Project on Inertial Navigation System (INS)
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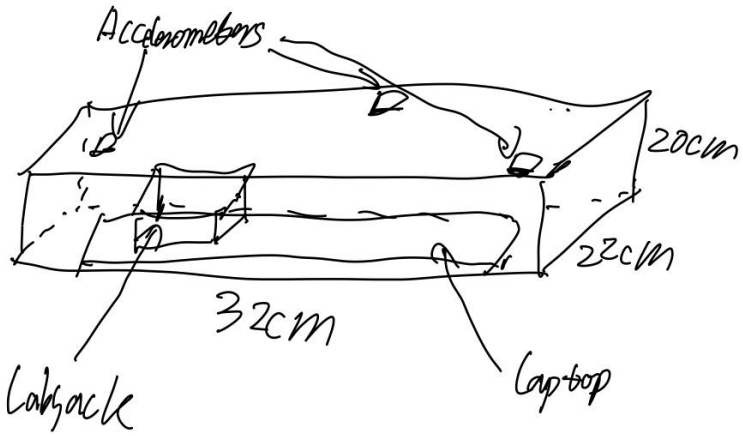
Background
The Inertial Navigation System (INS) has bothered humanity for decades. The history of INS can be traced back to 1940's (Wrigley, 1977, 1-6). With the development of integrated circuits, people nowadays can even build home-made INS (Hrisko, 2020). Based on their work and our experience of using accelerometers and LabJack in PHY CS 15B lab, our group plans to build an INS. Starting with one-dimensional trace tracking, our ultimate goal is to regenerate trajectories of roller coasters from acceleration data.

Reliability
It is physically achievable to calculate one's trajectory in 3D space with data from inertial measurement units (accelerometer and gyroscopes). Although double integration may magnify the drift errors, deviation from the actual path can be controlled with careful calibration and proper algorithms (*Wikipedia*). For our five-week project, we plan to first build a 1D INS prototype, which has been done by many others before (Hrisko, 2020). Then, if possible, we will try to expand our project to either higher precision, larger scales or multiple dimensions.

Technical Specifications
The INS we will build includes an accelerometer, a labjack and a personal computer. We will use the accelerometer and lab jack to collect acceleration data, and import them to the personal computer to analyze the data.The programming language used in this project will be python. The trajectory will be displayed using matplotlib.



Milestones
The possible timeline for our project is discussed to be the following: Starting in week three, we place orders for parts and review other people's work on the INS. Once we have access to the sensors (majorly accelerometers), we will start testing the connection between sensors and the main controller (laptop for example). This is aimed to be finished by week four, so that we can carry out one-dimensional imu experiments

in week five. Then, for week six and week seven, we will try to package all the parts into a portable box, and possibly expand our experiment to higher precision or higher dimensions.

Important date	Milestones
Week 3	Place order & literature review
Week 4	Test sensors (connection & calibration)
Week 5	1-d lab experiments
Week 6~7	Experiments & make the box
Week 8~9	Presentation

Budget

Estimated total budget (w/o tax) is about $559.84 to $634.84. Details are listed below.

Parts	Venders (price)	Quantity	Budget (no tax)
Accelerometer (LSM9DS1 - 9 DoF IMU)	Adafruit ($39.95)	3	$119.85
Alternative accelerometer 1 (FXOS8700 + FXAS21002 - 6+3 DoF IMU)	Adafruit ($14.95)	3	$44.85*
Alternative accelerometer 2 (ISM330DHCX - 6 DoF IMU)	Adafruit ($19.95)	3	$59.85*
11’’ Laptop w/ Windows 10	Amazon ($169.99)	1	$169.99
Six Flags one-day pass (outdoor experiment)	SixFlags ($65)	3	$195
Transportation expenses (outdoor experiment)	–	–	$150

References

Hrisko, J. (2020, December 29). *Calibration of an Inertial Measurement Unit (IMU) with Raspberry Pi - Part I — Maker Portal*. Maker Portal. Retrieved April 8, 2022, from https://makersportal.com/blog/calibration-of-an-inertial-measurement-unit-with-raspberry-pi

Inertial measurement unit. (n.d.). Wikipedia. Retrieved April 8, 2022, from https://en.wikipedia.org/wiki/Inertial_measurement_unit

Wrigley, W. (1977). HISTORY OF INERTIAL NAVIGATION. *NAVIGATION*, *24*(1), 1-6. https://www.ion.org/publications/abstract.cfm?articleID=100716