability to accurately track occupancy and usage patterns provides more efficient resource management and enhanced user experiences. For example, similar sensor systems could be employed in libraries, classrooms, and restaurants to inform individuals about space availability in real-time, facilitating smoother navigation and utilization of shared spaces.

However, this future also raises concerns about privacy, data security, and the potential for over-surveillance. Striking the right balance between gathering actionable insights and respecting individuals' rights to privacy will be crucial. Moreover, deploying such widespread sensor networks requires careful planning and investment in infrastructure, as well as considerations for maintenance and data management.

Ultimately, the envisioned future of urban interactions represents a paradigm shift in how we understand and design cities. By harnessing the power of advanced sensor technology, we can create more responsive, inclusive, and sustainable urban environments that adapt to the needs and behaviors of their inhabitants. Through ongoing collaboration and dialogue, we can navigate the complexities of this future, ensuring that technology serves as a tool for positive urban transformation.