UNIVERSITY OF PERADENIYA

FACULTY OF ENGINEERING

DEPARTMENT OF COMPUTER ENGINEERING

PROJECT PLAN DOCUMENT

FLOOD DETECTION AND SAFETY PREDICTION SYSTEM

THROUGH WATER LEVEL AND VELOCITY MONITORING

GROUP 09

E/14/080

E/14/228

E/14/240

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Abstract

This system would monitor the status of rivers in country in real time and would help to prevent the dangers associated with water flow of river bodies of the country. This system is able to detect a change in the usual water level and speed and would therefore is able to give notifications about the safety regarding that particular water body. The system has a sensing circuit connected to a microcontroller which sense and outputs the current water level and velocity of the surface in which the signals are transmitted to a main server where the data is analyzed by comparing with previous data. The current details regarding the water bodies could is accessible to the public through a web interface and a mobile application.

Related work

Background work:
http://www.irrigation.gov.lk/index.php?option=com_riverdata&Itemid=266&lang=en
Currently, this site gives an update of the river status of Sri Lanka. However this system is based on manually collected data and is updated only once per day. By constantly keeping track of this site we found that there are certain times that the system doesn’t output any data at all. This system is sufficient to get rough details about the water level of a river body but this won’t clearly serve any help at detecting a risky situation prior to the occurring of an event.
Since our system is based on data collected through sensors, human force used in collecting this data manually, informing the collected data to the central office, updating these data and keeping track of them would be minimized to a larger extent through our system. Our system would be more secure, efficient and less erroneous compared with the existing manual procedure and system.

Project Overview

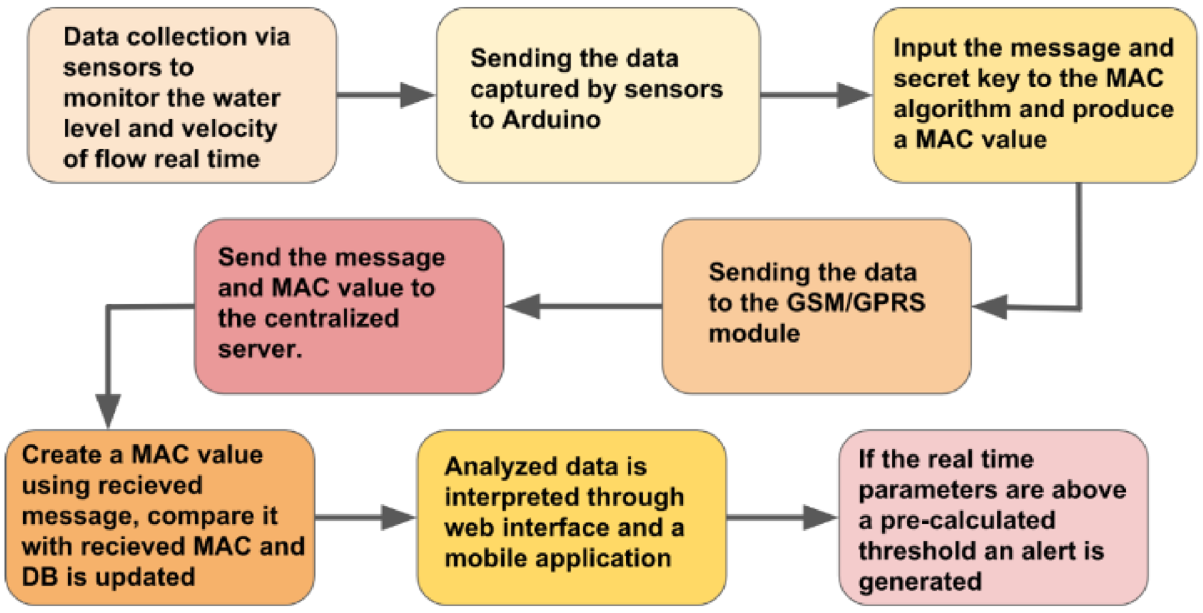

Data collection via sensors to monitor the water level and velocity of flow real time
Sending the data captured by sensors to Arduino
Input the message and secret key to the MAC algorithm and produce a MAC value
Sending the data to the GSM/GPRS module
Send the message and MAC value to the centralized server.
Create a MAC value using recieved message, compare it with recieved MAC and DB is updated
Analyzed data is interpreted through web interface and a mobile application
If the real time parameters are above a pre-calculated threshold an alert is generated

Figure 5:Project Overview

Hardware Design

The hardware part containing the microcontroller,gsm module and the batteries are embedded in a box where it's top is enclosed by the solar panels.The ultra sonic sensor is attached to the bottom of the box. This part should be fixed to a bridge above the water surface. A tube extrudes from this part until it reaches below the surface of water. The flow rate sensor is attached to the bottom end of the tube in which it is connected to the arduino board.

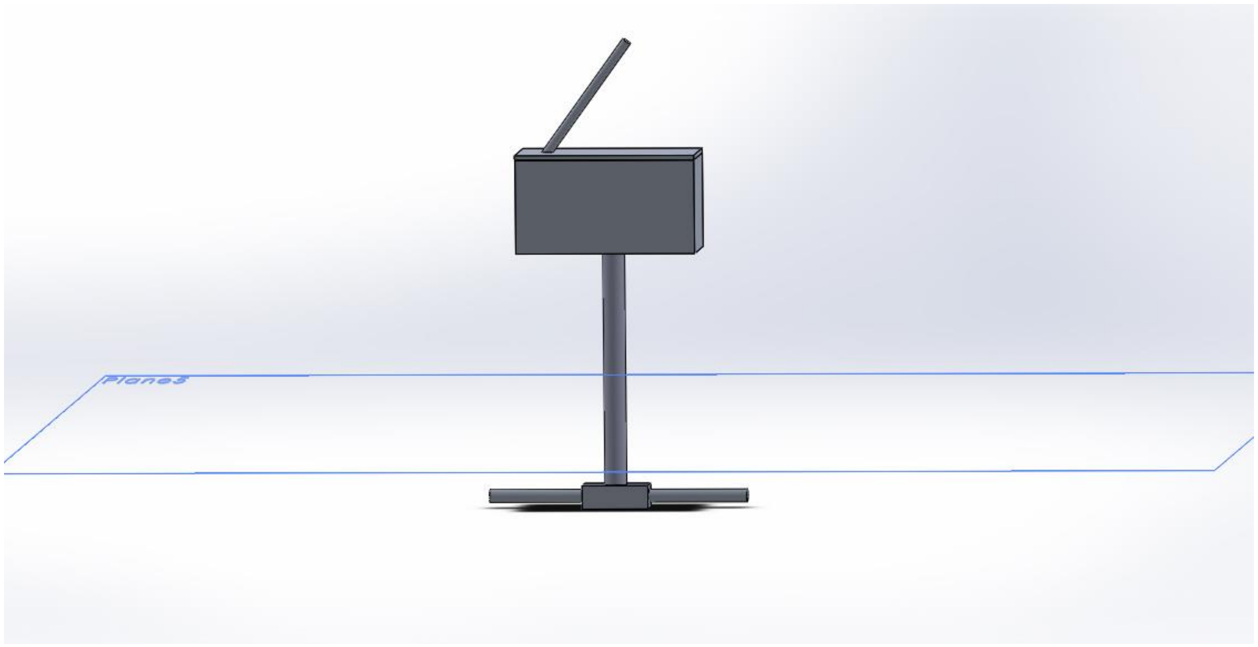


Figure 6:Hardware Design

Power Supply

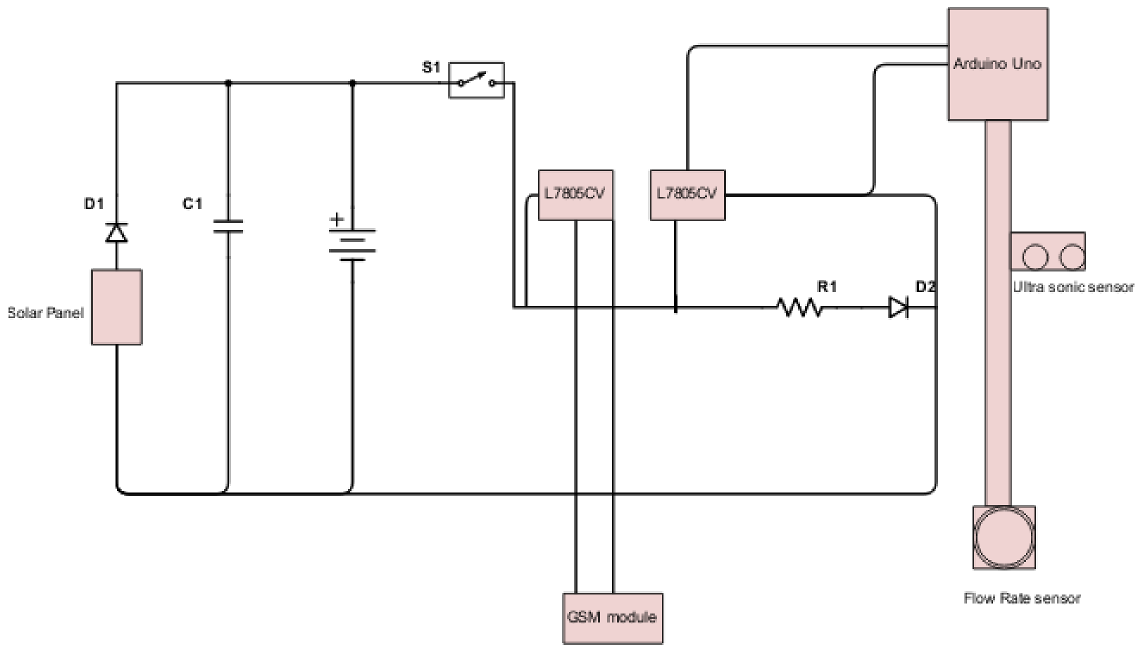


Figure 7:Power Supply

Power supplied by the solar panels=3 x 4.5 =13.5V
Power supplied by the batteries= 3 x 3.7V= 11.1 V
2 L7805CV Linear Voltage Regulators = 10V

R1 = 1k**Ω**

Capacitor =2200µF

Circuit Diagram

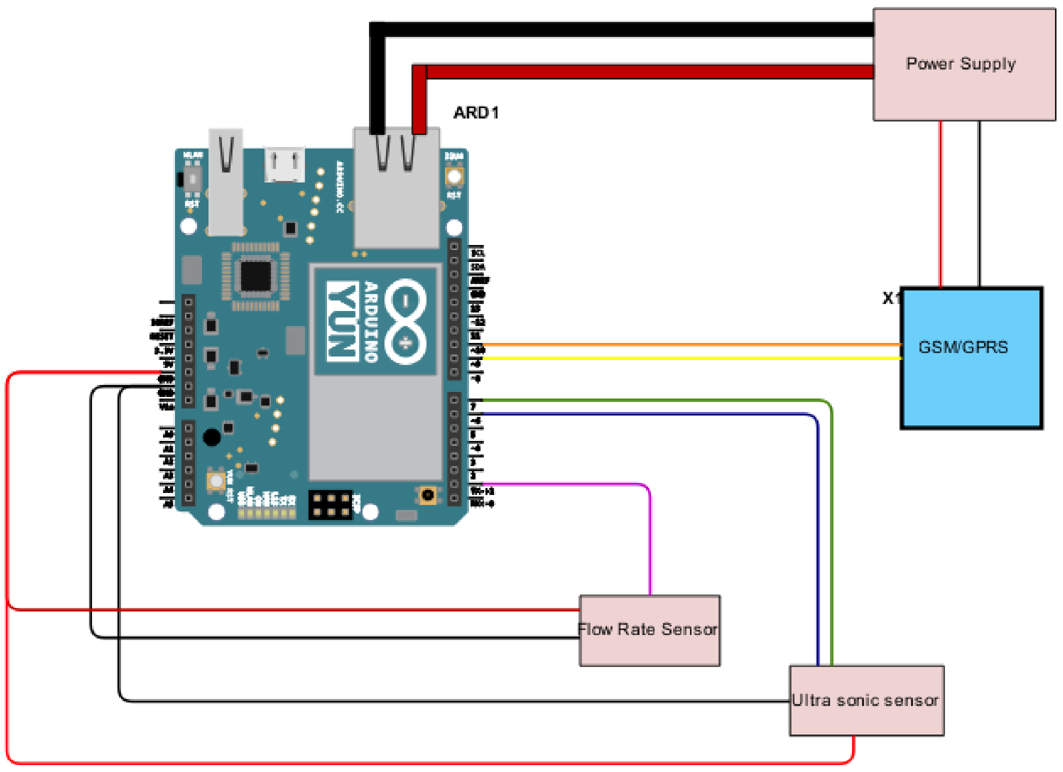


Figure 8: Circuit Diagram

Ultra sonic sensor(HC SR04)

To measure the water level we are using ultra sonic sensors which should be implemented above the water body and the sensor would output the distance from that given body to the surface of the water. Through this we could check whether there's a significant change in the water level by comparing this data with the pre-collected data. There were other sensing methods to get the water level but we chose ultra-sonic sensors as the best due to its accuracy when compared with other methods and its easy-maintainability since the components do not get in touch with the water (no rusting, less depreciation).

limitations

- The height from the surface to the fixed point can be obtained only with an accuracy of +-1cm. But since we do not need the minute changes of the water level and measure only the drastic changes, this error could be tolerated. With time, there might be a possibility to have a moisture layer on the face of the sensors and that'd change the density between the surface and might lead to erroneous results.

- Power Supply :+5V DC
- Quiescent Current : <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1" – 13ft
- Resolution : 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10uS

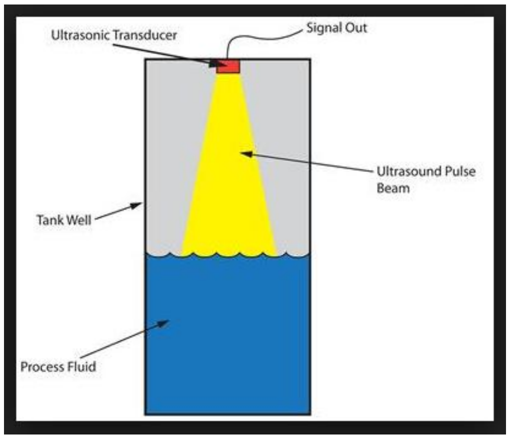


Figure 9: Working of an ultra sonic sensor

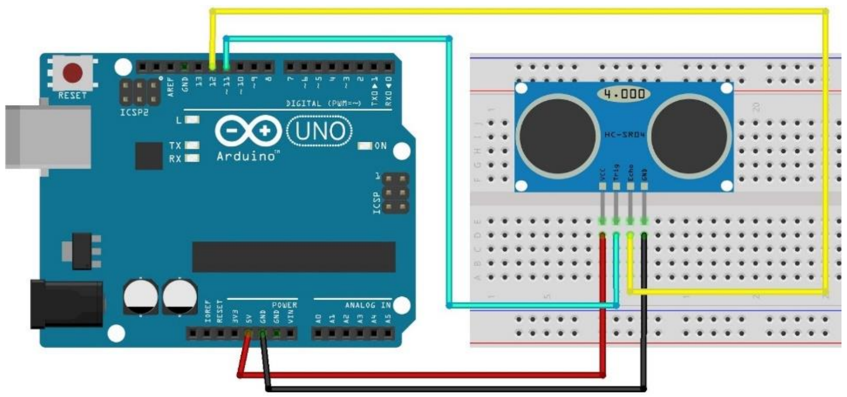


Figure 10: HC SR04 connected to an arduino UNO

Flow Rate Sensor

The flow rate sensor has to be emerged somewhere below the surface (according to the principles of hydro physics as at this point a more accurate measurement regarding flow rate of a river could be obtained) The flow meter works on the principle of the Hall effect. According to the Hall effect, a voltage difference is induced in a conductor transverse to the electric current and the magnetic field perpendicular to it. Here, the Hall effect is utilized in the flow meter using a small fan/propeller-shaped rotor, which is placed in the path of the liquid flowing. The liquid pushes against the fins of the rotor, causing it to rotate. The shaft of the rotor is connected to a Hall effect sensor. It is an arrangement of a current flowing coil and a magnet connected to the shaft of the rotor, thus a voltage/pulse is induced as this rotor rotates. In this flow meter, for every liter of liquid passing through it per minute, it outputs about 4.5 pulses. This is due to the changing magnetic field caused by the magnet attached to the rotor shaft as seen in the picture below. We measure the number of pulses using a micro-controller.

Limitations

- Since the flow rate is embedded within a tube, the friction and the cohesive forces exerted by the walls of the tube would hinder obtaining the exact flow rate at the point. But since the velocity of a flowing water body is not uniform, there’s no point in trying to get the exact velocity. We can position the flow rate sensor in a place the maximum velocity could be measured (somewhere just beneath the surface) and that would be effective than getting the exact value since this measurement is going to be an average estimation of the velocity.

- Working Voltage: 5 to 18V DC (min tested working voltage 4.5V)
- Max current draw: 15mA @ 5V
- Output Type: 5V TTL
- Working Flow Rate: 1 to 30 Liters/Minute

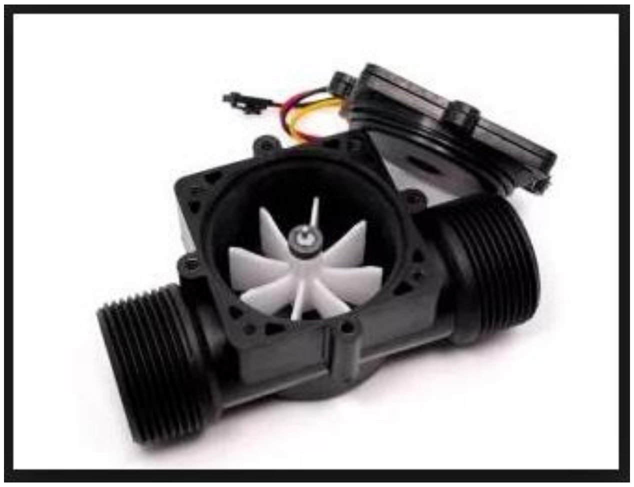


Figure 11: Flow Rate Sensor

Arduino UNO Board

We chose Arduino UNO as the micro-controller because of its moderate price over other micro-controllers and because it serves our purpose. We just need to get the output signals of our sensors and some simple computations, so arduino UNO would suffice. (we are planning to prototype only one node, but if multiple nodes had to be built we could also go with arduino nano as it is much cheaper)

A7 GSM Module

We'd be also using an A7 GSM module to capture the signals from the micro-controller and to transfer these signals to the centralized server.

- Working voltage : 3.3V-4.2V
- Power voltage: >3.4V

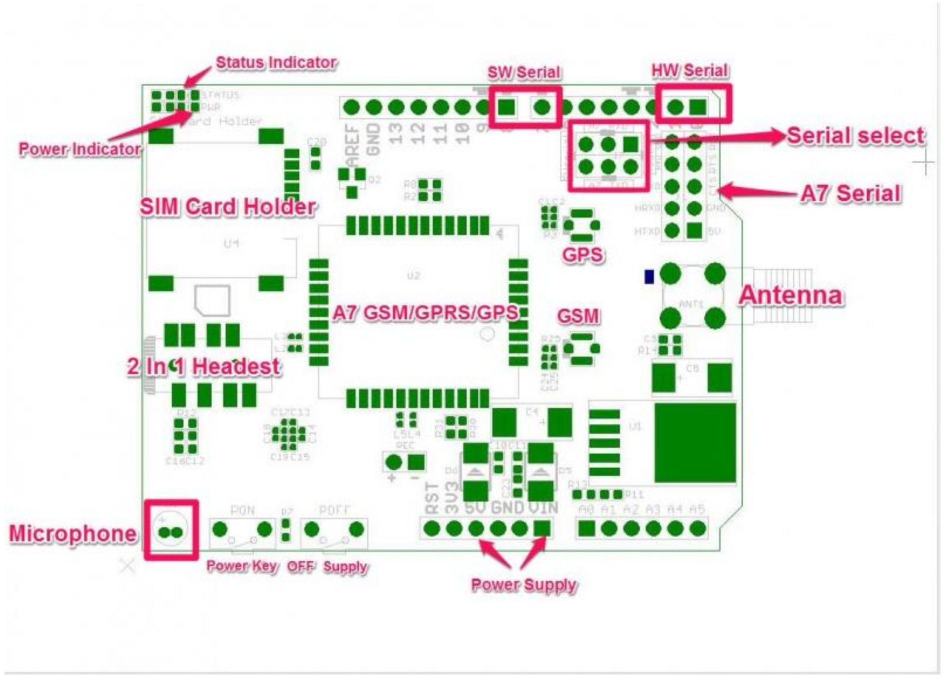


Figure 12: Layout of an A7 GSM module

Network Design

Overview

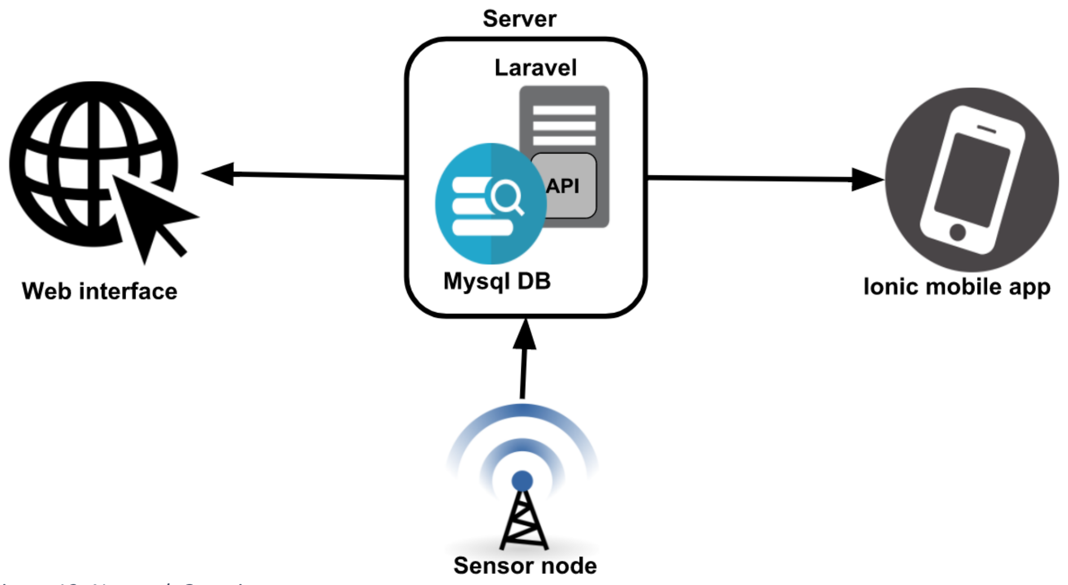


Figure 13: Network Overview

Data from multiple nodes are sent to the centralized server, in which database and other APIs are embedded within.

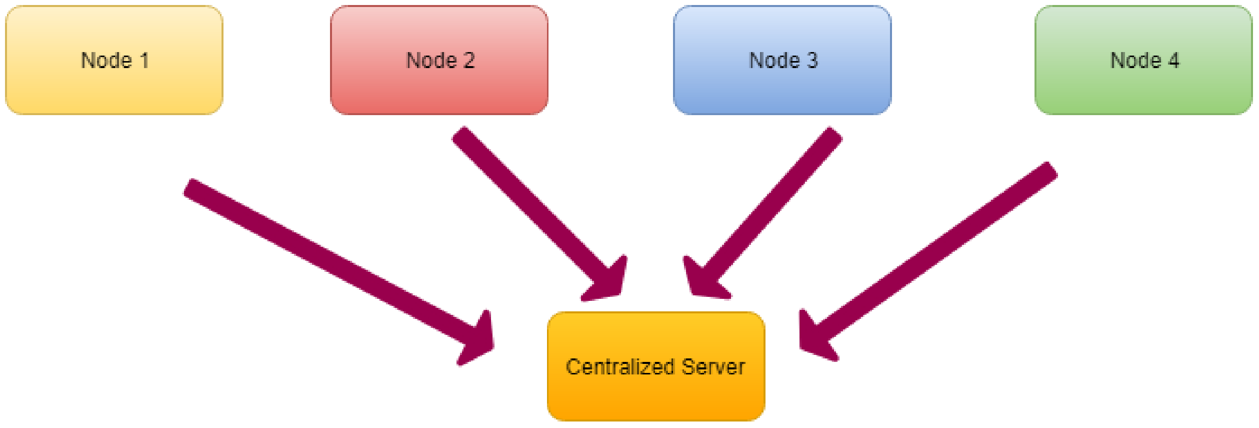


Figure 14: Multiple nodes connecting to the central server

Technologies

Laravel is basically a php framework.We mainly used laravel framework to create our application as it provides many features that are really helpful in building a real time notification system.

Some of the features to note down are ;

- Simple,fast routing engine.
- Powerful dependency injection container .
- Multiple back-ends for session and cache storage.
- Expressive, intuitive database ORM.
- Database agnostic schema migrations.
- Robust background job processing.
- Real-time event broadcasting.

Laravel also provides an attractive platform for MVC architecture.

1. Controller receives data from the GSM module
2. Controller requests data from model
3. Model returns data
4. Controller processes data
5. View receives data
6. Generated view is returned
7. Generated view is sent to the browser as a response.

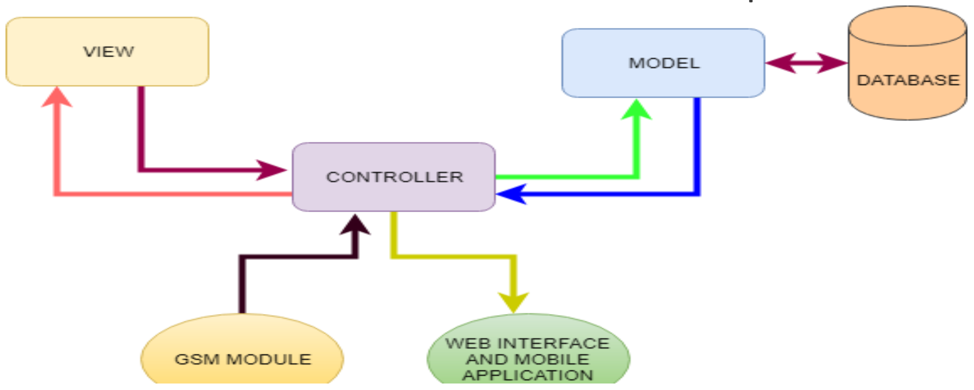
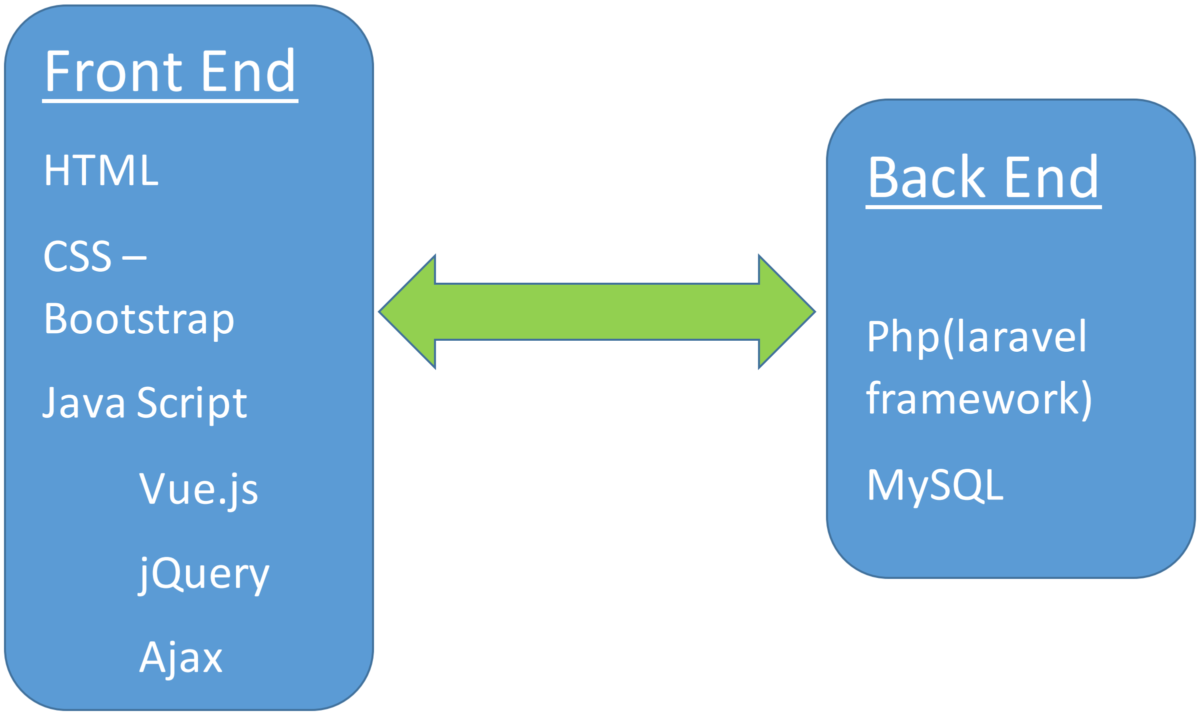


Figure 15 :MVC architecture of laravel framework

Technologies used in the web application



Technologies used in Mobile Application

We mainly used the ionic framework as it is compatible with both android and ios.

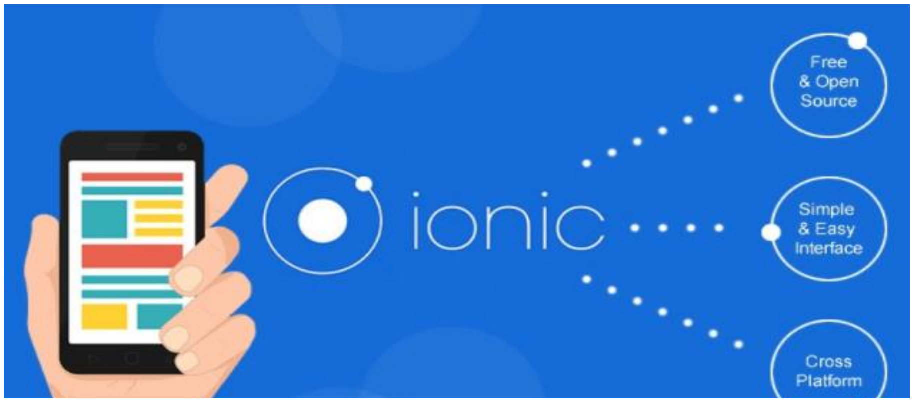


Figure 16: Reasons for choosing ionic

Application Platform Interfaces (APIs) Used

RESTful API (Laravel)

It is an application program interface that uses HTTP requests to GET, PUT, POST and DELETE data.
A RESTful API -- also referred to as a RESTful web service -- is based on representational state transfer technology, an architectural style.One of the key advantages of REST APIs is that they provide a great deal of flexibility. Data is not tied to resources or methods, so REST can handle multiple types of calls, return different data formats and even change structurally with the correct implementation of hypermedia.

Pusher API

Pusher is a simple hosted API for quickly, easily and securely adding real time bi-directional functionality via WebSockets to web and mobile apps, or any other Internet connected device. Pusher offers a rich suite of libraries that can be used within our applications. This makes the real time notification system much easier.

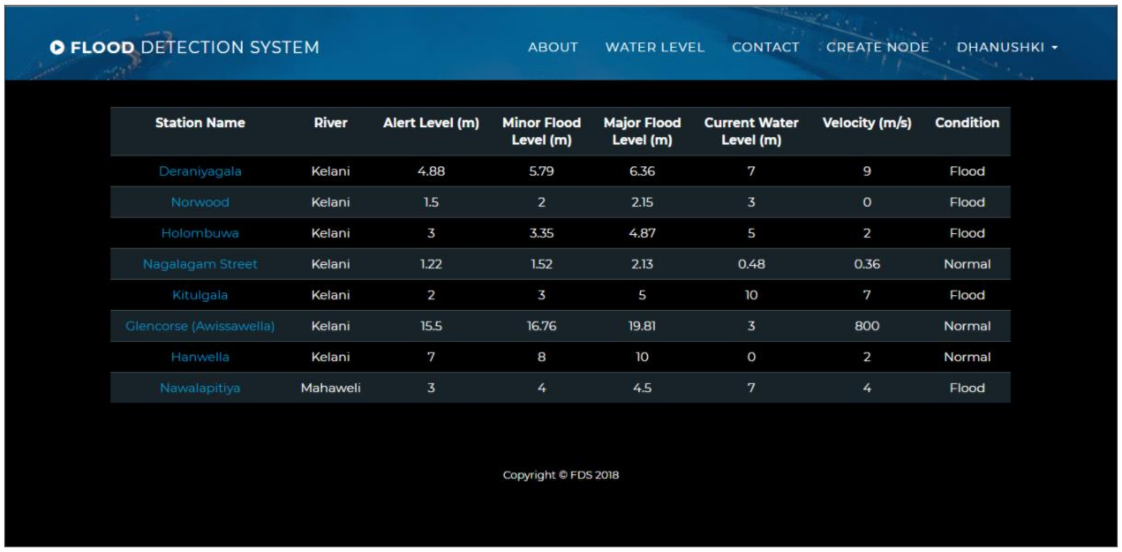
Google Maps API

Google Maps API allows display the location of each location of nodes in our web application and also the user can search nodes according to his/her location.

We use Postman to test and manage our APIs.Reasons for using postman are;

1. It has an easy to use interface
2. It’s automation capabilities - It helps to automate the process of making API requests and testing API responses, allowing developers to establish a very efficient workflow
3. History/Auto complete
4. Easy organization - Postman allows API calls to be organized into groups that can be saved as “collections.” Folders can be added to collections allowing API calls to be further organized into sub-collections. Collections and folders are especially useful when consuming many APIs and regularly testing a large number of API calls. Collections make it possible for developers to find and reuse specific API requests quickly.
5. Response viewer
6. Test Editor and runner

Interface Design



Station Name	River	Alert Level (m)	Minor Flood Level (m)	Major Flood Level (m)	Current Water Level (m)	Velocity (m/s)	Condition
Deraniyagala	Kelani	4.88	5.79	6.36	7	9	Flood
Norwood	Kelani	1.5	2	2.15	3	0	Flood
Holombuwa	Kelani	3	3.35	4.87	5	2	Flood
Nagalagam Street	Kelani	1.22	1.52	2.13	0.48	0.36	Normal
Kitulgala	Kelani	2	3	5	10	7	Flood
Glencorse (Awissawella)	Kelani	15.5	16.76	19.81	3	800	Normal
Hanwella	Kelani	7	8	10	0	2	Normal
Nawalapitiya	Mahaweli	3	4	4.5	7	4	Flood

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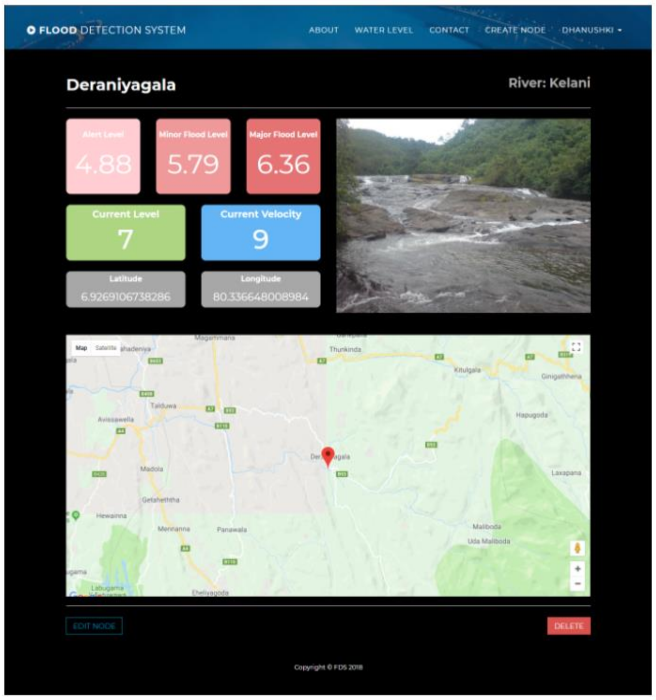

Deraniyagala River: Kelani

Alert Level 4.88
Minor Flood Level 5.79
Major Flood Level 6.36
Current Level 7
Current Velocity 9
Latitude 6.9269106738286
Longitude 80.336648008984

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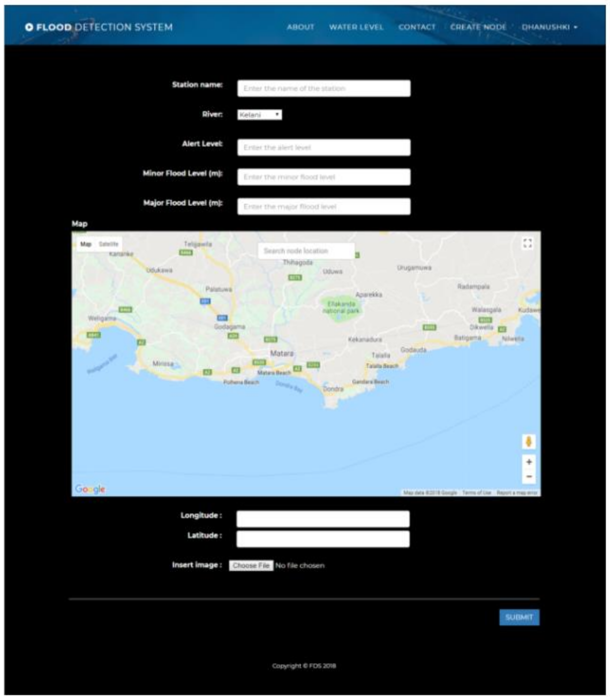

Station name: Enter the name of the station
River: Kelani
Alert Level: Enter the alert level
Minor Flood Level (m): Enter the minor flood level
Major Flood Level (m): Enter the major flood level
Longitude :
Latitude :
Insert image : No file chosen

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Figure 17: Interface Designs

Database Design

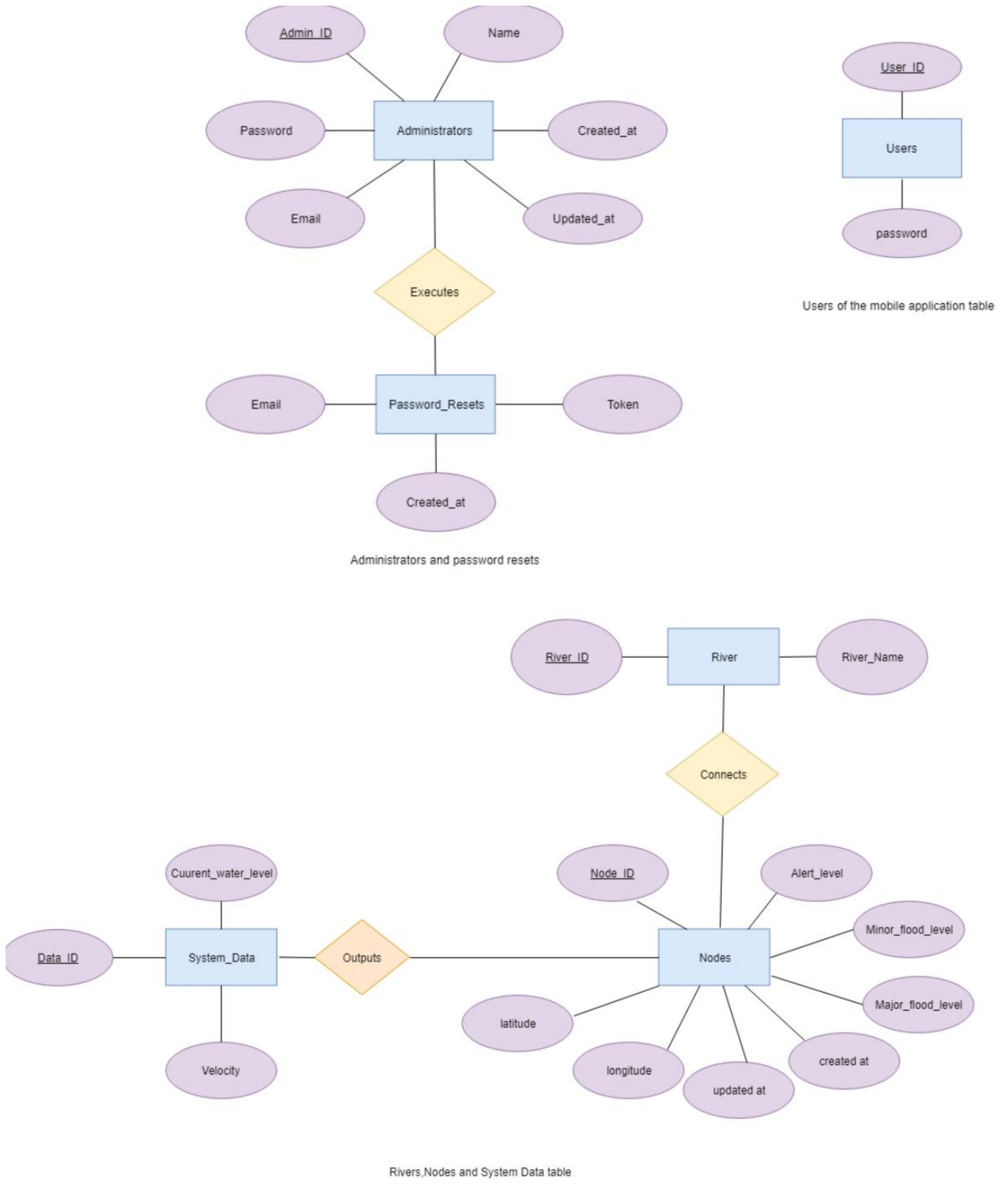


Figure 18: Database Design

Network Security

Since our system doesn’t contain any sensitive data,and is intended to be available to the public ,encrypting the data would not serve any purpose. Instead we are focusing on taking suitable precautions against any 3rd party manipulating and corrupting our data. To overcome this issue we are mainly focusing on 3 aspects.

- Activating an SSL certificate for the web interface
- User Authentication
- Authenticating the message from the microcontroller using message authentication code(MAC)

MAC

A message authentication code (often called MAC) is a block of a few bytes that is used to authenticate a message. The receiver can check this block and be sure that the message hasn't been modified by the third party

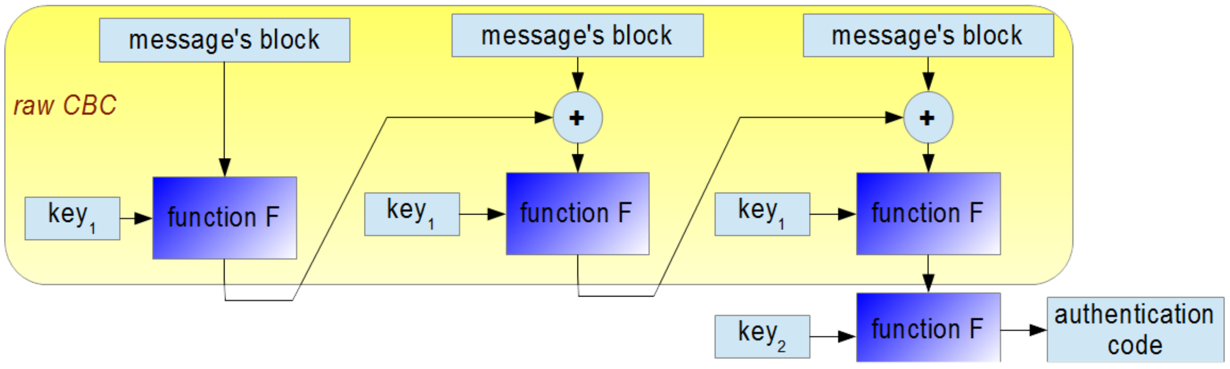
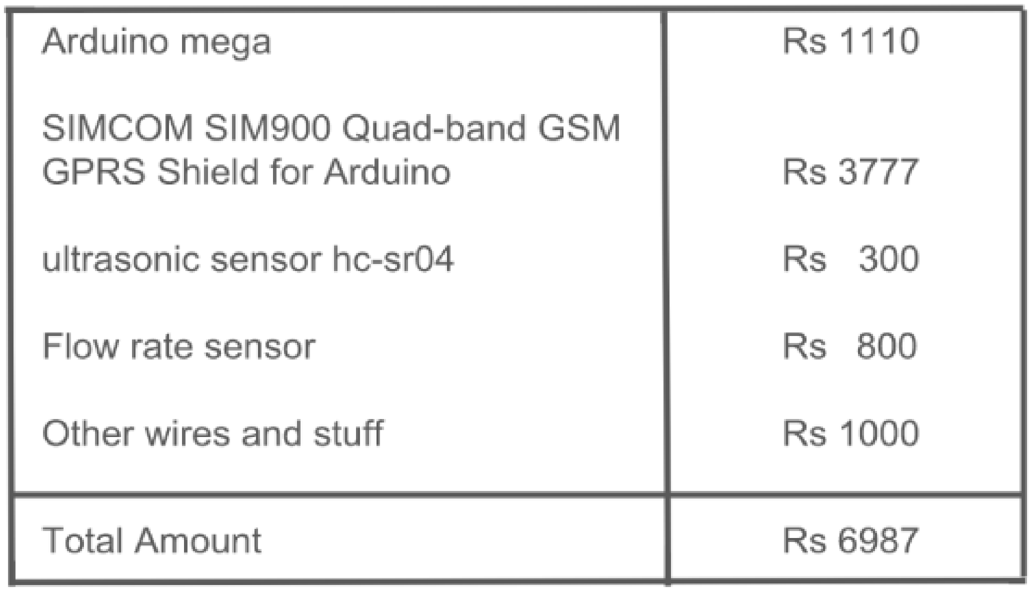


Figure 19: Theory behind MAC protocol

Budget

Table 1:Budget



Arduino mega	Rs 1110
SIMCOM SIM900 Quad-band GSM GPRS Shield for Arduino	Rs 3777
ultrasonic sensor hc-sr04	Rs 300
Flow rate sensor	Rs 800
Other wires and stuff	Rs 1000
Total Amount	Rs 6987

Timeline

Table 2:Timeline

Description	1	2	3	4	5	6	7	+6	8	9	10	11	12	13	14
Project selection,Problem identification,feasibility analysis and background study	■														
Planning and designing of the embedded system,required network for communications,servers and security aspects		■	■												
Testing with different components of the initial plan,implementing the hardware,developing the communication network considering security aspects,developing the web interface and the mobile application while making relevant changes to overcome the limitations of the initial plan				■	■	■	■	■	■	■	■				
Testing and other further implementations												■	■	■	
Project completion and documentation															■