EE 448 Lab Tachometer

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Client / Advisor: Matt Post

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Executive Summary

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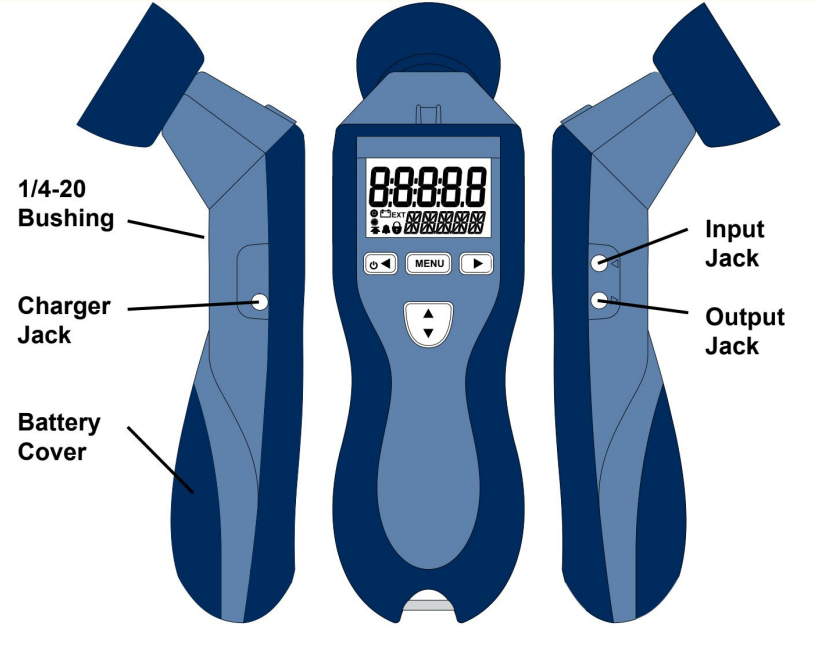
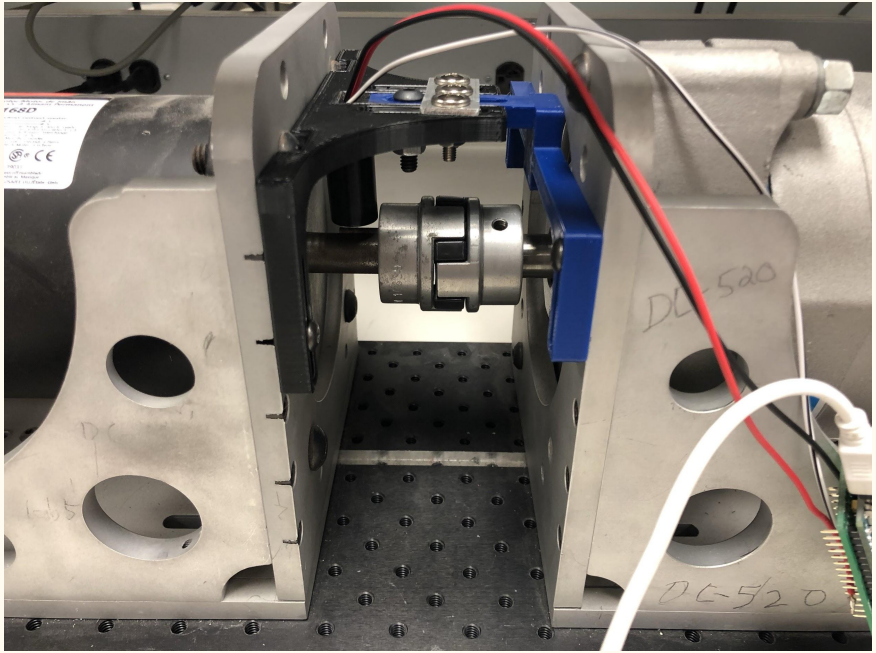
The Problem





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Project Plan

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Requirements

Functional	Non-Functional
• Perform all lab functions • 99% accuracy • Range from 100 to 2000 RPM	• More cost-effective • User friendly • Documented sufficiently • Resistant to breaking

Use Cases

Student	ETG Worker
• Change the COM port • Check the motor RPM • Use the ‘help’ button	• Mount the tachometer • Test the mount stability • Load the software

System Design & Development

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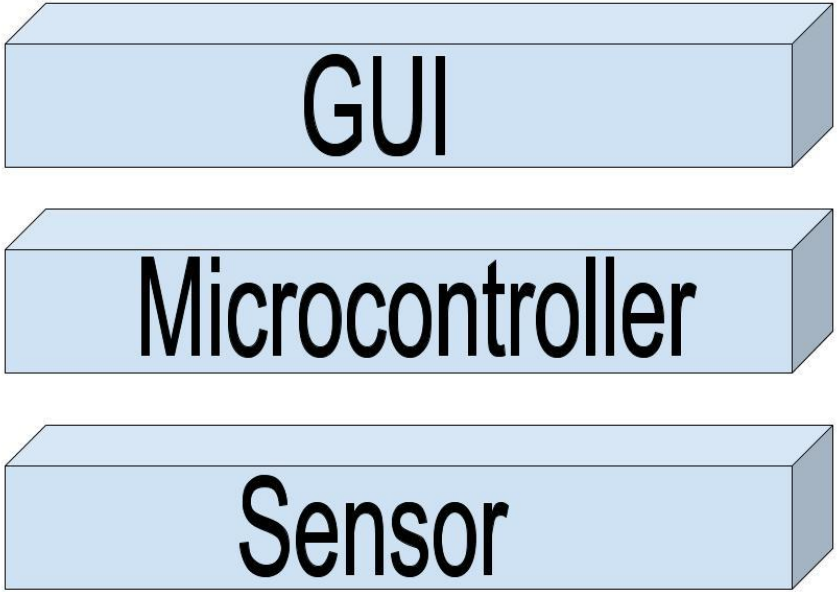
Design Plan / Objectives



- Satisfy all requirements
- Approval from all user groups
- Field testing

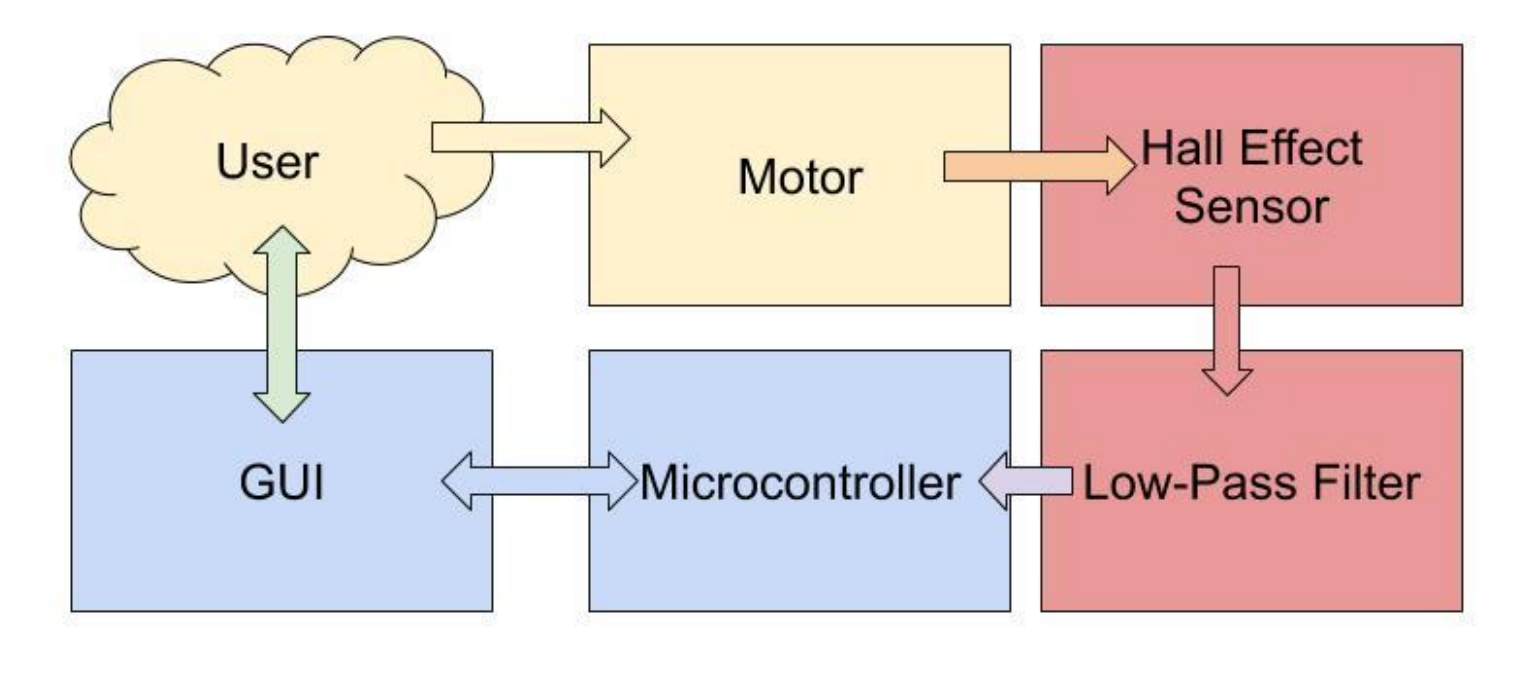
System Constraints

Assumptions	Limitations
• Used by two students • Used in the EE 448 lab • Lab/lab setup will not be drastically changed • Students will refrain from touching • The lab computers run on Windows	• The RPM should only go from 100 to 2000 RPM • The size of the tool should be no larger than the motor it is evaluating • The cost to produce the end product should not exceed $500

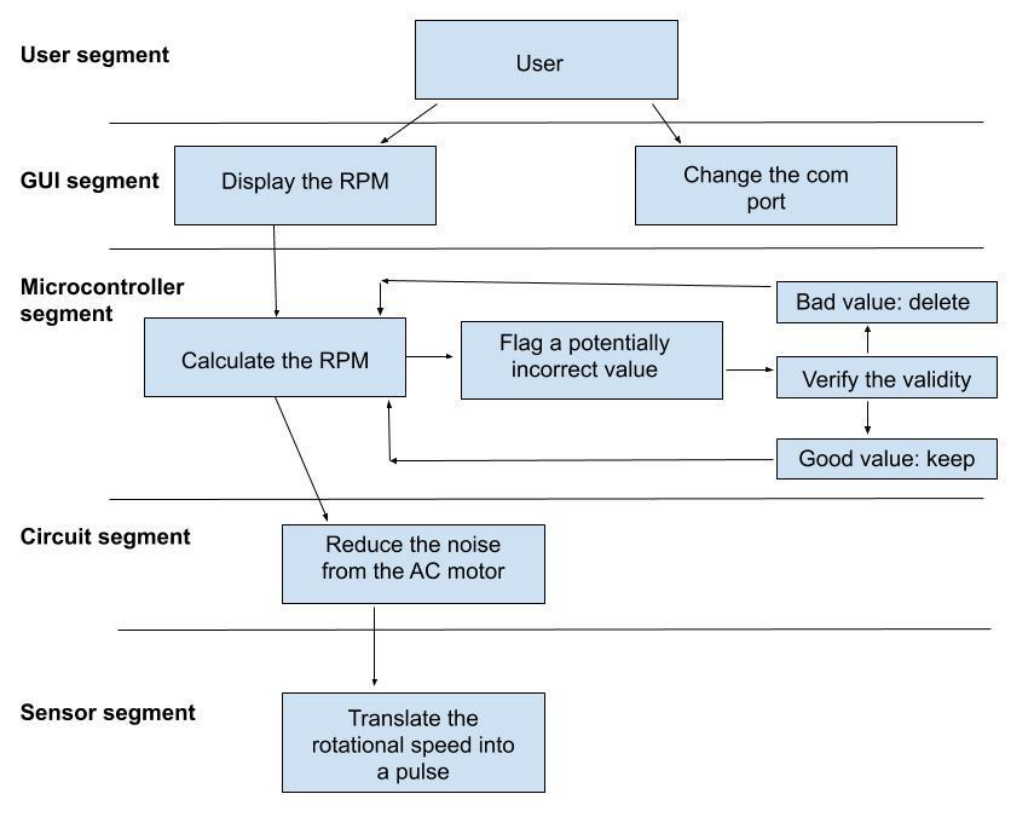
Design Trade-Offs

Optical Encoder ● Fast, easy ● Expensive	**Low-Pass Filter** ● Cheap and easily accessible ● Requires time to design
Tiva Board ● Started here ● Need to rewrite	**Arduino** ● Easy to code fast ● No previous experience
Java ● Previous experience but required learning new, unfamiliar functionalities	**Python** ● Client suggested ● Limited previous experience

Design Block Diagram / Description of Modules / Interfaces



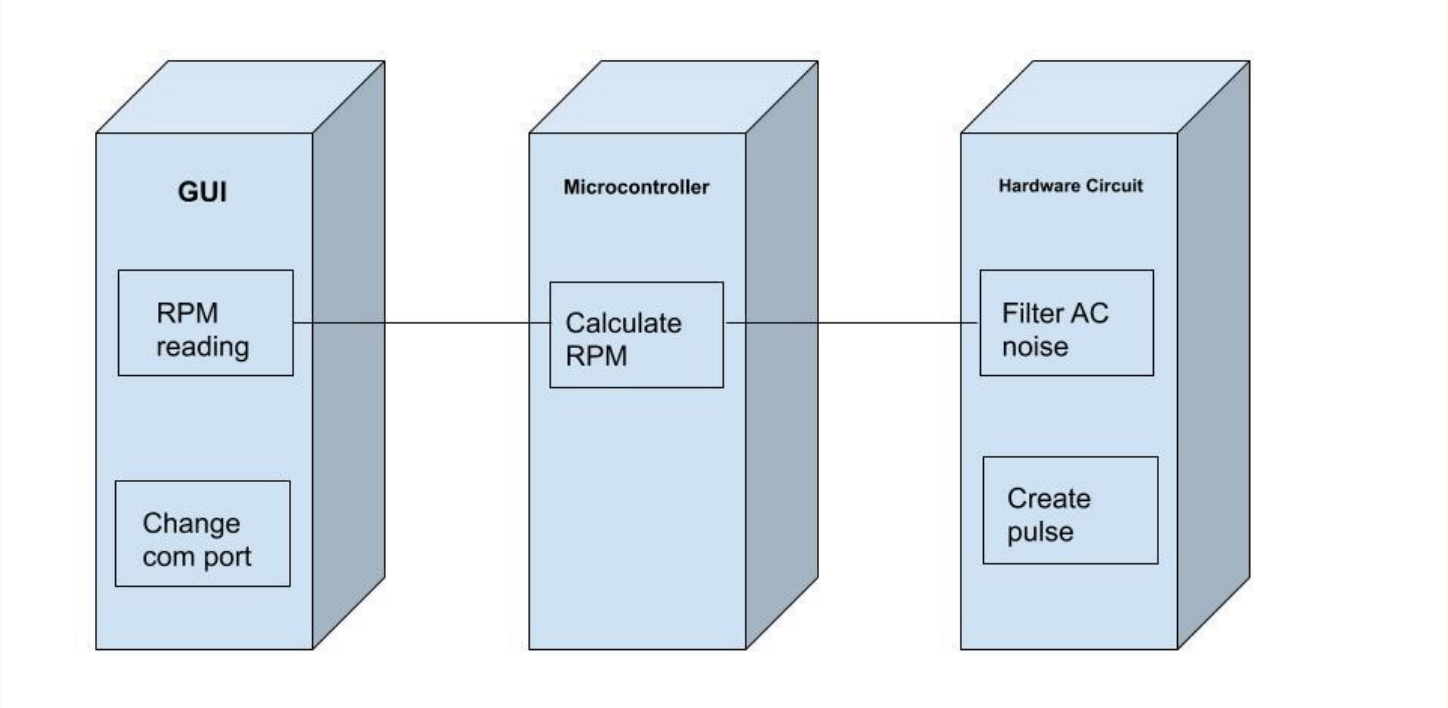
Architectural Diagram / Constraints



- GUI
- Price
- Motor
- Lab

Implementation

Implementation Diagram



Technologies / Software Used and Rationale

GUI	Microcontroller	Hardware
• IDE: PyCharm • Libraries: tkinter, serial, PyInstaller	• Microcontroller: Arduino Nano • Language: Arduino	• Filter: Low-pass • Sensor: Hall effect • CAD: SolidWorks, MultiSim

Standards / Best Practices

- IEEE Standard for Software and System Test Documentation
- IEEE Standard for System, Software, and Hardware Verification and Validation
- IEEE Guide for Selecting and Using Reliability Predictions Based on IEEE 1413
- **Peer Code Reviews**

Testing, Validation, & Evaluation

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Test Plan

- All manual tests
- Unit, Interface, System Integration, and Field testing
- Focus on linking to requirements

Unit Testing / Interface Testing

Unit	Interface
(Software) Function Requirement #4: • GUI for user interaction	(Hardware) Requirement: • Hardware output a pulse should be clean and consistent • With 0.5% accuracy • From 100 RPM to 2000 RPM
(Hardware) Requirement: • Hall effect sensor will create clear pulse	(Software) Requirement: • Calculate RPM with 0.5% accuracy • From 100 RPM to 2000 RPM

System Integration Testing / Field Testing / Validation and Verification

System	Field	Validation and Verification
Functional Requirement #2 & #3: ● Accuracy of 99% ● From 100 to 2000 RPM	Non-Functional Requirement #2: ● It will have a user-friendly GUI	Non-Functional Requirement #1: ● Cost effective
Functional Requirement #1: ● Perform all lab functions.	Non-Functional Requirement #3: ● It will be documented sufficiently	

Evaluation

- Meets all requirements
- Client, student, professor, and TA approval
- **88%** cost reduction
- **80%** time reduction
- Removed direct user/motor interaction
- Rated **9.5/10** for ease of use

Project & Risk Management

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Roles and Responsibilities

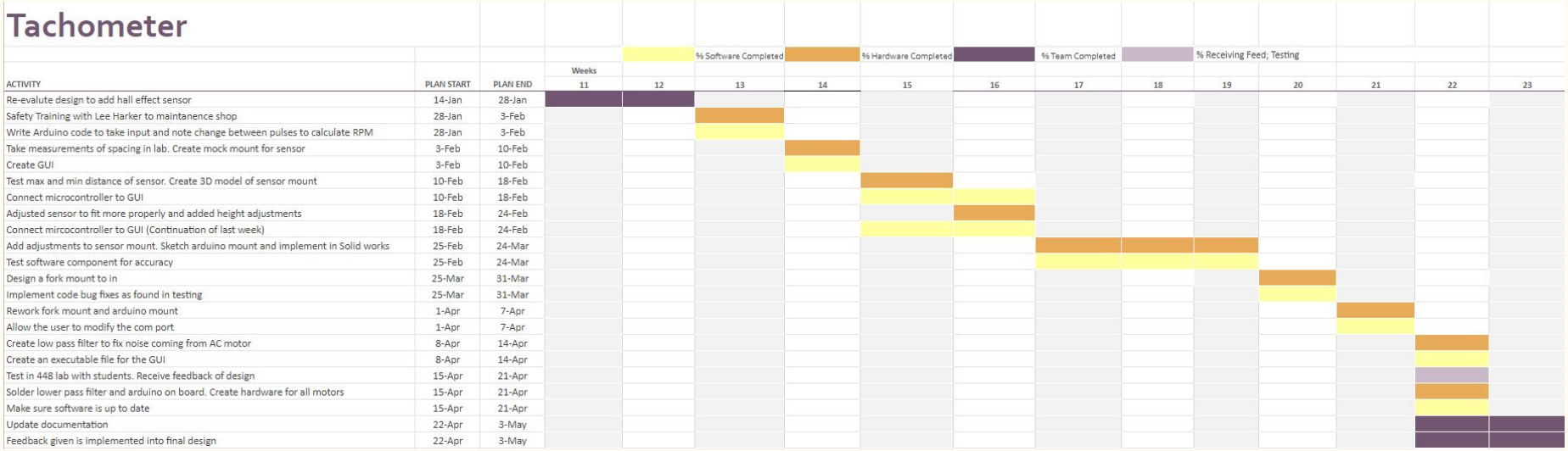
Role	Member
Hardware Team	Kyle, Katrina, Seth*
Software Team	Meghna, Jessica, Seth*
Systems Engineer	Seth
Testing Team	Meghna, Jessica, Seth
Timeline Manager	Katrina
Communication Manager	Jessica

* refers to member holding this role for a partial semester

Task Decomposition

Task	Team Member(s)		Task	Team Member(s)
GUI creation	Jessica, Meghna		Mounting	Katrina, Kyle
Arduino programming	Jessica, Meghna		Low-pass circuit design	Seth
GUI/Arduino interface	Jessica, Meghna		PCB Design	Kyle
Software testing	Jessica, Meghna, Seth		Hardware testing	Seth
Picking/ordering components	Seth, Katrina, Kyle		System-level testing	Seth, Meghna, Jessica

Project Schedule



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Risks and Mitigation

Anticipated	Actual
Shipping time for parts	**Shipping time for parts**
Redo design and implementation	Testing software without hardware
Redo our documentation	System needed to be mounted securely
Work on hardware and software at the same time	**System would not be documented well enough to maintain in future**

Lessons Learned

- Test in the environment early
- Check with first to third party users early
- Order parts early

Conclusions

Closing Remarks

- Met all requirements
  - Client, student, TA, and professor approval
  - Less cost
  - Higher durability
  - Save time

Future Work

- **Use the GUI to control the motor**
- Set the microcontrollers to the same port
- Put the program icon on the desktop

List of References

IEEE Standard for Software and System Test, IEEE Standard 829, 2008.

IEEE Standard for System, Software, and Hardware Verification and Validation, IEEE Standard 1012, 2012.

IEEE Guide for Selecting and Using Reliability Predictions Based on IEEE 1413, IEEE Standard 1413.1, 2002.

T. Bigelow. “EE 448 Lab 5 Report.doc.” Unpublished manuscript, EE 448: Introduction to AC Circuits and Motors, Iowa State University, Ames, Iowa, U.S.A.

T. Bigelow. “EE 448 Lab 6 Report.doc.” Unpublished manuscript, EE 448: Introduction to AC Circuits and Motors, Iowa State University, Ames, Iowa, United States.

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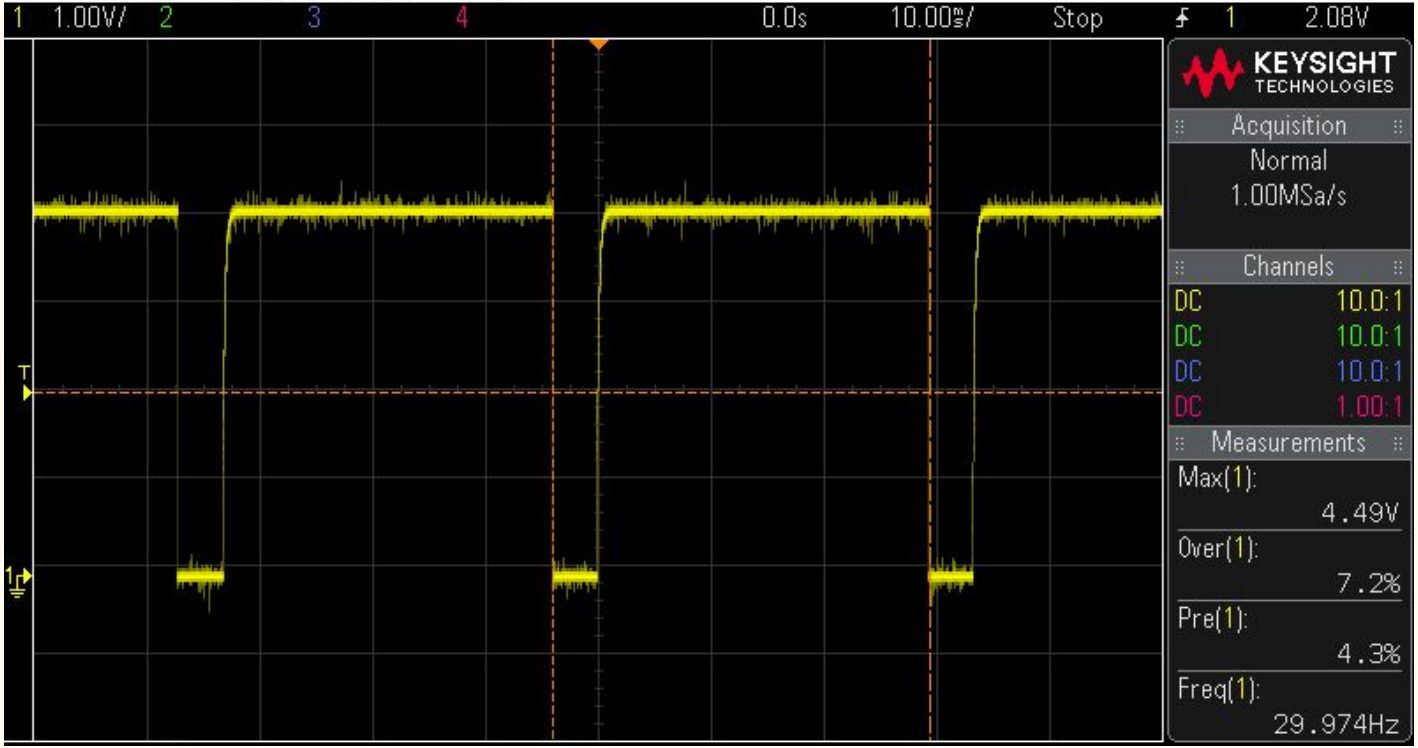
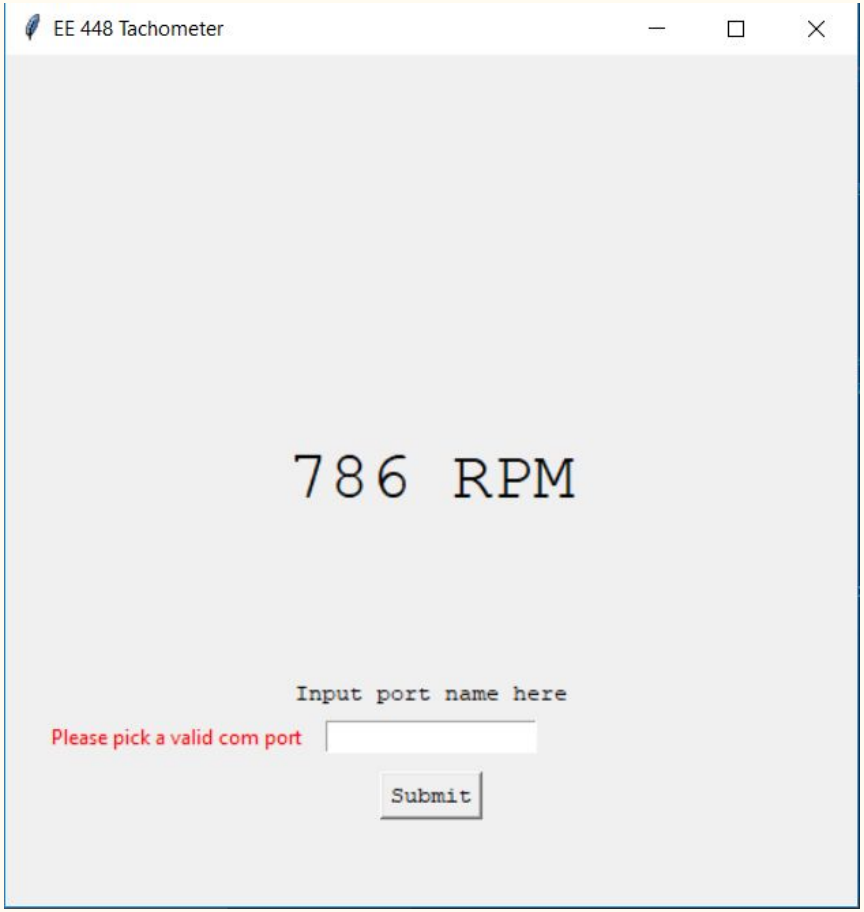
Additional Information

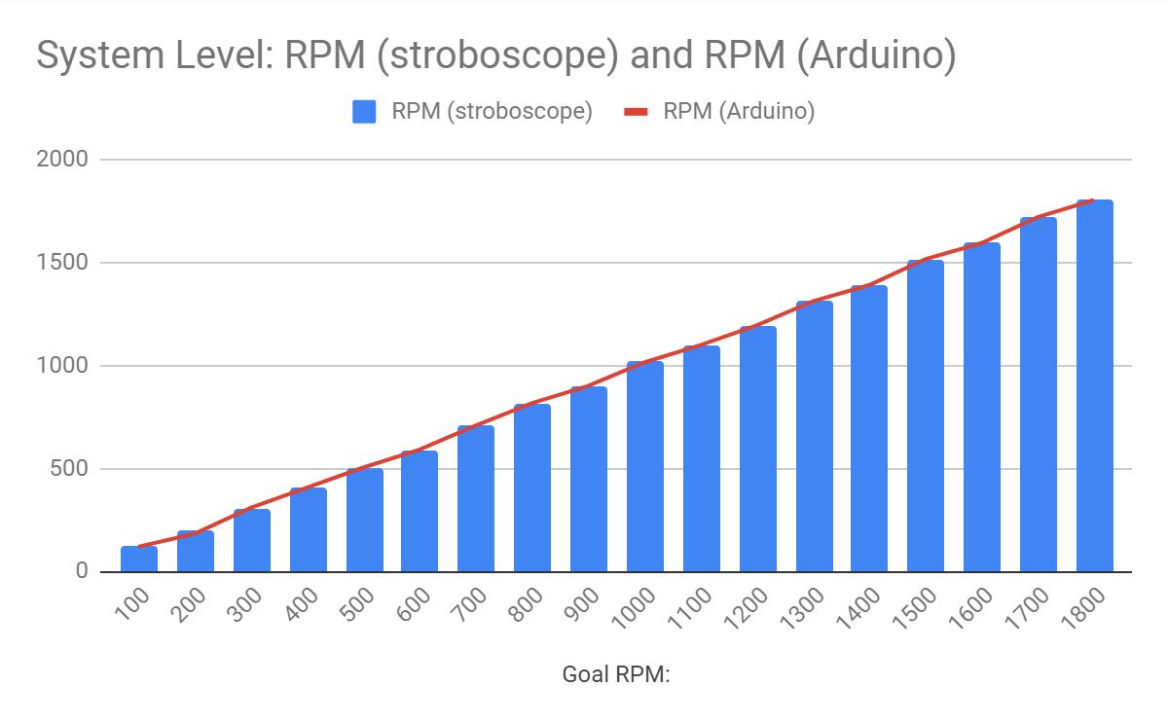
Hardware Output Waveform



GUI


EE 448 Tachometer
786 RPM
Input port name here
Please pick a valid com port
Submit

System Accuracy Graph



Student Feedback

Feedback	Status
Add ‘help’ button	Done
Do not use ‘start’ button	Done
Get rid of junk values that come up on start	Done
Move executable file to desktop	In-Progress
Make the measurements faster	Declined
Have more accuracy (1 RPM instead of 6 RPM)	Declined