GNSS in the Classroom: Taking the Paralysis out of Analysis - Abstract

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Teaching any subject can be difficult, but teaching GNSS offers a set of unique challenges. GNSS represents one of the most complex and interdisciplinary undertakings ever achieved by mankind. The modernization of these systems today continues to push the boundaries of orbital mechanics, material science, modern physics, rocket science, and a host of other fields. But for being such a complex system, GNSS has turned into one of the most recognized and widely used utilities throughout the world. Everyone has become a capable ”Navigator” with their cell phone at their fingertips. So how does one boil all of this information down in to a 10 week graduate engineering course? Furthermore, how does one go beyond giving students a theoretical background to give them the vocational tools necessary to innovate and carry the field of navigation forward?

At Stanford, the GPS course has always thrived to achieve proficiency in these two domains. The class has served as the inspiration to many to join the navigation profession and who continue today to lead in the GNSS field. With the emergence of the GNSS Analysis Tools from Google [1], many new opportunities have arisen that allow students to explore the world of GNSS by

following their passions and their own creativity. The GNSS Analysis Tools available on Android [2], allows anyone with an Android phone to record raw GNSS measurements. By raw GNSS measurements, we're not simply referring to pseudoranges. After all, a pseudorange is a derived measurement. True raw measurements comprise the time stamps associated with satellite signal reception and transmission, AGC, C/N_0, and other values used to create a PVT solution. With these measurements available to the masses, everyone can tinker and toy with real GNSS data and learn-by-doing. The Stanford GPS course has wholeheartedly embraced these new tools.

Over the years, the GPS course has been shaped in a way to engage students who come from different backgrounds and help them explore the intersection between their passions and GNSS. The course is ten weeks long with each week covering a different part of the system. (show figure of the course here). The class is now structured as a project based class where while the students are learning about the different subsystems that constitute GNSS, they are developing projects that push their understanding of GNSS to another level. These projects can take inspiration from their current work and interests or they can be derived from any aspect of GNSS that piques their interest. One of the most unique advantages afforded to those who are just beginning to learn the subject is a sort of innocent naievity. This frees many students from imposing limits on their creativity of what they want to accomplish with a GNSS project and leads to innovative ideas that feel only accessible to those who haven't been immersed in the world of navigation for years. This paper showcases some of the projects that these students were able to accomplish in a mere matter of weeks. Below are some example ideas and results carried out by the students.

Showcase several projects here

The ultimate goal of this paper is to serve as an inspiration to those teaching GNSS. Whether instructing undergraduates, graduates, or professionals, this paper outlines a hands on strategy useful to anyone wanting to learn more about GNSS.

REFERENCES

[1] Van Diggelen, Frank, and Mohammed Khider. "GNSS analysis tools from Google." Inside GNSS 13 (2018): 51.

[2] https://github.com/google/gps-measurement-tools/releases/tag/2.0.0.1