Bicycle Tire Pressure Sensors

Team # 33

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Table of Contents:

Motivation

Riding a bicycle with under-inflated or leaky tires can reduce traction and cause faster tire deterioration, but tire pressure monitoring systems are currently unavailable for bicyclists. A system that monitors the pressure as well as rate of change of pressure for the rider can be greatly beneficial to the riding experience via an easily interpreted display that warns of potentially dangerous pressure conditions.

Goals

Our goal is to design an easily integrable bicycle tire pressure sensor that will monitor both pressure and rate of change of pressure for the rider. The sensors will wirelessly transmit their measurements to a control unit mounted on the handle bars, which will light LEDs when pressure falls to dangerous levels or changes at a dangerous rate. The LEDs will be color coded to indicate the severity of the pressure abnormality, and there will be one set of LEDs for each tire to distinguish where the problem is.

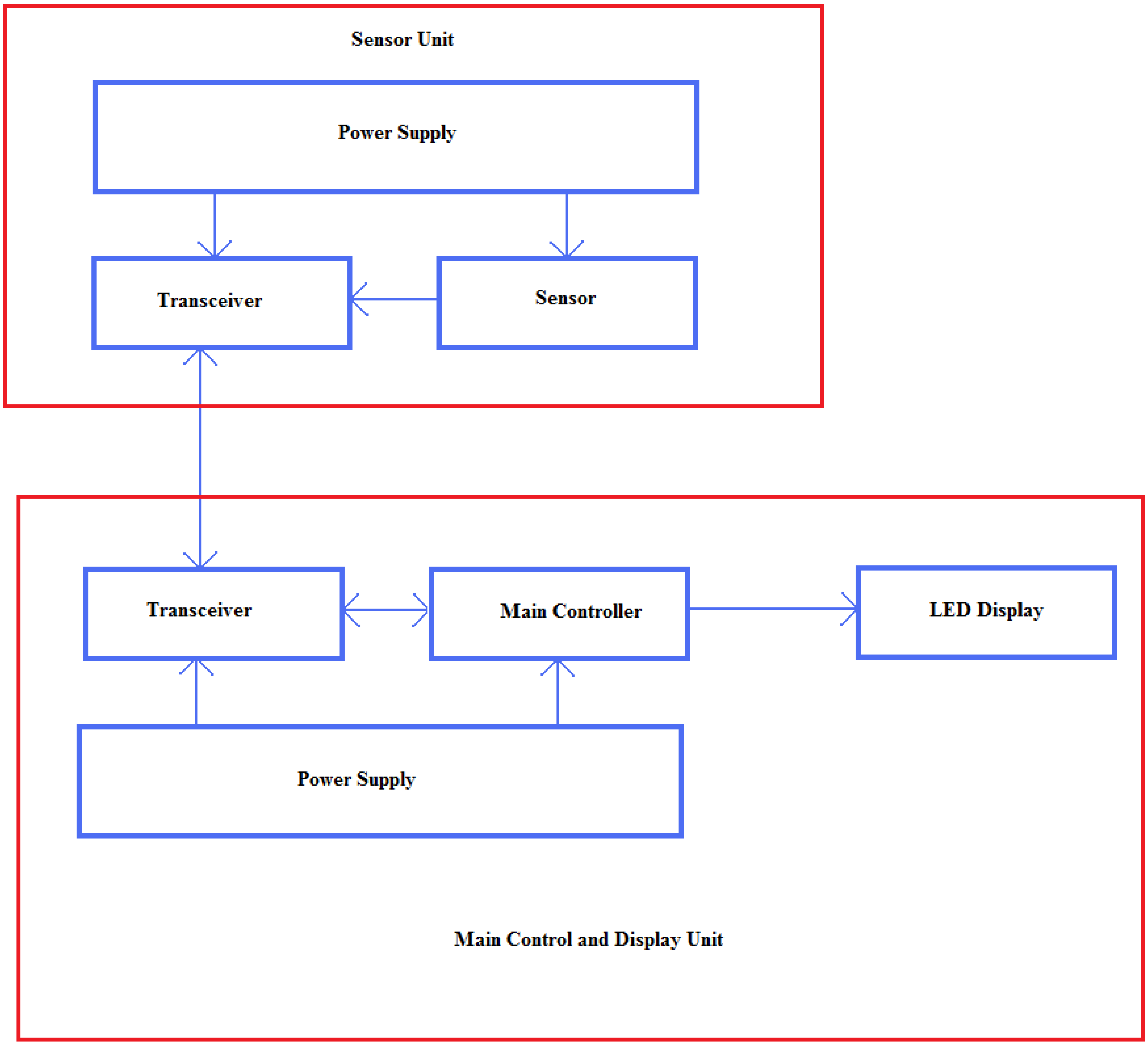
Benefits

- Improve bicycle safety by warning riders against non-ideal riding conditions
- Prevent tire and wheel damage from under-inflation
- Alert riders to tire damage when rapid pressure changes occur

Features

- Simple, user friendly LED display
- Constant update of tire pressure while riding
- Variable sampling rate will conserve power by sampling slowly under nominal conditions and sampling rapidly when conditions become non-ideal
- "Parked mode" enabled via an external switch to completely stop sensing to conserve more power

Block Diagram



Block Description

The Sensor will be implemented as a force sensor mounted between the rim and the tire tube. It will be controlled and read by a microcontroller, which will also send the measurements to be transmitted to the transceiver. All three transceivers will be implemented with single transceiver chips.

Each of the three power supplies will be implemented as two coin type batteries.

The main control and display unit's transceiver will send the received measurements to the main controller, which will be another microcontroller as well as a memory chip. The main controller will store measurements and compare them to various thresholds to determine what range the pressure is currently in (normal, low, very low, etc.). It will also compare the most recent measurement to previous measurements to estimate a rate of change, which it will compare to other thresholds in a similar manner. If pressure falls into one of the non-normal ranges or if the rate of change is too high, then the main controller will send a command signal via the transceivers to the sensor unit in order to force it to begin sampling faster. When pressure returns to normal levels or if the "park mode" is engaged, another command will be sent to return to the regular sampling rate or stop sampling respectively.

When pressure is in one of the low ranges or when the rate of change is above the safe threshold, LEDs will also be illuminated by the main controller to indicate which tire is at fault and the severity of the problem.

Performance Requirements

- Power efficient, such that battery replacement will not be required for at least 4 months with moderate use
- Pressure measurement accuracy within ±10%
- LED illumination within 0.5 seconds of measurement

Verification

- Deflate each tire to be within each defined range of low pressure one after the other and observe the corresponding LEDs. Once the first range is entered, the other LEDs should illuminate much faster as a result of the increased sampling rate.
- Deflate each tire such that they remain within the normal range, but that the rate of change is above the allowed threshold and observe the corresponding LED.
- Measure current drawn over one sampling cycle as well as current drawn while in "park mode" and extrapolate to determine how long batteries should last, assuming 90% of the time will be spent in park mode and 1% of the time will be spent sampling at the increased rate.

Tolerance Analysis

The sensor is the most crucial component to our design. This is because without accurate data nothing else can be accomplished. Furthermore, battery replacement for the sensor will be inconvenient for the user, and as such power efficiency is very important. We will measure tire pressure with an external device and compare our measured value with values from the main control unit's memory to determine if the accuracy is within the acceptable 10% range.

Cost Analysis

Part ID	Description	Cost
30056-ND	Force Sensor	2 x $27.65
PIC16F887	Microcontroller	3 x $2.84
FM24V02-GTR	Memory	$5.88
DS2155L	Transceiver	3*$15.24
796136-1	Battery Holder	6*$1.592
CR2032	Batteries	6*0.28
Labor	160 hours	40$/hour * 160 * 2

Total = Labor + Parts = 12800 + 126.652 = $12,926.65

Schedule

Week	Michael	Bryan
2/5	Research Parts	Write Proposal
2/12	Order Parts	Finalize Design
2/19	Adjust design according to design review	Take measurements in lab
2/26	Code microcontrollers	Find optimum implementation for attaching to bike
3/4	Interface microcontrollers with transceivers and sensors	Interface microcontroller with LEDs and transceiver
3/11	Finish building sensor circuit	Finish building main controller circuit
3/18	Spring Break	Spring Break

3/25	Build casing and attachment for sensor circuit	Build casing and attachment for controller circuit
4/1	Test sensors while on wheels	Test main control unit while on bike
4/8	Debug/final adjustments for sensors	Debug/final adjustments for main control
4/15	Final test runs	Analyze data from final test runs
4/22	Write final report	Write final report
4/29	Demo	Demo