Smart Roads OR Smart City's Regulated and Dynamic Traffic Control System

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Abstract—Motivation: Many a times during the peak office hours of traffic, a situation occurs when the Traffic signal light is Green in one of the four ways of the 4-way crossing even though there are no vehicles in that way of the 4 Way crossing; however there is a huge amount of traffic on the other ways of the 4-way crossing which is not ideal for the system to work efficiently. Also many road accidents occur due to confusion occurring because of the above flaw in the current Traffic control system. Whenever the Traffic Guard is not present, general public does not follow the Traffic signal as they think they ought to go first as the traffic is more on their way and hence they break the signal and in this way vehicles from all the ways of the 4-way crossing too break the signal which results into a chaos and sometimes a fatal accident. Another flaw of the current Traffic control system is that as the Traffic light of one of the way of 4-way crossing turns Green, a countdown starts which signifies for how much time the signal will remain Green. The initial value of this countdown timer does not depend on the number of vehicles in that way but is constant which creates a situation where the countdown is going on and Traffic signal is Green even though all the vehicles passed the traffic signal and there are no vehicles in that way at that time. Hence overall these flaws are occurring as the current system is more uniform and less dynamic. Hence we thrive to make the system more dynamic through different resources of IoT.

Solution: The idea is that in each way of the 4 Way crossing, piezoelectric sensors would be installed. Piezoelectric sensors would be installed some distance away from the zebra crossing and would cover the whole width of the road(call it a strip). As soon as, a vehicle passes through the piezoelectric sensors, the electric centre of charge in the piezoelectric sensors would shift which would produce some voltage and current. As soon as an Arduino or any microprocessor or micro-controller connected to the piezoelectric sensors senses change in voltage greater than some threshold value(decided later), it increases the value of the counter by 1. Several piezoelectric sensors are installed on the strip. Each piezoelectric sensor on the strip is connected to its individual Arduino as of now(certain number of piezoelectric sensors can also be connected to one Arduino depending on the number of input pins available on the Arduino board). These Arduino boards are connected to a computer. Hence the computer knows the number of vehicles which are present between the strip and zebra crossing. Similarly different Arduinos and computer(connected to these different Arduinos) on all the other three ways of the 4-way crossing perform the same operation. These computers send their data to a common server which compares the values of the counters(no of vehicles) and respectively makes decision of which way's traffic light should be made green first. Once in one cycle one way is chosen by the server, it eliminates that way from consecutive comparisons as we don't want a situation to occur where Traffic signal remains Green only for one way of the 4-way crossing all the time. After one cycle(traffic lights of all the ways turn green once), the process continues. Also Automatic barrier gates can be installed on each way of the 4-way crossing which would be controlled by the server too and would open when server turns the Traffic signal green. This would prevent the general public from breaking the signal.

1 Detailed Problem Statement and Prescribed Solution

Smart City's Regulated and Dynamic Traffic control system aims at solving the inefficiencies of the present Traffic control system. Detailed Problem Statement is already included in the Abstract. We have devised a Lab simulator of the Prescribed Solution which represents how the proposed system would operate when implemented in real life. The detailed minutes of the project are as follows:

1.1 Equipments

The equipments used for simulation are piezoelectric sensors, Arduino Uno microprocessor controller for controlling or choosing which way's traffic light should be turned green first and in consecutive steps; eliminating the previously chosen way in a cycle, LEDs representing the Traffic Signal lights, IC 7404 (NOT Gate), breadboards and connecting wires.

1.2 Arduino Code

```
int D0=6;
int D1=9;
int D2=10;
int D3=11;

int VAInput=A0;
int VBInput=A1;
int VCInput=A2;
int VDInput=A3;

float diff=0.5;

int bA=0;
int bB=0;
int bC=0;
int bD=0;

int cA=0;
int cB=0;
int cC=0;
int cD=0;

float VA=0.0;
float VA0=0.0;
float VB=0.0;
float VB0=0.0;
float VC=0.0;
float VC0=0.0;
float VD=0.0;
float VD0=0.0;

float lst[4];
float lst1[4];
float lst2[4];
float lst3[4];
float lst4[4];

float p;

float maxValue(float lst[]){
  float p;
  p=lst[0];
  for (int i=0;i<4;i++){
  if (lst[i]>p){
    p=lst[i];
    }
  }
  return p;
}

void setup() {
  // put your setup code here,
  // to run once:
  Serial.begin(250000);
  pinMode(VAInput,INPUT);
  pinMode(VBInput,INPUT);
  pinMode(VCInput,INPUT);
  pinMode(VDInput,INPUT);

  pinMode(D0,OUTPUT);
  pinMode(D1,OUTPUT);
  pinMode(D2,OUTPUT);
  pinMode(D3,OUTPUT);

}

void loop() {
// put your main code here,
```

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```
// to run repeatedly:
  while (true){
    VA0=(5.0/1023.0)*
     analogRead(VAInput);
    delay(1000);
    VA=(5.0/1023.0)*
     analogRead(VAInput);
    bA=bA+1;
    if(bA>30){
      break;}
    if(VA-VA0>diff){ //|| VA0-VA>diff){
      cA=cA+1;}
    Serial.print("VA:");
    Serial.println(VA0);

    Serial.print("bA:");
    Serial.println(bA);
    Serial.print("cA:");
    Serial.println(cA);
    }

  while (true){
    VB0=(5.0/1023.0)*
     analogRead(VBInput);
    delay(1000);
    VB=(5.0/1023.0)*
     analogRead(VBInput);
    bB=bB+1;
    if(bB>30){
      break;}
    if(VB-VB0>diff){ //|| VB0-VB>diff){
      cB=cB+1;}
    Serial.print("VB:");
    Serial.println(VB0);

    Serial.print("bB:");
    Serial.println(bB);
    Serial.print("cB:");
    Serial.println(cB);

    }
  while (true){
    VC0=(5.0/1023.0)*
     analogRead(VCInput);
    delay(1000);
    VC=(5.0/1023.0)*
     analogRead(VCInput);
    bC=bC+1;
    if(bC>30){
      break;}
    if(VC-VC0>diff){ //|| VB0-VB>diff){
      cC=cC+1;}
    Serial.print("VC:");
    Serial.println(VC0);

    Serial.print("bC:");
    Serial.println(bC);
    Serial.print("cC:");
    Serial.println(cC);

    }
   while (true){
      VD0=(5.0/1023.0)*
       analogRead(VDInput);
      delay(1000);
      VD=(5.0/1023.0)*
       analogRead(VDInput);
      bD=bD+1;
      if(bD>30){
        break;}
      if(VD-VD0>diff){ //|| VB0-VB>diff){
        cD=cD+1;}
      Serial.print("VD:");
      Serial.println(VD0);

      Serial.print("bD:");
      Serial.println(bD);
      Serial.print("cD:");
      Serial.println(cD);

      }

  float lst[]={cA,cB,cC,cD};

  for (int i=0;i<4;i++){
    Serial.print(lst[0]);
    Serial.print(",");
    Serial.print(lst[1]);
    Serial.print(",");
    Serial.print(lst[2]);
    Serial.print(",");
    Serial.println(lst[3]);
    }
  p=maxValue(lst);

  if(p==cA){
    digitalWrite(D0,HIGH);
    delay(5000*cA);
```

```
  digitalWrite(D0,LOW);
  for(int i=0;i<4;i++){
    if(lst[i]!=p){
      lst1[i]=lst[i];
      }
    else{lst1[i]=0.0;}
    }
   };
if(p==cB){
  digitalWrite(D1,HIGH);
  delay(5000*cB);
  digitalWrite(D1,LOW);
  for(int i=0;i<4;i++){
    if(lst[i]!=p){
      lst1[i]=lst[i];
      }
    else{lst1[i]=0.0;}
    }
   };
if(p==cC){
  digitalWrite(D2,HIGH);
  delay(5000*cC);
  digitalWrite(D2,LOW);
  for(int i=0;i<4;i++){
    if(lst[i]!=p){
      lst1[i]=lst[i];
      }
    else{lst1[i]=0.0;}
    }
   };
if(p==cD){
  digitalWrite(D3,HIGH);
  delay(5000*cD);
  digitalWrite(D3,LOW);
  for(int i=0;i<4;i++){
    if(lst[i]!=p){
      lst1[i]=lst[i];
      }
    else{lst1[i]=0.0;}
    }
   };

for (int i=0;i<4;i++){
  Serial.print(lst1[0]);
  Serial.print(",");
  Serial.print(lst1[1]);
  Serial.print(",");
  Serial.print(lst1[2]);
  Serial.print(",");
  Serial.println(lst1[3]);
  }
p=maxValue(lst1);

if(p==cA){
  digitalWrite(D0,HIGH);
  delay(5000*cA);
  digitalWrite(D0,LOW);
  for(int i=0;i<4;i++){
    if(lst1[i]!=p){
      lst2[i]=lst1[i];
      }
    else{lst2[i]=0.0;}
    }
   };
if(p==cB){
  digitalWrite(D1,HIGH);
  delay(5000*cB);
  digitalWrite(D1,LOW);
  for(int i=0;i<4;i++){
    if(lst1[i]!=p){
      lst2[i]=lst1[i];
      }
    else{lst2[i]=0.0;}
    }
   };
if(p==cC){
  digitalWrite(D2,HIGH);
  delay(5000*cC);
  digitalWrite(D2,LOW);
  for(int i=0;i<4;i++){
    if(lst1[i]!=p){
      lst2[i]=lst1[i];
      }
    else{lst2[i]=0.0;}
    }
   };
if(p==cD){
  digitalWrite(D3,HIGH);
  delay(5000*cD);
  digitalWrite(D3,LOW);
  for(int i=0;i<4;i++){
    if(lst1[i]!=p){
      lst2[i]=lst1[i];
      }
    else{lst2[i]=0.0;}
    }
   };
```

```
for (int i=0;i<4;i++){
  Serial.print(lst2[0]);
  Serial.print(",");
  Serial.print(lst2[1]);
  Serial.print(",");
  Serial.print(lst2[2]);
  Serial.print(",");
  Serial.println(lst2[3]);
  }
p=maxValue(lst2);

if(p==cA){
  digitalWrite(D0,HIGH);
  delay(5000*cA);
  digitalWrite(D0,LOW);
  for(int i=0;i<4;i++){
    if(lst2[i]!=p){
      lst3[i]=lst2[i];
      }
    else{lst3[i]=0.0;}
    }
   };
if(p==cB){
  digitalWrite(D1,HIGH);
  delay(5000*cB);
  digitalWrite(D1,LOW);
  for(int i=0;i<4;i++){
    if(lst2[i]!=p){
      lst3[i]=lst2[i];
      }
    else{lst3[i]=0.0;}
    }
   };
if(p==cC){
  digitalWrite(D2,HIGH);
  delay(5000*cC);
  digitalWrite(D2,LOW);
  for(int i=0;i<4;i++){
    if(lst2[i]!=p){
      lst3[i]=lst2[i];
      }
    else{lst3[i]=0.0;}
    }
   };
if(p==cD){
  digitalWrite(D3,HIGH);
  delay(5000*cD);
  digitalWrite(D3,LOW);
  for(int i=0;i<4;i++){
    if(lst2[i]!=p){
      lst3[i]=lst2[i];
      }
    else{lst3[i]=0.0;}
    }
   };

for (int i=0;i<4;i++){
  Serial.print(lst3[0]);
  Serial.print(",");
  Serial.print(lst3[1]);
  Serial.print(",");
  Serial.print(lst3[2]);
  Serial.print(",");
  Serial.println(lst3[3]);
  }
p=maxValue(lst3);

if(p==cA){
  digitalWrite(D0,HIGH);
  delay(5000*cA);
  digitalWrite(D0,LOW);
  for(int i=0;i<4;i++){
    if(lst3[i]!=p){
      lst4[i]=lst3[i];
      }
    else{lst4[i]=0.0;}
    }
   };
if(p==cB){
  digitalWrite(D1,HIGH);
  delay(5000*cB);
  digitalWrite(D1,LOW);
  for(int i=0;i<4;i++){
    if(lst3[i]!=p){
      lst4[i]=lst3[i];
      }
    else{lst4[i]=0.0;}
    }
   };
if(p==cC){
  digitalWrite(D2,HIGH);
  delay(5000*cC);
  digitalWrite(D2,LOW);
  for(int i=0;i<4;i++){
    if(lst3[i]!=p){
      lst4[i]=lst3[i];
      }
    else{lst4[i]=0.0;}
```

```
    }
   };
if(p==cD){
  digitalWrite(D3,HIGH);
  delay(5000*cD);
  digitalWrite(D3,LOW);
  for(int i=0;i<4;i++){
    if(lst3[i]!=p){
      lst4[i]=lst3[i];
      }
    else{lst4[i]=0.0;}
    }
   };

for (int i=0;i<4;i++){
  Serial.print(lst4[0]);
  Serial.print(",");
  Serial.print(lst4[1]);
  Serial.print(",");
  Serial.print(lst4[2]);
  Serial.print(",");
  Serial.println(lst4[3]);
  }

Serial.println("Press any button to continue..");
while(Serial.available()==0){}
}
```

1.3 Details of how the problem is being currently addressed and related work in this area

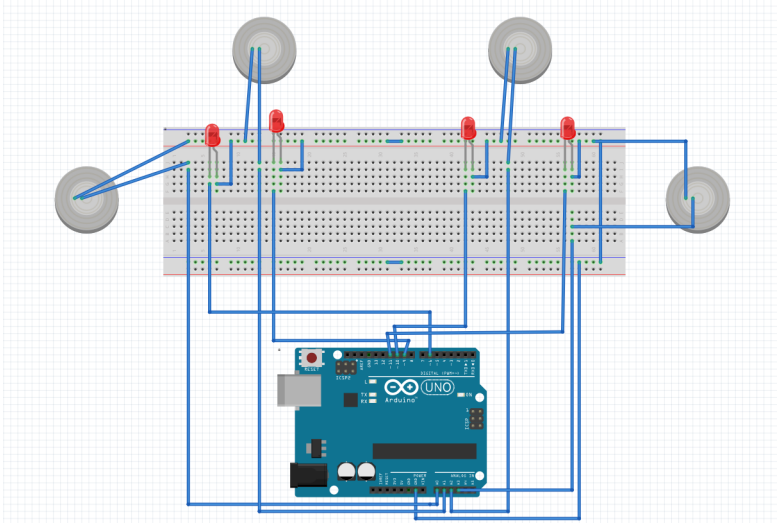
The Concept of making the Traffic Control system more dynamic is being thought of by many great minds using different tools of IOT. The chief idea is to know the number of vehicles present at that instant of time on a particular roadway. Most of them are leaning towards Computer Vision. CCTV cameras placed near the Traffic Signal would differentiate vehicles from other objects; just as in Face Detection, the computer differentiates the face of a Human Being from the surrounding objects. Hence through Machine Learning the computer connected to CCTV cameras would be able to differentiate vehicles from other objects like tree. By this we get information about the number of vehicles in that particular road. In the US, the city of Pittsburgh embraced SURTRAC (Scalable Urban Traffic Control) after years of struggling with intense traffic conditions. SURTRAC uses Computer Vision as mentioned above. The project, executed with Carnegie Mellon University's Transportation Center, showed tremendous promise. However a big disadvantage in using the CCTV cameras is that they are very vulnerable. Anything(can be natural or man-made) can harm the CCTV cameras pretty easily. And the maintenance cost for the entire system is very high which makes it non-economical. Some great minds tried to install a magnet inside a vehicle and then through the Hall effect sensors placed inside the road they were trying to count the number of vehicles by rapid changes in voltage across Hall effect sensor which is directly proportional to change in magnetic field. However they didn't seem to get the desired result when they implemented in real life. Link for the same is here. Many great minds are trying to control the traffic by giving real time information to the public about the amount of traffic in different areas of the city with the help of Traffic Apps.

2 Uniqueness of the Project/Innovation

A question arises that what makes our project different from that mentioned in the section 1.3 i.e. how our project is unique from the above mentioned ones. Many of the limitations observed in the above mentioned ones can be rectified by our project. Like as mentioned in section 1.3 CCTV controlled traffic control system is very vulnerable. This limitation is rectified by our system as our system is completely out of reach from the general public. The piezoelectric sensors are present a layer beneath the uppermost layer of the road and the computer can be connected either with the help of wires or can be wireless. These computers can be isolated from the general public however the CCTV cameras cannot be. Another limitation of CCTV controlled Traffic system is that the CCTV cameras are unable to differentiate between a car and a truck(as of now machine learning has not been successful in making a computer differentiate between photos of car and a truck). This

makes the system inefficient as heavy vehicles like truck need more time than lighter vehicles like motorcycle to pass the Traffic signal. This limitation can be rectified by our system as the change in voltage noted by the computer due to a truck would be much more than that of a car as electric center of charge of a piezoelectric sensor would deviate more due to a truck than a car. hence the initial value of countdown timer would be the sum of time values obtained by operating a special function(decided later) on the magnitude of change in voltages due to different vehicles. Hence the above limitation is rectified. The system developed using Hall effect sensor and a magnet seems impractical as we would not be able to install magnets in all the vehicles of that particular city. And also the magnetic field strength of two magnets cannot be maintained same in practical life. Hence a situation may occur that a magnet installed in a car could produce magnetic field strength proportional to that of two cars which makes the system faulty. Here also the system cannot differentiate between a car and a truck. Also there is danger of a magnetic object getting attracted towards the vehicle due to the magnet installed in the vehicle. Traffic apps on the other hand are not trying to curb the problem but they are just trying to divert the problem into a different direction. Limitation of Traffic apps is what to do when we are forced to pass through that particular high traffic region.

3 System or Concept level Block Diagram of our Simulation(close to real ones)



4 Objectives to achieve in 9 months of development time

If we get selected for Anveshan IoT Fellowship, we would definitely set up our project in real life. We would try to rectify each and every limitation that we encounter during the setting up of our project and make our system more and more efficient during the duration of 9 months. Also once after setting up of the project in real life, we would take reviews from those who used our Traffic Control system by comparing it with the former ones. Statistically we would take the data from the nearby hospitals and police stations regarding the number of road accidents occurred near the area where our modified Traffic Control system was established. We would also take the data of how much time the general public had to wait at the Traffic signal. The success of our project more importantly depends on reduction of the above two parameters. Moreover we would build a Facebook page regarding the project and would spread awareness among the general public about road safety and request them to visit our page and give their honest reviews regarding our project. We would spread awareness through different media like television, internet, radio and newspaper. Once everything gets established, we are most eager to make further modifications in our

project and test the same, so as to make the Traffic Control system set up by us more and more efficient. During 9 months, we would also try to modify the system such that the period for maintenance of the system is very long as well as the cost of maintenance of system is less. Once our project is declared successful then we would try to promote our project by inviting some local celebrities, leaders or philanthropist.

5 Long Term Plans for the project

If the project turns out to be successful, then we would definitely modify the system using different existing technologies. Moreover we don't know whether the rights of the project is in our hands or not. However if it would be in our hands then we would definitely give the intellectual property of the project to a firm as we alone would not be able to expand these system to other places(if the project turns out to be successful). We would also try to establish a start-up related to our project collaborating with different companies. We would also try to sell our project to Government, Private Organization, NGO or to a philanthropist. There are many future possibilities but right now we are solely concentrating on establishing our project in practical life.

6 Conclusion

6.1 Pros

- The condition of Traffic Control system would improve significantly.
- The Traffic Control system would become more dynamic and not the static or periodic one.
- The countdown on the timer of the Traffic signal would depend on the number and type(car or truck) of vehicles sensed by the system and not the one which is pre-initialized in the system.
- Time wasted waiting for the signal to turn green would turn out to be less than at present.
- Most of the system is protected from public attacks, which is unlike of the case of a CCTV camera detecting the number of vehicles through computer vision and sending the data to the server in which the CCTV camera is vulnerable to public attacks.

6.2 Cons

- The simulation done by us consisted of only one Arduino controller, hence we can't simultaneously calculate the number of vehicles on each way of the 4 Way crossing. As a result in simulation, we gave a time frame of 30 seconds to Arduino controller to calculate the number of vehicles in each way which went consecutively in each cycle and not simultaneously.
- Inspite of improving the present Traffic Control system, the proposed solution would not work without the cooperation of the public. Hence some more work needs to be done towards stopping the public from breaking the Traffic Rules.
- Maintenance of the sensors and the system have to be done periodically.
- (working on it) A situation may occur when we would need a vehicle to pass the Traffic Signal no matter what the Traffic Signal is on that way of the road due to urgency of the situation. For example, we would need to allow an Ambulance to pass the Traffic Signal no matter what the Traffic Signal is on that way of the road.

7 Equipments needed for setting up of Project in Real life

In this section, we would need help from Educators, as they would have used these Design Resources they would easily get to know which Design Resources would be the Best for our project. However looking at the Design Resources section in the website, we could say that we would need an Arduino Compatible Platform as we have included Arduino microprocessor in our project. We would also need highly sensitive sensors(can be piezoelectric or

pressure sensor). We would also need Wireless Sensor Network and Cloud platforms to connect all the computers used in the project to stay connected with the common server which does the comparisons and then turns the Traffic signal Green based on those comparisons. These are the things which we would definitely require but as we go on establishing the project in practical life we would also need more resources.

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REFERENCES

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Watch the video of our Simulation Project here.