Smart Weather Station

Introduction

The aim of this proposal is to find a solution for smart weather station with no mechanical moving parts for measuring all weather conditions with a focus on rain and wind based on low power ML at the edge that can be deployed locally with low cost, low power, reliable, accurate, easy to install and maintain.

Problem

Currently we're monitoring weather station parameters such as rain and wind using mechanically moving sensors such as tipping bucket, problem with such sensors is that they are easy to damage when they are deployed locally.

Solution

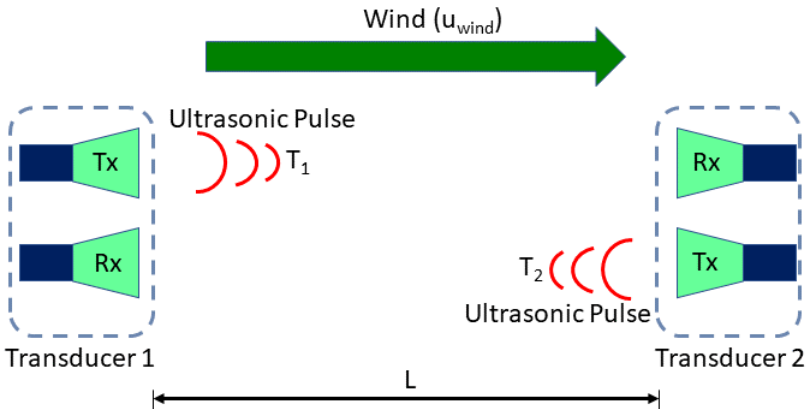
To solve these issue,We're recommending non mechanical moving sensors that uses the feature of ultrasonic transmission and reception for detecting wind direction and speed and acoustic sensors such as sound sensor and loudness sensor for rain.

Methodology

- Sensor Specification

  1.Seeed Grove - Loudness Sensor
  2.Seeed Grove - Sound Sensor
  3.Ultrasonic sensor hc-sr04

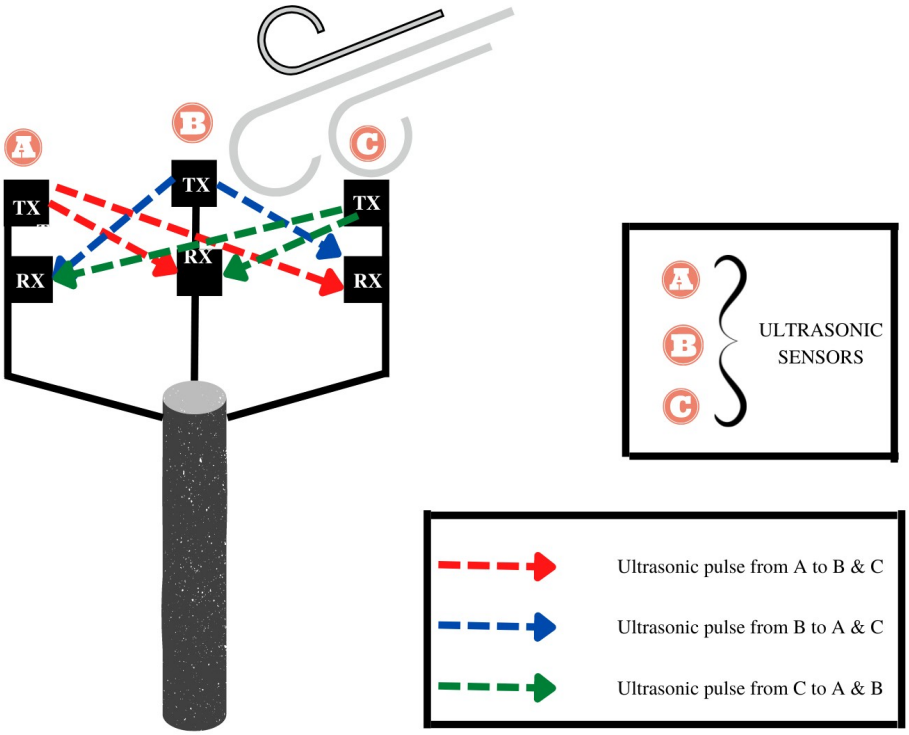
- Wind direction and wind speed detection principle



- Wind Speed and Direction Monitoring

Speed of the ultrasonic pulse is increased by the wind speed in the direction that wind is blowing.Ultrasonic pulses are transmitted between sensors A,B,and C.
Ultrasonic pulse transmitted from sensor A and measure the speed of pulses fron sensor B and C. Similar for sensor B and C.thus a total of six measurements are taken to determine wind speed and direction.These measurements are used to create the dataset for ml. These datasets are mapped with mechanical wind sensor and corresponding value is mapped

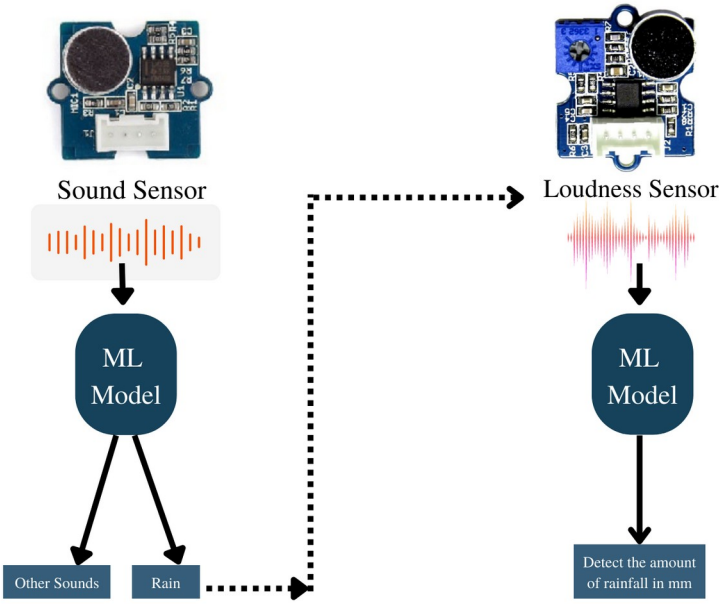
Wind speed and direction Monitoring hardware setup



- Rainfall Monitoring

Identify the sound of rain using ML algorithm for classification (sound sensor)If it is detected as rain identify the frequency of sound (loudness sensor)using ML algorithm .

Rainfall Monitoring Model



Rainfall Monitoring hardware setup

Dataset Creation

Priliminary set of datas for evaluation can be created by simulating a rainy atmosphere in the lab with new proposed rainfall monitoring setup and a mechanical rainguage(eg :Davis). Randomly take datas for rain detection with sound sensor and Loudness sensor. Correspondingly map the frequency of loudness with mechanical rain guage output such that

Loudness	Rainfall rate
Eg: 100Hz	0.2mm
.....	.....
.....	....
.....	.....

Dataset from Loudness sensor mapped to Rainfall rate

To identify whether it is rain or not we have to create some other data corresponding to naturally occuring sounds too.

Rain sound	Other Sound
Eg: 100 Hz	5Hz
.....	.....
.....	.....
.....	.....

Dataset from Sound sensor represent both rainfall sound and other sounds

ML model

To deploy the ML model at the edge the reliable model will be decision tree model for that we can use features of both sound sensor and loudness sensor.First of all we can perform the classification with sound sensor and determine whether it is rain or not. Next level of classification will be performed based on loudness thus we can determine the intensity of rain with respect to sound frequency.

Cost Estimation

Sl No:	Commodity	Quantity	Cost (in USD)
1	Arduino nano BLE sense	1 nos	24.74
3	Seeed Grove - Loudness Sensor	1 nos	7.52
4	Seeed Grove - Sound Sensor	1 nos	5.01
3	Ultrasonic sensor hc-sr04	1 nos	3.72
4	Aluminum Sheet	1 square feet	0.75
5	GI pipe	2 meter	6.03
6	Concrete block	-	2.51
7	3-D printing	-	12.56
	Total Cost		62.84

Project plan

Project phase	Time Scheduled	Work Scheduled
1	18th july 2022	1. Selection of sensors 2. Cost Estimation 3. Project proposal draft
2	1st August 2022	1. Purchase of components 2. Integration of sensors
3	5th August 2022	1. Hardware setup 2. lab setup
4	10th August 2022	1. Dataset Creation 2. Data sorting and manupulation
5	25th August 2022	1. ML model testing with created dataset. 2. Fix the ML Model
6	25th September 2022	Testing and evaluation inside the lab