Localization of Wireless Sensor Nodes using Arduino

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ABSTRACT: WSNs has significant applications such as distant environmental monitor and end track particularly in previous years with the help of sensors that are slighter, cheaper and intelligent. Localization of *Wireless Sensor Nodes* at a given network area are used some known location Anchor nodes for better results. By considering the anchor nodes as reference nodes at given area, the localization of unknown sensor Nodes Location be able to be estimated, to approximate the sensor nodes triangulation method was adopted. The data of each sensor node is collected in wireless manor exploit the ESP8266 Wifi module which is connected wirelessly to other sensor nodes where as anchor node connected to PC through a wire (mostly USB). The collected data is interpreted using Arduino and displayed on serial monitor. This paper mainly focused on localization of sensor nodes where few nodes are interfaced with GPS modules and other nodes without GPS. The nodes with GPS will gather location information and sends to the node which is connected to PC called anchor node. In this paper we try to establish the connectivity of physical nodes, and its location identification. The results show that physical nodes localization with Arduino shows better performance.

Keywords: Arduino, Triangulation, ESP8266, GPS, Wireless Sensor Nodes.

I. INTRODUCTION:

In the recent years *Wireless sensor networks (WSN)* are the most vigorous investigate area from the past few years, as the demand for sensor nodes in real time applications are growing gradually. In WSNs the location of sensor nodes is the critical element in the deployed area where especially nodes are in movement, then it is extremely complex to find the exact location of unknown node, and it's difficult to estimate how far unknown nodes away from the anchor nodes. Many algorithms were proposed to estimate the correct Location of sensor nodes but when the nodes are in motion, most of the algorithms failed to approximate the exact Location of Target nodes. We proposed triangulation method to find the correct Location of unknown nodes, whose location is often changes, in this situation it is very hard for the anchor nodes to estimate the exact location of targeted . WSNs integrate sensor technology, embedded computing techniques etc. [1][2][3]

Arduino is a microcontroller board based on the ATmega328P and it is an open source electronics platform based on easy to use hardware, software and low cost [4]. Arduino boards are capable of read inputs and make it to an output for display. The Arduino board consists of everything to support the microcontroller means simply connect it to a PC with a USB cable or power it with a battery or adapter.

II. ARDUINO:

Arduino is a simple suitable and flexbile hardware and software open source electronic based platform, derived from a easy input/output interfacing of open sourec code, its enlargement enviromnent uses the programing language similar to other languages like Java and C. Arduino majorly contains of 2 parts

a. Hardware Module

b. Software

Arduino have a range of open circuit board designed resources, and open program interfacing and programming. All the developers in the development process carryout the hardware ckt simplified designs, to develop with the functional circuit operating separately and that meet the requirements.

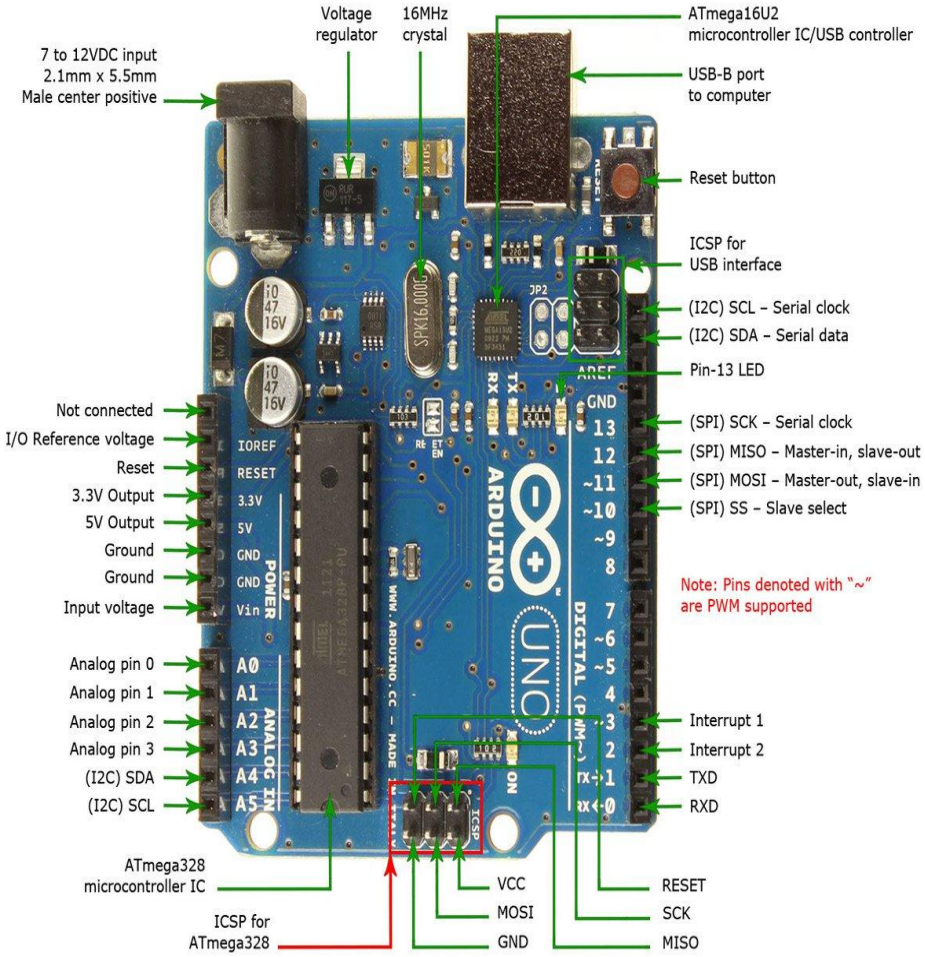

Fig.1 Arduino pin configuration

As shown in figure1the various pin configuration of Arduino board consists of number of supply and ground pins, few pins are multiplexed.

ESP8266WIFI:

Arduino ESP8266 capable of function constantly in industrial environments, due to its wide operating temperature range. With highly-integrated on-chip features and minimal external discrete component count, the chip offers reliability, compactness and robustness. The ESP8266 achieve low power consumption with a mixture of several proprietary technologies. The power saving design characters are 3 modes of operation: active, sleep and deep sleep mode.

ESP8266 WiFi modules are (SoC) self contained with integrated TCP/IP protocol stack be capable of provide any microcontroller access WiFi network. As shown in figure.2 the ESP8266wifi modules have a powerful on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal improvement upfront and minimal loading runtime.

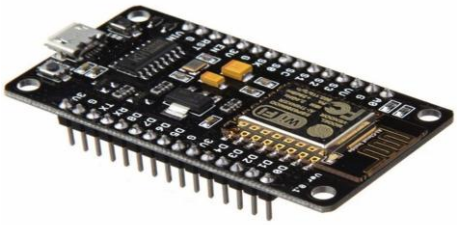

Fig.2 ESP8266wifi module

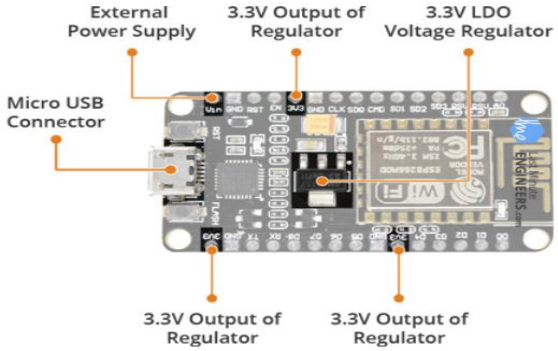

Fig.3 Functional elements of ESP8266wifi

The other main elements which are widely used for many applications are given in figure.3 which consists of external power supply, Micro USB Connector, 3.3V Output of regulator etc.

III. NODE LOCALIZATION:

There are many techniques are available for node's position estimation for localization process, example, Trilateration is the most widely used 2D Localization method which requires the distance information of 3 reference nodes then the target nodes position is estimated at the intersecting points of the target nodes encircles with the radius of the targeted nodes encircle with the reference nodes and in multilateration more than 3 reference nodes used to estimate the unknown node, distance estimation errors are minimized as compared to the Trilateration method [1][2][3].

In Triangulation technique the measured angles between the reference nodes to unknown nodes are formed. The unknown node estimates location using trigonometrically relations by the angles to each of the 3 anchor nodes which forms a triangle [1] [2].

Figure 4 demonstrates the interconnectivity of ESP8266 modules as sensor nodes through wifi router, here wifi router may be a mobile or a wifi router, physical connection establishment procedure and figure 5 shows how the client connects to server through wifi.

Procedure:

The connection procedure is as follows

- Load Arduino program into the ESP8266 modules
- Load the program separately for anchor and other nodes
- Connect the Anchor node to PC
- Open arduino COM terminal to display the location of nodes
- Client connects to server wirelessly and server to the PC through wire

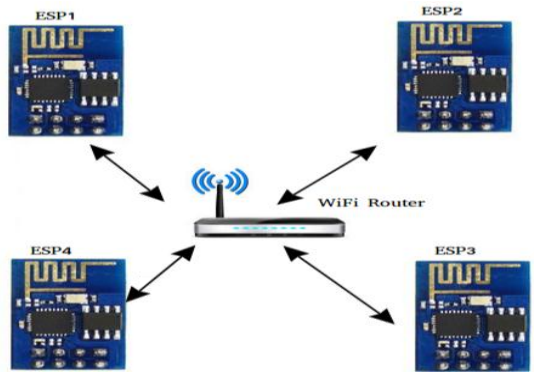

Fig. 4 ESP8266 node interconnection

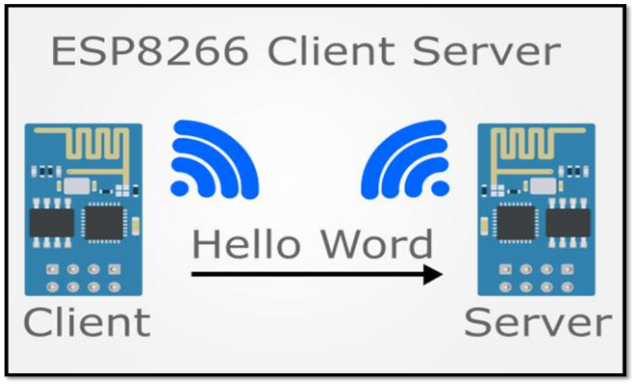

Fig. 5 ESP8266 Server-Client configuration

Program:

- **Anchor Node:**

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Anchor_Node §

```
#include <ESP8266WiFi.h>
const char* ssid = "Hanshu";
const char* password = "Venkat@411";
const char* host1 = "192.168.43.214";
const char* host2 = "192.168.43.38";

void setup()
{
Serial.begin(115200);
Serial.println();

  //Serial.printf("Connecting to %s ", ssid);
WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED)
  {
delay(500);
Serial.print(".");
  }
Serial.println(" connected");
}
void loop()
{
WiFiClient client;
  client.connect(host1, 80);
client.print(String("GET /") + " HTTP/1.1\r\n" +
                "Host: " + host1 + "\r\n" +
                "Connection: close\r\n" +
                "\r\n"
               );
```

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Anchor_Node §

```
                "\r\n"
               );
               delay(1000);
               while (client.connected() || client.available())
    {
      if (client.available())
      {
        String line = client.readStringUntil('\n');
Serial.println(line);
      }
    }
client.stop();
delay(5000);
client.connect(host2, 80);
client.print(String("GET /") + " HTTP/1.1\r\n" +
                "Host: " + host2 + "\r\n" +
                "Connection: close\r\n" +
                "\r\n"
               );
    while (client.connected() || client.available())
    {
      if (client.available())
      {
        String line = client.readStringUntil('\n');
Serial.println(line);
      }
    }
client.stop();
}
```

- **Sensor Node**

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Node

```
#include <ESP8266WiFi.h>
#include <SoftwareSerial.h>
#include <TinyGPS.h>
float lat = 21.1014,lon = 79.0068; // create variable for latitude and longitude object
SoftwareSerial gpsSerial(D1,D2);//rx,tx

TinyGPS gps; // create gps object
const char* ssid = "Hanshu";
const char* password = "Venkat@411";
WiFiServer server(80);
void setup()
{
  Serial.begin(115200);
  delay(10);
  gpsSerial.begin(9600); // connect gps sensor
  Serial.println();
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED)
  {
    delay(500);
    Serial.print(".");
  }
  server.begin();
  Serial.printf("Web server started, open %s in a web browser\n", WiFi.localIP().toString().c_str());
}
```

Node | Arduino 1.8.10

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Node §

```
  return htmlPage;
}
void loop()
{
  while(gpsSerial.available()){ // check for gps data
  if(gps.encode(gpsSerial.read()))// encode gps data
  {
  gps.f_get_position(&lat,&lon); // get latitude and longitude
  Serial.println(lat);
  Serial.println(lon);
  }
  }
  Serial.println(lat);
  Serial.println(lon);
WiFiClient client = server.available();// wait for a client (web browser) to connect
  if (client)
  {
    Serial.println("\n[Client connected]");
    while (client.connected())
    {
      // read line by line what the client (web browser) is requesting
      if (client.available())
      {
            Serial.println("started");
          client.println(prepareHtmlPage());
          break;
        }
      }
      delay(1); // give the web browser time to receive the data
```

Hardware Implementation:

For the implementation of nodes with hardware we used battery to power up the nodes, which are randomly deployed in the predefined network area, here only 3 nodes are taken for physical implementation purpose. The ESP8266 modules are established the connection between the nodes and transmits its location information to the PC through anchor node. Anchor node wirelessly connects to the sensor nodes and collects the information from the nodes and transmits to the PC in serial mode using COM terminal the data is displayed and hardware configuration as shown in figure.6 and figure.7 where the nodes can move randomly and automatically its location information is updated at the server node and the same information is sent to the PC where it is displayed on COM terminal.

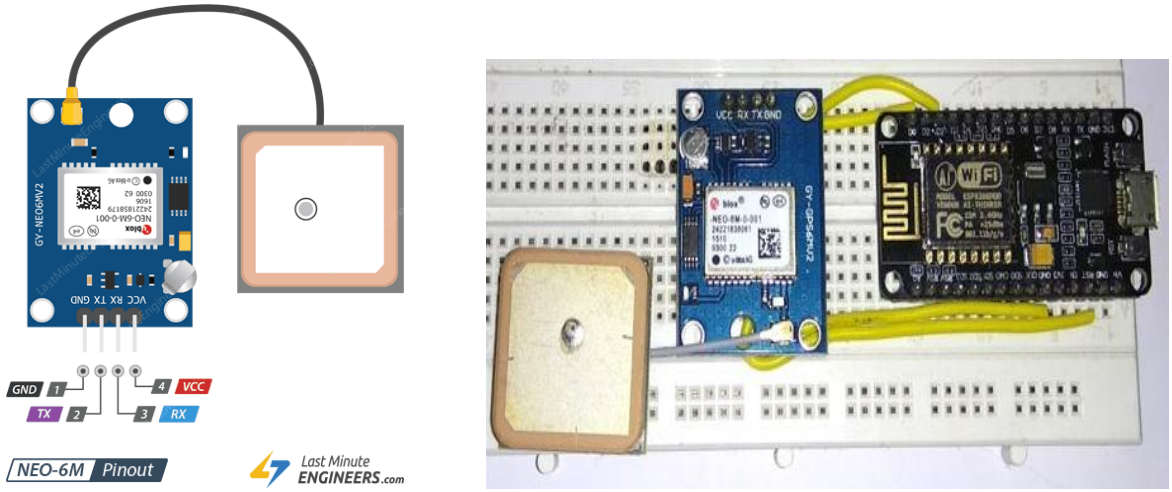

Fig. 6 ESP8266 to GPS interfacing

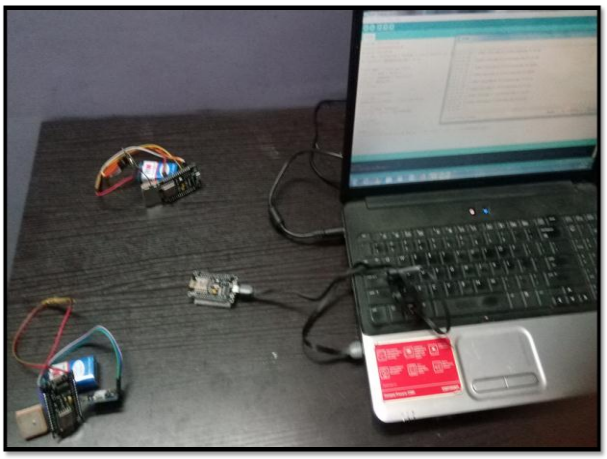

Fig.7 Node localization

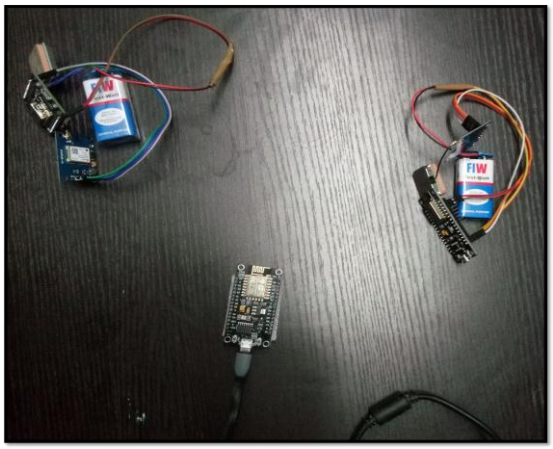

Fig.8 Random deployment of ESP8266 nodes

The above hardware configuration shows that even when the sensor nodes move randomly as in figure.8 the location information is updated to the PC through anchor node. The anchor nodes are arranged in the form of triangulation and established the connection between them physically to achieve triangulation method.

IV. SIMULATION RESULTS:

The paper mainly focused on Hardware implementation of sensor nodes and sensor nodes location identification for that we used Arduino ESP8266wifi module as sensor node as well as anchor node. Initially wifi router ID and Password is provided in the program for each node interconnection, then anchor node connects to PC and displays its status on the terminal and the other nodes connects to anchor node to update its location information. When the nodes move randomly then its updated information is passed to the anchor node immediately. For hardware implementation initially 3 nodes are used.

V. CONCLUSION:

We estimated the location of mobile nodes with Arduino ESP8266 hardware module which are interfaced with GPS modules. The location information of sensor node is passed to anchor nodes then to PC via anchor node. In future more number of sensor nodes connected to anchor nodes. Based on the performance of hardware modules we conclude that the exact location of sensor nodes is estimated and updated through GPS which is interfaced to sensor node.

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