

Monitoring Factors Potentially Influencing the Built Environment Microbiome Via Data-logging Sensors



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Abstract

Bifidobacteria are a major component of gut microbiome of breast-fed infants. Colonization of the infant gastrointestinal tract by bifidobacteria is associated with several positive health outcomes. However, it is unknown how infants acquire bifidobacteria. Two possible hypotheses argue transmission from the mother, or alternatively, other infants. Live bifidobacteria found in built environments associated with mothers or infants may be a discriminating signature of potential transmission. In this study, designated lactation rooms were used to disentangle these two possible sources, as breast-feeding mothers are present in these rooms without their infants. These rooms were tested for bifidobacteria and positive results were attributed to the mothers. In order to account for the possible influence of temperature, relative humidity, and room usage on bifidobacteria deposition and survival, custom sensors were designed and installed in each room to monitor these factors and custom analysis software was written to interpret the data. Preliminary results indicate a negative relationship between temperature and room usage, and a comparison of room usage tracking via in-room sign-in sheets confirmed the accuracy of our infrared beam-break approach to tracking room usage. Continued usage of these tools will help clarify the mechanism by which bifidobacteria are transferred to newborn infants.

Materials & Methods

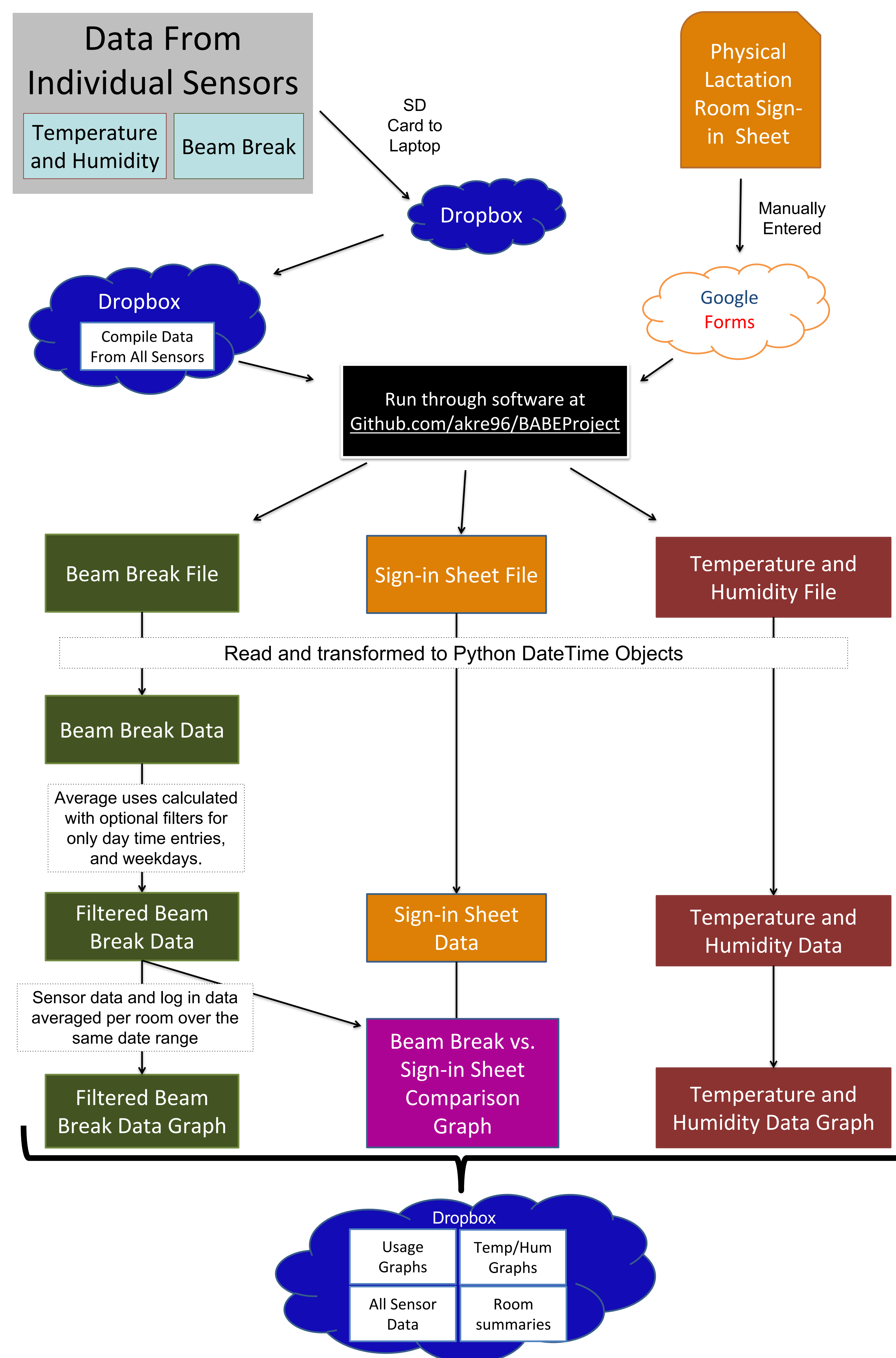


Figure 1: Sensor Design Schematic

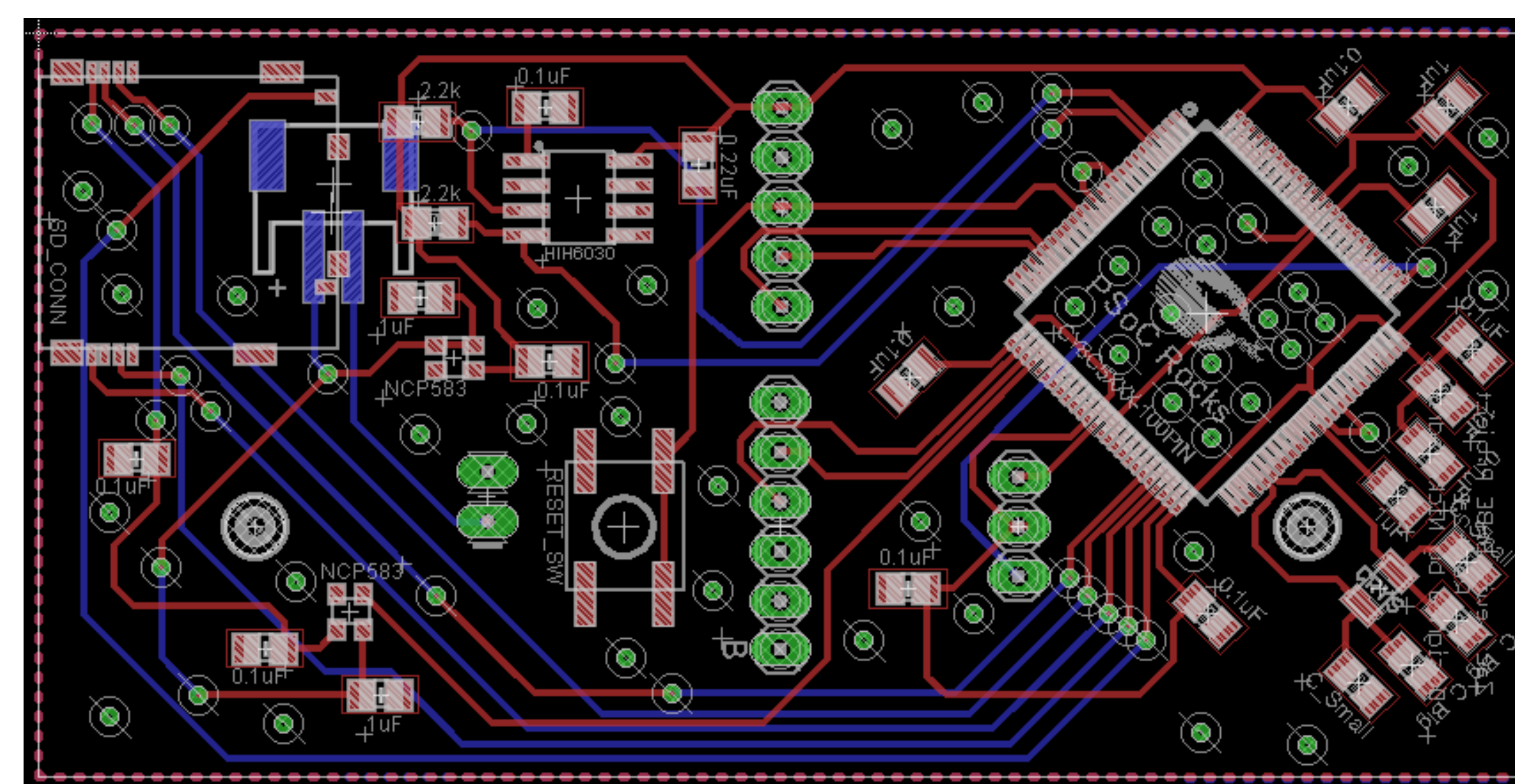


Figure 1: Diagram of sensor unit using Cypress Programmable System on Chip 5 (PSoC5) microcontroller to retrieve measurements from Honeywell HIH6130 temperature/relative humidity sensor and Parallax PIR Mini proximity sensor and store formatted data on 8GB microSD card, powered by 2500mAh battery.

Figure 2: Example Individual Room Temperatures, Humidity, and Usage

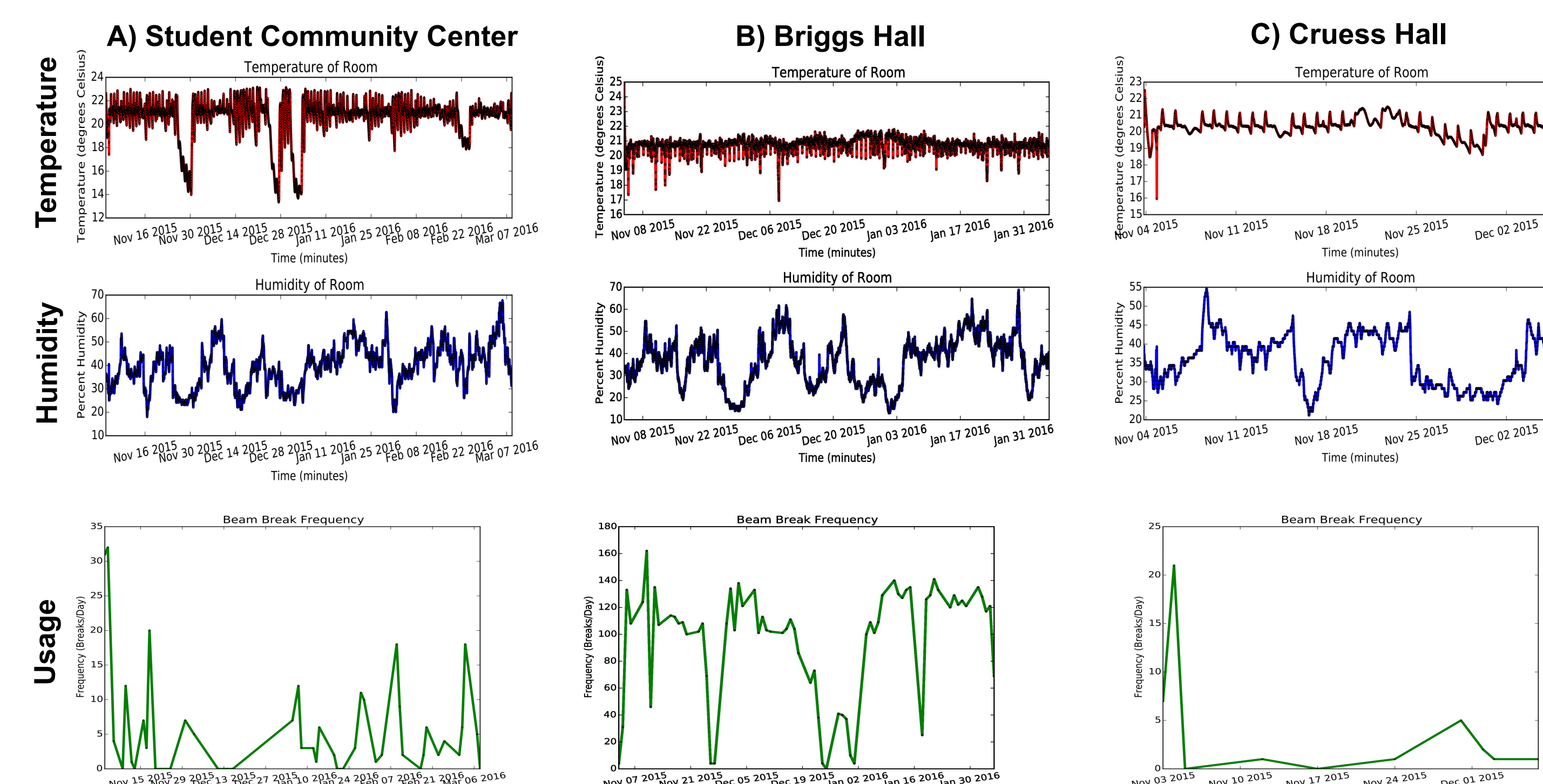


Figure 2: Example graphs showing the usage, temperature and humidity of three rooms over an extended period of time. Graphs show diurnal fluctuations in all three parameters. The set A) of graphs demonstrate the sensors ability to track fluctuations in temperature. B) Graphs illustrating consistency throughout extended periods of time of continued usage. C) Shorter date range graphs showing more clearly how the sensors pick up on the individual rises and falls of temperature and humidity over a day.

Results

Figure 3: Average Temperature, Humidity, Usage Across All Rooms

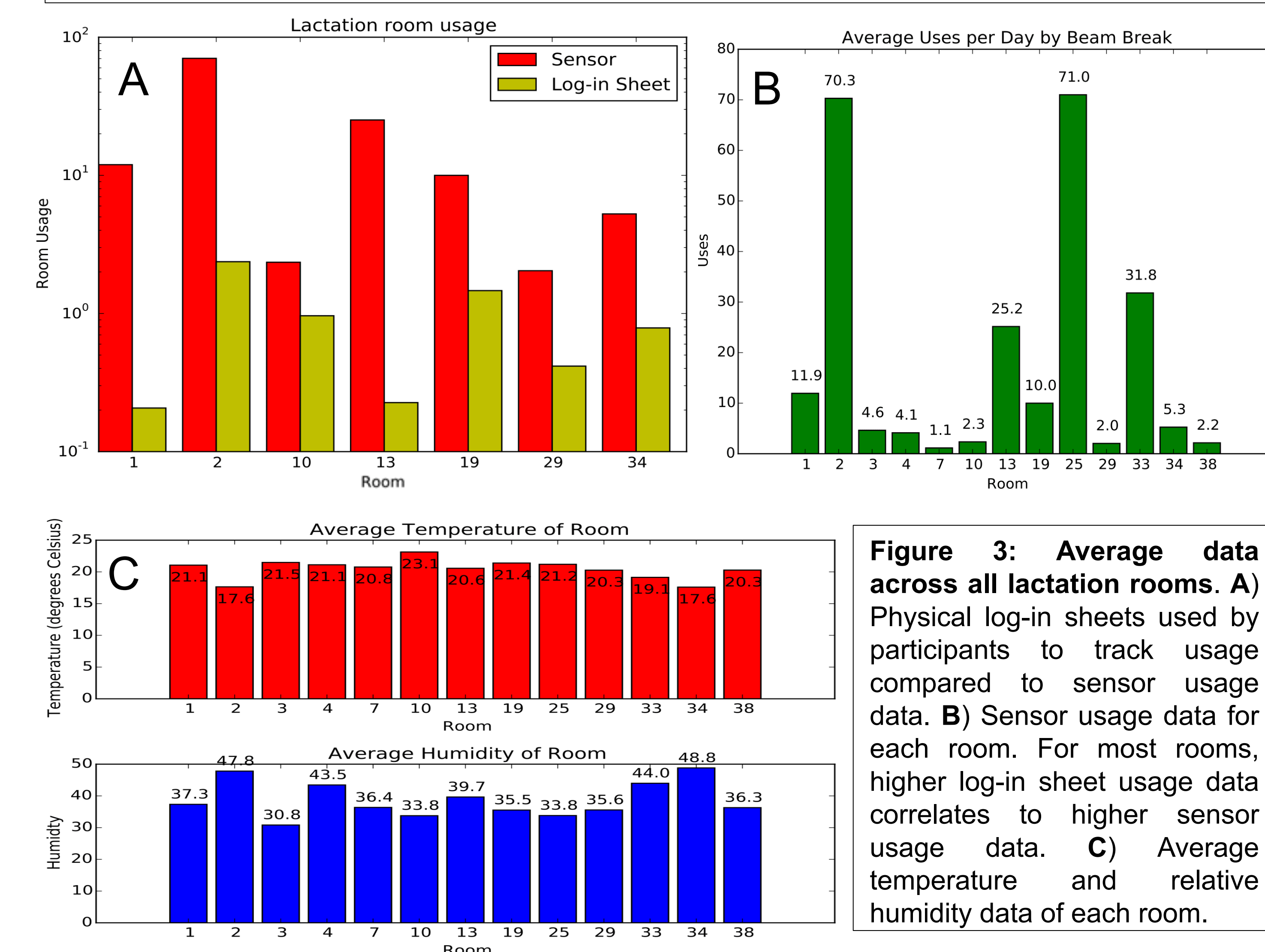


Figure 3: Average data across all lactation rooms. A) Physical log-in sheets used by participants to track usage compared to sensor usage data. B) Sensor usage data for each room. For most rooms, higher log-in sheet usage data correlates to higher sensor usage data. C) Average temperature and relative humidity data of each room.

Conclusions

- The sensors successfully detect fluctuations in temperature and humidity
 - temperature and usage rise during the day and fall at night
 - temperature often falls during gaps in usage, which may represent a university policy of turning off building heat when school is not in session
- Sensor usage measurements are supported by sign-in sheet data
 - though the physical lactation room sign-in sheets are filled out on a voluntary basis, they can be taken as a relatively accurate measurement of lactation site usage
 - rooms with anomalous measurements had non-lactation site-related purposes, leading to increased usage measurements without an increase in lactation usage
- The sensors generate usable metadata to correlate to microbiome data
 - future work will involve correlating each room's environmental conditions with the presence of live bifidobacteria
 - some conditions (high temp, low humidity) may be deleterious for survival of some bacteria
 - it is possible that some built environments may not transmit Bifidobacteria as easily as others

Acknowledgements

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