

From: Jay Frothingham
To: Professor Aaron Rubin
Date: November 11th, 2022
Subject: Proposed Ground Penetrating Radar Survey of the Smith College Physics Department

Introduction

Students in the course EGR 390, a seminar on remote sensing, have been exposed to the basic operating principles and some use cases of remote sensing technologies such as lidar, sonar, radar, and ground penetrating radar. Students have also read and discussed complex published journal articles detailing more advanced remote sensing applications and techniques. With this background, students are prepared to design and carry out their own survey or experiment that can be carried out with the Smith College Engineering Department ground penetrating radar equipment. The purpose of this memo is to propose one such project.

Project Scope

This project includes a ground penetrating radar survey of 3 rooms used by the Smith College Physics Department in McConnell Hall. Rooms included in the survey will consist of a current research lab, a current teaching lab or classroom, and a current faculty member office. All rooms used in the survey will be located on the same floor of McConnell Hall. To expand the scope of the project, a ground penetrating radar survey will also be conducted in Ford Hall. Rooms included in the Ford Hall survey will also consist of a research lab, a classroom space, and an office space. Again, the surveyed rooms will all be on the same floor of Ford Hall.

Preparation work for the project includes interviews with long-standing members of the physics department on the history of space usage in McConnell Hall, comparison of current and original building floor plans to select survey candidates, and coordination with physics professors to obtain permission to survey the spaces in which they work.

The project scope is limited in that it will initially include only one floor each of two buildings. The survey of McConnell Hall will be prioritized over the survey of Ford Hall. If time permits, additional surveys may be conducted of basement spaces in McConnell Hall and Ford Hall.

Project Description

Scientific research labs can have a significant effect on the physical spaces they occupy. That can include cosmetic changes, such as wiring/ventilation renovations or furniture rearrangement.

However, it can also include significant structural changes. Heavy equipment often requires a minimum thickness of concrete for support, and sometimes equipment must be partially buried or routed in the floor of a lab. The structural construction of a space can provide information about its current or past usage.

This project will engage with that idea in two to three stages. In the first stage, the project will investigate whether there are in fact structural differences between different types of spaces in McConnell Hall. In the second stage, the project will investigate whether there are structural differences between different types of spaces in the more modern Ford Hall. Finally, if time allows, the project will investigate whether there are structural differences between basement spaces and upper-floor spaces in both McConnell Hall and Ford Hall. The project will be completed through qualitative interviews with long-time faculty and ground penetrating radar measurements with a 900MHz antenna for finer resolution.

After completion of the first stage, the project will have addressed the question of whether the history of a room's function can be determined through structural changes detected by ground penetrating radar. It is predicted that there will not be noticeable changes between research spaces, teaching spaces, or faculty offices on the second and third floors of McConnell Hall. This prediction is based on interviews conducted with physics department faculty, who recalled significant changes to spaces (including bringing in multi-ton lab equipment via crane through the building's exterior windows) without the need for any renovations or structural concerns.

McConnell Hall opened in 1967, while Ford Hall opened in 2010. After completion of the second stage, the project will have addressed the question of whether the findings of the first stage apply to more modern buildings as well. It is predicted that in Ford Hall, there will be noticeable differences between research spaces, teaching spaces, and faculty offices on upper floors. In modern building planning, the intended purpose of each room is more intentionally considered in the design of the building.

After completion of the third stage, the project will have addressed the question of whether basement spaces are structurally different from upper floor spaces in both older and modern buildings.

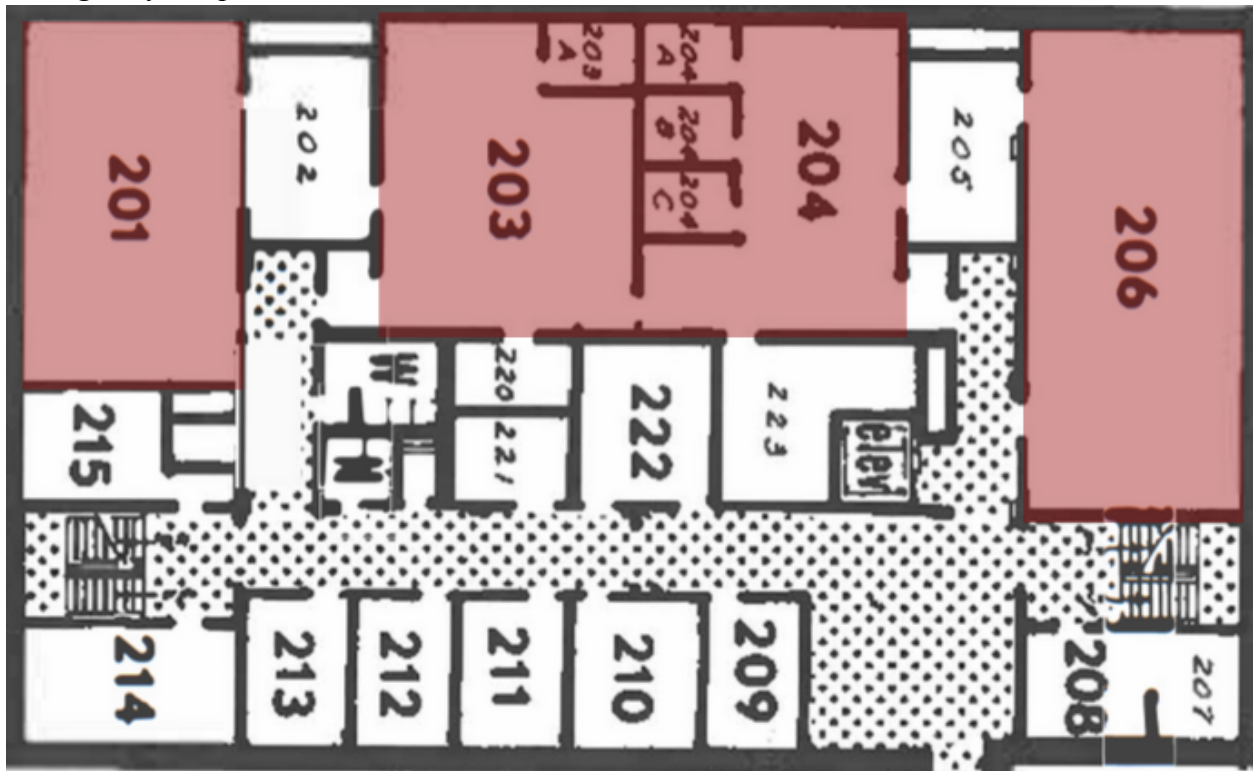
Anticipated challenges include navigating current room setups. It is likely that there will be furniture and heavy equipment limiting the areas available for surveying, and that there may be structural features in areas that can't be surveyed. To mitigate these challenges, rooms will be selected that do contain open floor space, and scans will be conducted along the edges of any obstructions as well as in the center of the available space.

Proposed Field Work

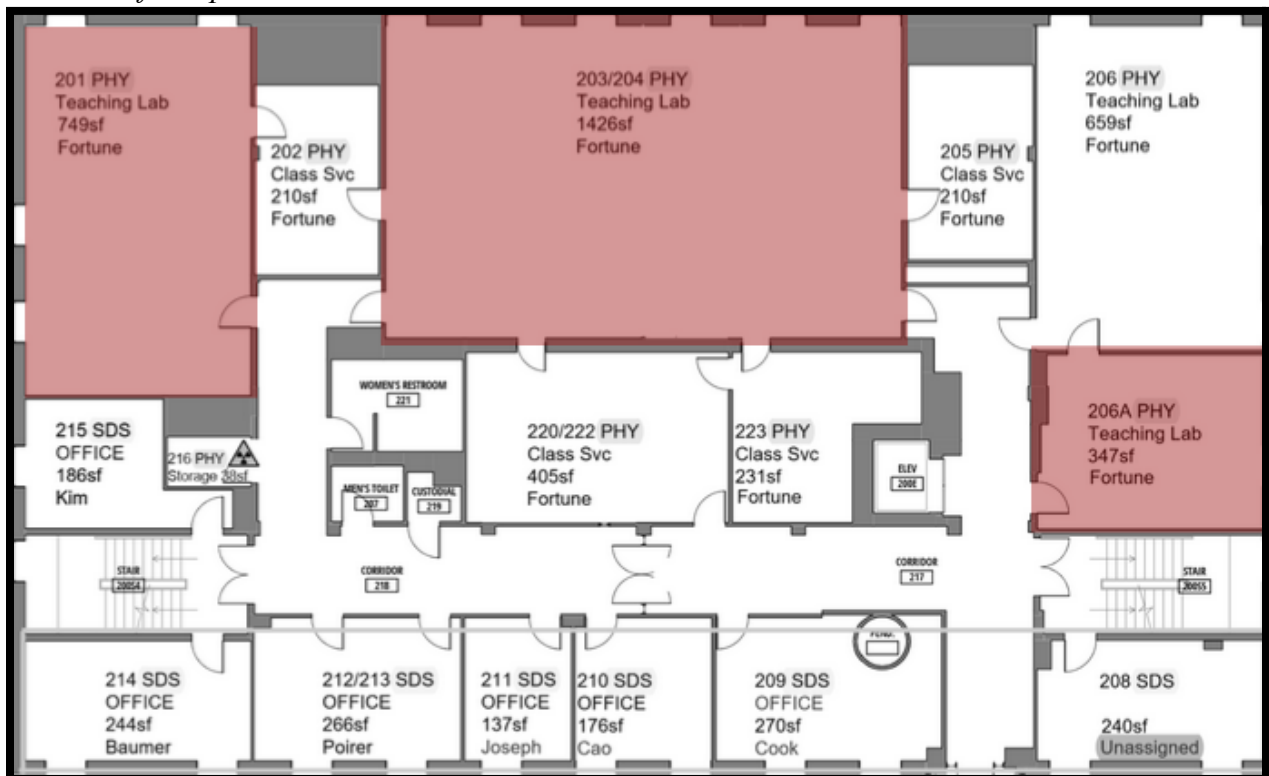
Ground penetrating radar scans will be conducted in McConnell Hall rooms 206, 203/204, and 201. Room 206 is a research lab containing heavy equipment, room 203/204 is a classroom, and room 201 is a teaching lab containing light equipment.

Figure 1. Floor plans of the second floor of McConnell Hall. Planned GPR survey sites marked in red.

a. Original floor plan, 1967.



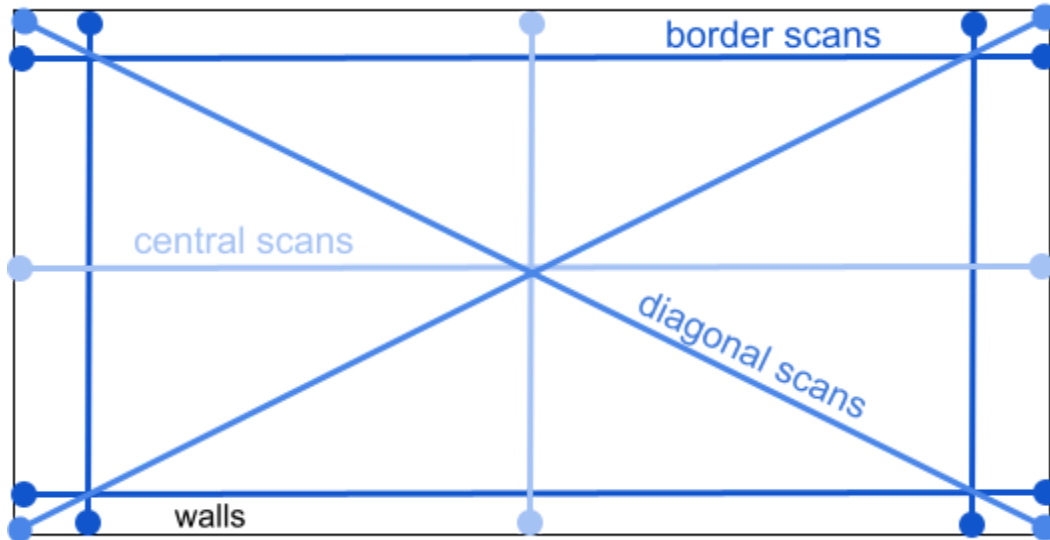
b. Current floor plan, 2022.



The proposed survey involves large spaces and many rooms. Those two factors alone will increase the amount of time it will take to complete the survey. For this reason, the ground penetrating radar survey will be carried out with free-running scans rather than incremental spans. Free-running scans will take less time to set up and complete than incremental scans.

In each room, data will be collected in a total of eight scans. Four scans will run as close as possible along the edges of the room. Two scans will bisect the room in the horizontal and vertical directions. Two scans will diagonally connect the corners of the room.

Figure 2. Proposed scanning pattern for each room.



This scanning pattern should capture features present at the edges of the surveyed rooms as well as in the centers of the rooms. The different scanning angles will offer several perspectives on detected features and provide more information that can be used to identify any detected features. The corner and central points of the room will be well-characterized, while some of the open space in the rooms will not be scanned.

In the field, it will be important to record how the actual scanning patterns used may differ from the planned pattern. The approximate location of each scan should be noted, as well as the distance spanned by each scan and the approximate time taken to complete each scan. The equipment and setup of each room should be recorded with photographs.

The scale of the project will increase depending on which stage(s) of the project are completed. At the very least, it will take 1-2 surveying sessions of an hour or two each to scan the three selected rooms in McConnell Hall. If additional rooms in Ford Hall are surveyed, the project will require additional time in the field—likely another 1-2 surveying sessions of the same duration.

Data will be inspected in situ, with multiple trials if time allows. In the proposed scanning pattern, each scan intersects at multiple points with other scans, allowing for data validation and some protection against single bad scans.

Conclusion

The purpose of this memo was to detail a proposed final project for the course EGR 390, a seminar on remote sensing. The proposed project makes use of the Picker Engineering Program's ground penetrating radar equipment and is a compelling application of concepts covered in the course. Completion of the project will provide insight into the physics department's usage of space in McConnell Hall. This memo includes motivation and background for the proposed project as well as a plan for field work and technical requirements to complete the project.