تصميم جهاز قياس نسبة هطول الامطار

كلية الهندسة / قسم هندسة الميكاترونكس

DESIGN OF RAINFALL MEASURMENT INSTRUMENT

By

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Introduction:

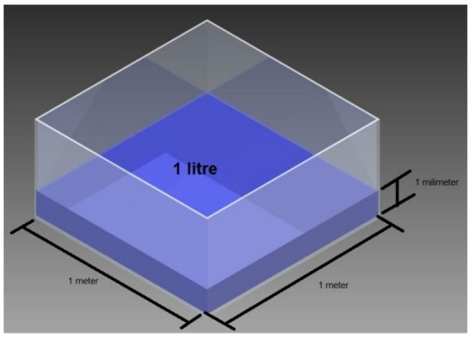
A rain gauge (also known as an udometer, pluviometer, or an ombrometer) is a type of instrument used by meteorologists to gather and measure the amount of liquid precipitation over a set period of time.

The first known rainfall records were kept by the Ancient Greeks, people in India also began to record rainfall. The readings were correlated against expected growth, and used as a basis for land taxes. In the Arthashastra, used for example in Magadha, precise standards were set as to grain production. Each of the state storehouses were equipped with a rain gauge to classify land for taxation purposes .

In 1441, the Cheugugi was invented during the reign of King Sejong the Great of the Joseon Dynasty in Korea as the first standardized rain gauge.

Rain Unit:

Rain is measured in units of length per unit time, typically in millimeters per hour, or in countries where imperial units are more common, inches per hour. The "length", or more accurately,



"depth" being measured is the depth of rain water that would accumulate on a flat, horizontal and impermeable surface during a given amount of time, typically an hour. One millimeter of rainfall is the equivalent of one liter of water per square meter.

$$1\ mm = \frac{litre\ of\ water}{1\ m^2}$$

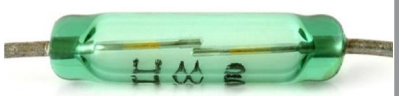
Aim of the Project:

Design a Rainfall Measurement instrument which involves design of both of the mechanical and electrical parts and view the results on a PC monitor or an LCD.

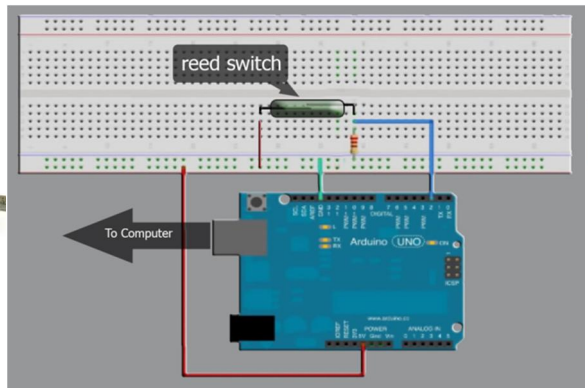
The Electrical Circuit (Magnetic Reed Switch and Arduino Uno):

The reed switch is an electrical switch operated by an applied magnetic field. It was invented at Bell Telephone Laboratories in 1936 by W. B. Ellwood. It consists of a pair of contacts on ferrous metal reeds in a hermetically sealed glass envelope. The contacts may be normally open, closing when a magnetic field is present, or normally closed and opening when a magnetic field is applied. Once the magnet is pulled away from the switch, the reed switch will go back to its original position.

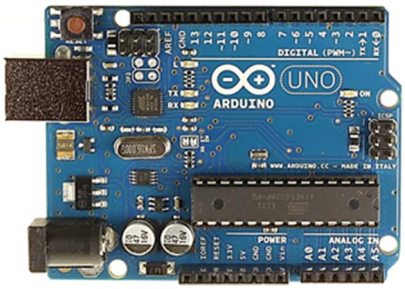
The Arduino Uno is a microcontroller board based on the ATmega328 .It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started



Magnetic reed switch



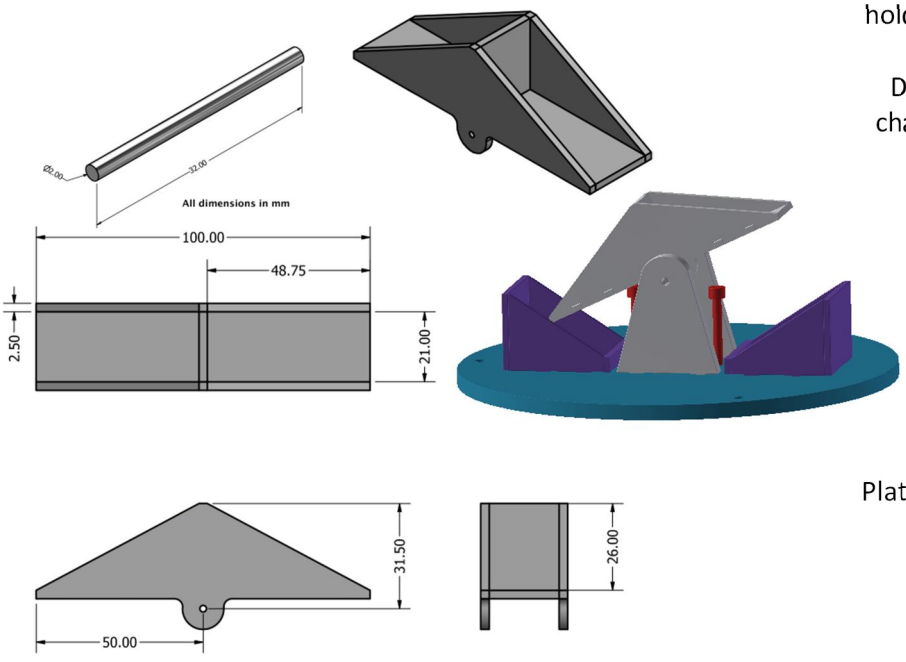
The Electrical Circuit

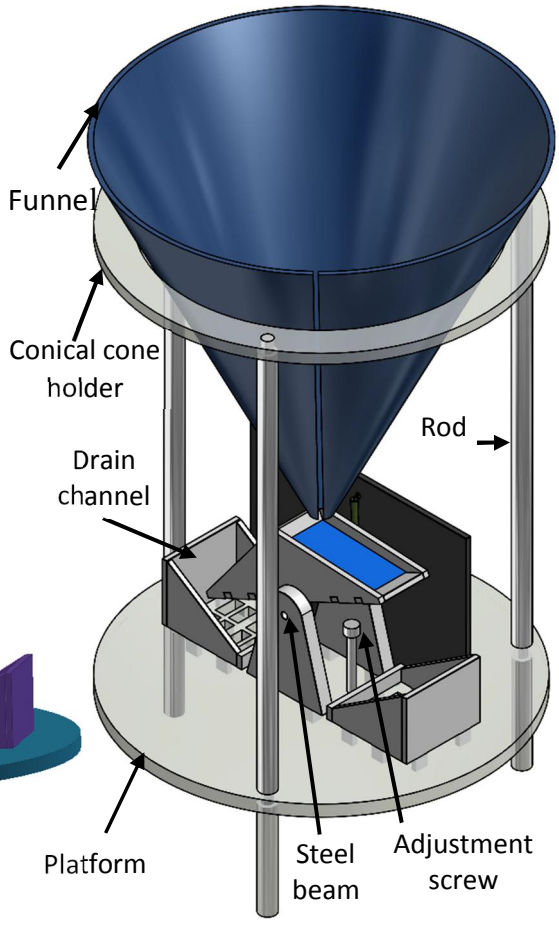


Arduino UNO

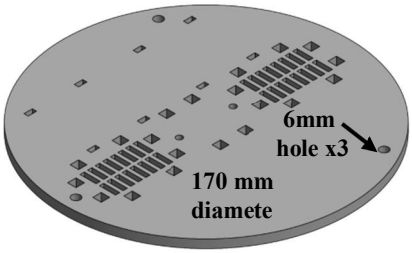
Mechanical Design of Rain Gauge:

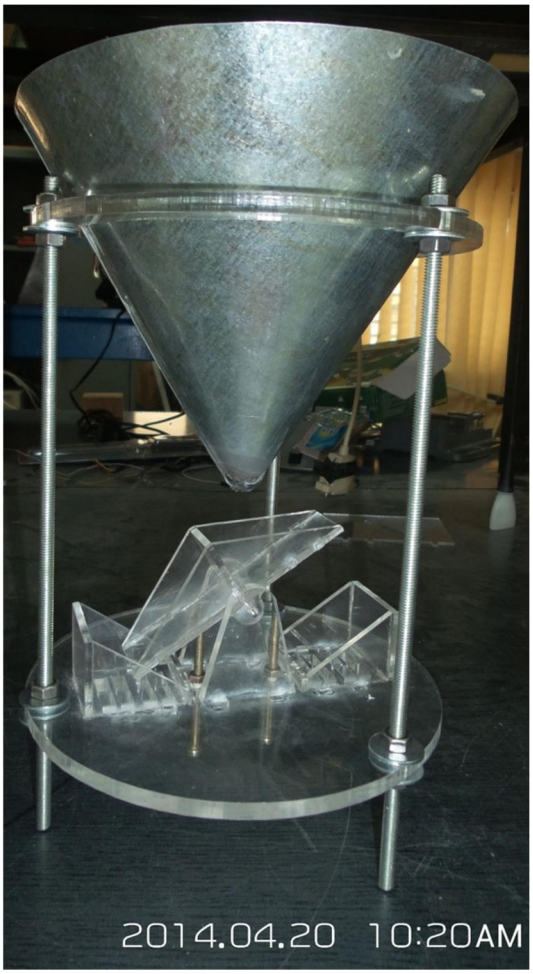
We have designed the mechanical components of rain gauge using CAD program "Autodesk Inventor Professional" which enables designers to draw, assemble and test their design with a powerful tools after specifying forces, objects relationship and fixtures. Whole view of the rain gauge and its parts are shown in the following,

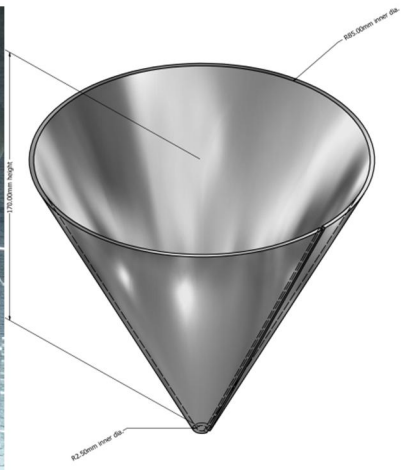




Whole View of Rain Gauge







Calibration:

For the calibration of the manufactured device, we poured the water on the funnel with a very little flow rate for **15 minutes** and recorded the corresponding number of pulses and the volume of the drained water from the drain channels; then we increased the flow rate a little more for the same time period mentioned above and recorded as above; we had repeat this operation till we got four experiments as shown in below:

Experiment Number	Number of pulses/hr	Water volume (Liter)	Height (mm) =liters/m^2
1	120	1.360	1.360
2	1120	4.400	4.400
3	1500	19.000	19.000
4	2696	36.800	36.800

Since height (h mm) =Volume of
collected water (L)/Area of the collector (m^2)
Then h=volume for area =1m^2 therefore, plotting these data is as follow:

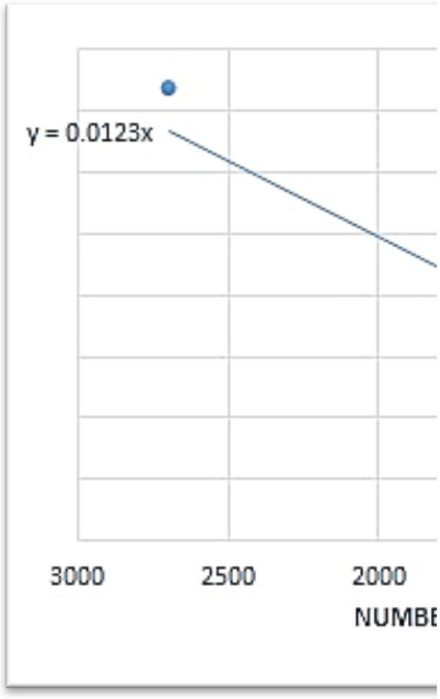


Table: Results of Experiments

Plotting data and trending it using Microsoft Excel shows that the equation that describes these data is: $y=0.0123x$

as one can see, it is a straight line equation with a slope of **0.0123**;Then, the experiments constant is **c=0.0123mm/ pulse** then the Rainfall can be found by multiplying this constant by the number of pulses:

Rainfall [mm/hr] =c [mm/ pulse] * pulses [pulses/hr]