Team Presentation

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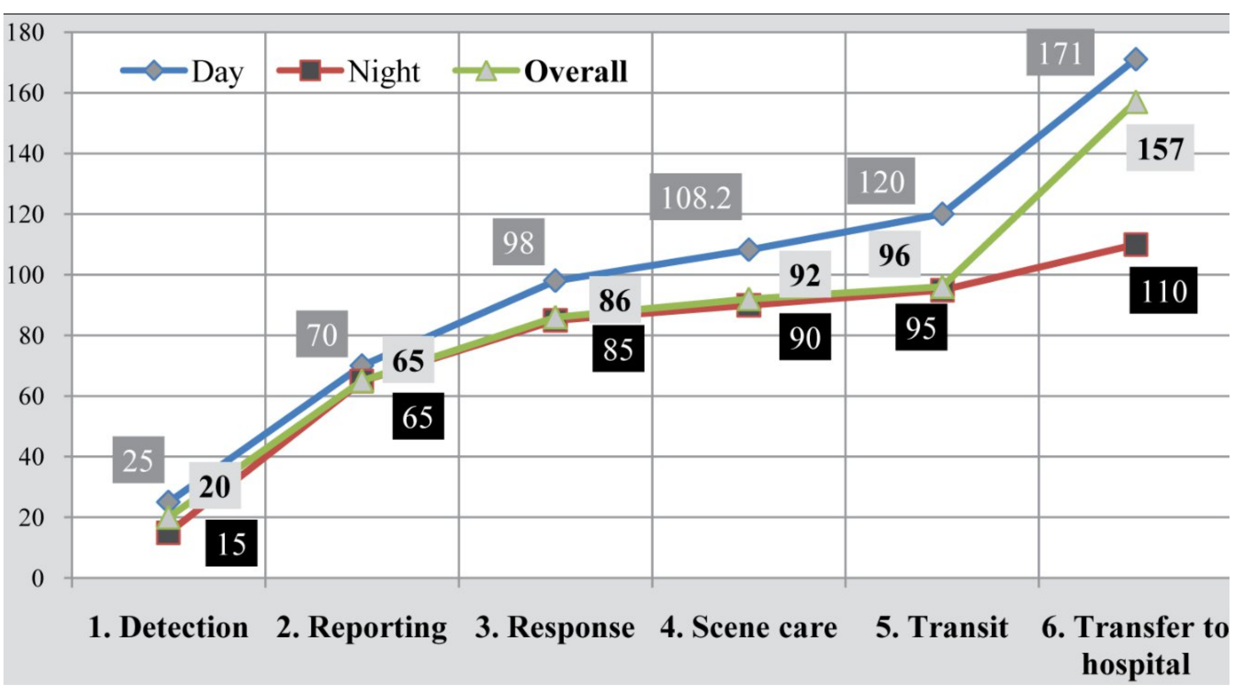
“Quieter Streets, Efficient Transport”

Abstract

Some of the world’s busiest cities are infamous for their extreme traffic congestion and disorderly road behavior. Narrow lanes, unregulated parking, and dense flows of rickshaws and vendors routinely block emergency vehicles, even when sirens are on costing lives that could be saved with timely care. To tackle this urgent issue, we team, “**Dumb Potatoes**” tried to develop a **Smart Traffic Infrastructure** aiming to achieve noise pollution free road by introducing **“Silent Horn”** and **“In-Vehicle Emergency Alert System”** that will notify the other drivers in the vicinity to make a way for the ambulances and the fire brigade. To support this eco-system, we have developed an **“Priority Based Adaptive Traffic Control System”** that gives real-time signal priority to emergency vehicles and uses features like retractable mechanical spikes to clear heavier lanes when needed. By dynamically adjusting traffic flow and creating clear corridors, our system aims to reduce emergency vehicle (ambulance and fire-truck) delays, speed up response times, and make our roads safer and more responsive during emergencies.

Problem Statement

Urban traffic congestion is an issue in many cities around Dhaka, causing severe delays in emergency response and daily communications. Throughout peak hours and holiday seasons, urgent-service vehicles frequently become stuck in traffic, delaying critically time-sensitive care.

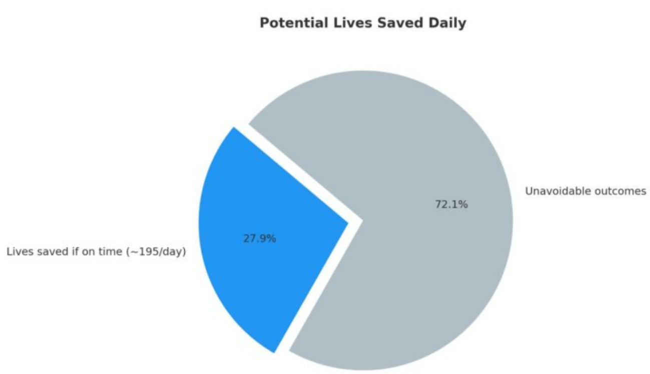


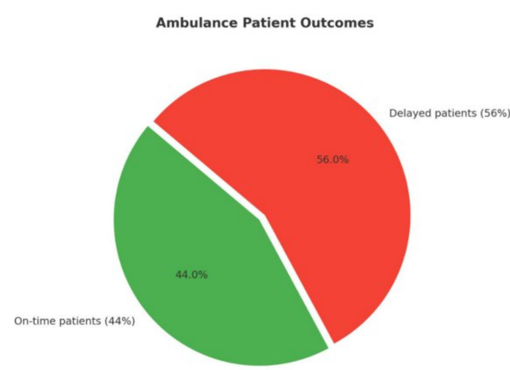
These conditions make it challenging to accurately assess situations, and our team tried to identify the crippling need for an even more monitored system developed to reduce human labor. The key factors we tried to focus on are:

- Fixed signal timing that fails to adapt to real-time traffic volume or priority vehicles.
- Ambulance services struggle due to congested intersections, reducing survival rates drastically.
- Road users and pedestrians face elevated risk from unpredictable driver behavior when traffic signals are ignored.
- Hawkers and vendors on highways, making drivers more accident prone.
- Lack of enforcement mechanisms to physically reduce illegal road entry.
- Unregulated roadside parking, narrowing lanes.
- Low awareness signaling, excessive honking contributes to chaos and noise pollution.

Reason for Choosing this Problem

In Dhaka, nearly **1,000 ambulances** are on the road every day, transporting about **700 critically ill patients.** Severe traffic congestion turns rescue missions into tragic delays. An ambulance travels for 85 minutes, and daytime **delays** normally reach up to **102 minutes**. *In emergencies, **every second matters**, and rapid response can be the difference between life and death.* As a result, **56% of emergency patients** arrive more than one hour after calling for help**,** and experts estimate that approximately **195 lives** could be saved each day if ambulances had reached on time. These prolonged journeys don't just waste time, they cost lives.





The loss of a loved one makes a devastating impact on family lives. That means each year, tens of thousands of lives hang in the balance; caught between the chaos of gridlocked roads and the promise of immediate care. Our goal isn't just to improve traffic flow, it is to ensure that those precious minutes are won back and critical patients reach help before it's too late. That's why we chose to work on traffic congestions.

Robotic Solutions

Our traffic control system is designed to ensure a safe and sustainable environment, regulating noise and reducing the dependency on human labor. Cameras measure the density of vehicles on every lane. Traffic signals change their intervals based on readings. If any emergency vehicle is detected, the system creates a clearing of the lane for the vehicle to pass through within a short time. Equipped with a retractable spike mechanism by servo motors, rule violation has immediate consequences. RFID punch cards are identified and noted on a spreadsheet during entry and exit of a vehicle and an amount is calculated to be deducted ensuring payment without human interference.

Key Features

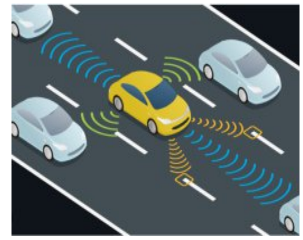
• Our system runs depending on the present situation and do not rely on regular traffic intervals. This system reduces the need for human interference, and limits need for human labor. The system is fully automated and relies on ongoing vehicles and situations.

• It is equipped with a web camera that captures real-time video, counting the number of vehicles per lane. The system then adjusts green light duration based on density of vehicles, keeping traffic flowing smoothly even in peak hours. The system autonomously manages intersections by processing live traffic camera and sensor data directly at each intersection.

• Vehicles carry RFID cards that are scanned at entry and exit points of roadside parking areas. When a car enters, the system logs it in a spreadsheet and at the time of departure, the system reads the card again to determine how long it was parked and the parking fee calculated based on the duration and deducted.

• The system detects approaching ambulances and clears a path by switching signals ahead of them, ensuring they don't get stuck in traffic and can reach destinations faster. This allows emergency vehicles to navigate through traffic without delays, reducing response times.

• Drivers press a button to send real-time alerts via ESP-NOW. The nearby cars instantly flash LED lights instead of honking, reducing noise and improving communication with minimal delay. The system uses ESP-NOW protocol, peer-to-peer communication method allowing devices to communicate directly ensuring efficient and real-time data exchange between vehicles.



• If any vehicle violates any traffic rules, an automated spike mechanism will be activated to keep the vehicle in place. This ensures the rules to be followed and the consequences be delivered.

Value of our Solution and Real-Life Implementations

Our comprehensive traffic-control system features adaptive signal control**,** emergency vehicle preemption**,** mechanical spike enforcement**,** and RFID-based parking management delivering measurable improvements in safety, efficiency, and emergency response; which, if implemented accordingly can assist in:

◦ Fast response times for emergency vehicles.

◦`Reduced congestion and travel time.

◦ Efficient and smart parking control.

◦ Immediate rule enforcement.

◦ Easy communication.

◦ Reduced reliance on human labor.

If an ambulance approaching an intersection during rush hour, the system instantly detects its presence via cameras, halts all conflicting traffic, and displays a direct green signal for swift passage. Our solution replaces noisy horn signals with LED-based alerts**,** transforming vehicle communication silent and smooth. RFID-based parking eliminates the need for attendants at entry and exit booths, minimizing manual ticketing and cash handling. Similarly, automated spike deployment and adaptive traffic signals replace on-the-ground traffic controllers who typically direct or enforce rules. This means cities can reallocate personnel from mundane monitoring tasks and focus on higher-value roles like incident response, public outreach, and maintenance.

Limitations

◦ Our system doesn't detect people walking or biking near intersections.
◦ Vehicles cannot detect the direction the horn is coming from.

Components

ESP32:

ESP32 is a low-cost, low-power system on a chip- microcontroller with integrated Wi-Fi and dual-mode Bluetooth. It is a microcontroller that can be programmed and be used for specific tasks. The **ESP32** serves as the **main microcontroller** for each vehicle, enabling our **sound-free horn system** and coordinating real-time traffic communication using **ESP-NOW communication system.**

Li – ion Battery:

Li-ion batteries are a type of rechargeable battery that uses lithium ions to store and release energy. This works as the power supply of our system. We chose this as it is affordable and enables to store more energy for extended periods without significant capacity loss, benefitting our system.

LDR:

LDR – Light Detecting Resistor is a type of electronic component whose resistance changes with light intensity. It is a passive electronic component that detects light in its environment.

Boost Module – HW-085:

The HW085 is a voltage regulator that helps adjust and maintain a stable output voltage from a lower input voltage to a higher output voltage. The mini boost converter is converting the lower input voltage to a higher, stable output voltage before distributing it to the other devices**.**

Buzzer:

The buzzer is a sounding device that can convert audio signals into sound signals. It works as an indicator for vehicles to move aside if they are in the way of other vehicles or transport.

Servo Motor – SG90:

A servo motor is a rotary actuator that allows for precise control of angular or linear position, velocity, and acceleration. The servo motor controls the direction of the spike after getting signal from the microcontroller. The reason of choosing it is because it can precisely control the position of the ESP32 Cam by rotating it to a specific angle.

Transistor – BC547:

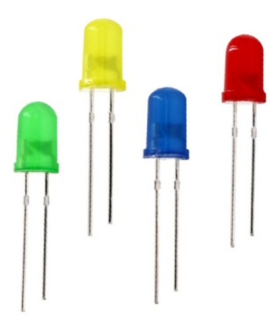
The BC547 is a semiconductor device that controls the flow of current or voltage, acting as a switch or amplifier in electronic circuits. The transistor is used in the system to control the flow of electrical power.

RFID Module – RC522:

The RC522 is used for reading data from RFID (Radio Frequency Identification) tags or cards. The system uses **RFID cards** for automated parking payment where entry and exit timestamps are recorded and fees are deducted based on the duration of stay.

LED:

LED (Light Emitting Diode), is a small, energy-efficient light source that produces light when an electrical current passes through it. It is used in traffic lights and as the headlights of vehicles. When an emergency vehicle approaches, it sends a signal via ESP-NOW, causing nearby cars to flash an LED beside the driver's seat as a silent visual alert.

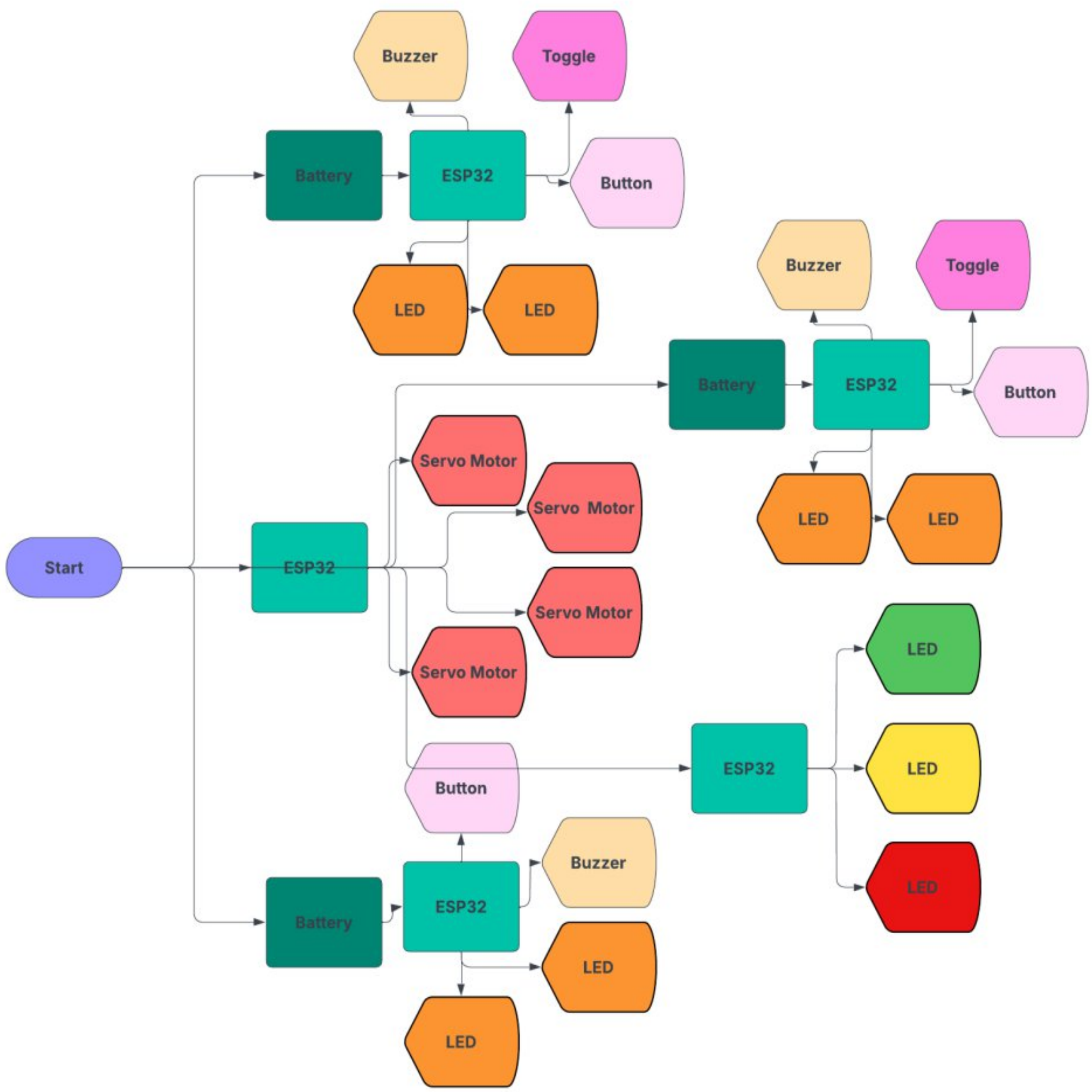


IR Sensor:

An infrared IR sensor is a device that detects infrared radiation, a type

of light invisible to the human eye. It works by emitting IR light and detecting when it's reflected back. It is used to detect vehicles when depositing fee.

Flow Chart



C
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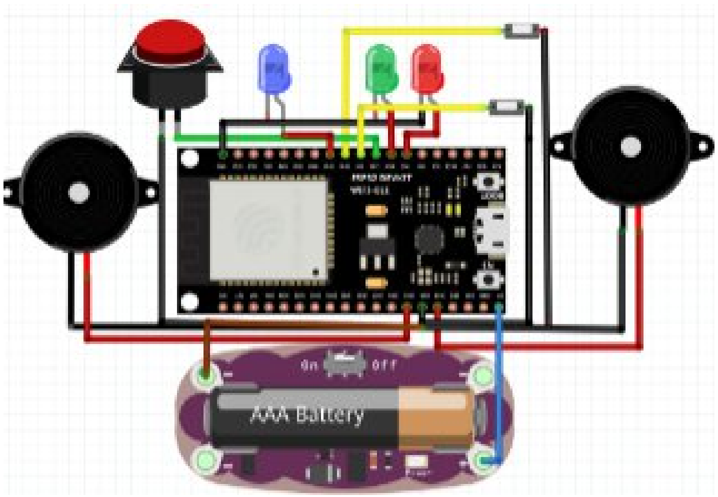
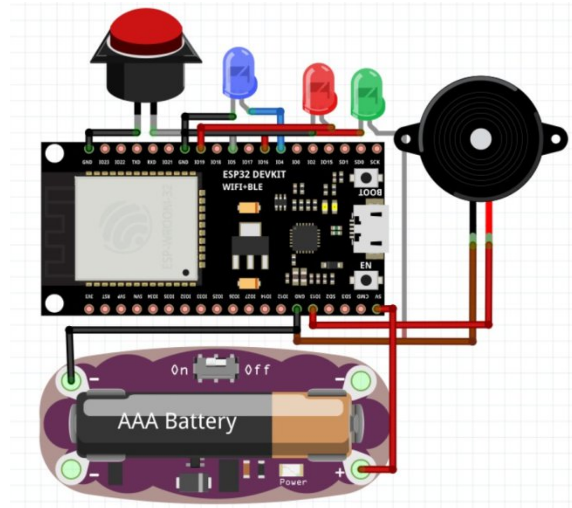
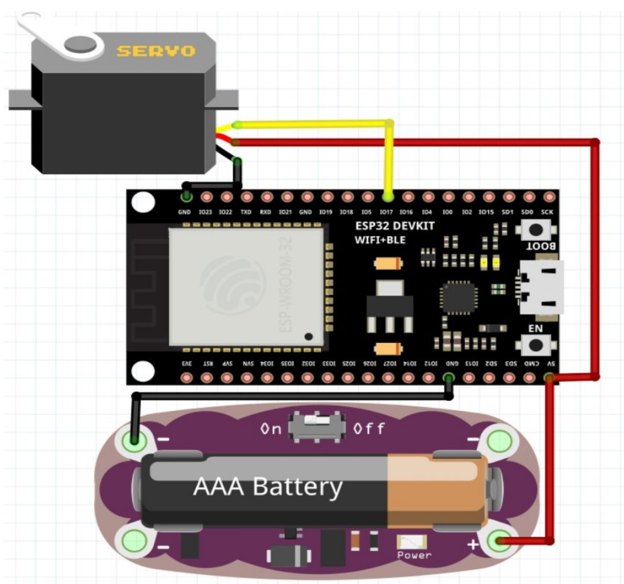


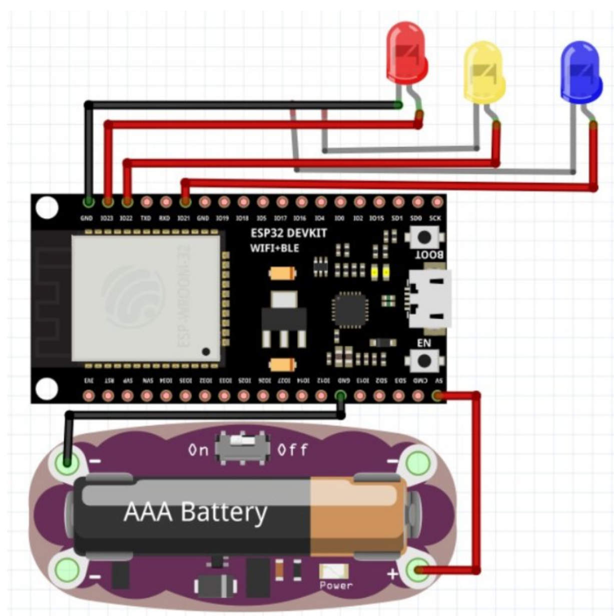
Ambulance Circuit



Car Circuit



Spike Circuit



Traffic Light Circuit

Code

```
  }
  esp_now_register_recv_cb(OnDataRecv);
  for (byte i = 0; i < 6; i++) pinMode(led[i], OUTPUT);
  Servo1.attach(Servo_Pin1);
  Servo2.attach(Servo_Pin2);
  Servo3.attach(Servo_Pin3);
  Servo4.attach(Servo_Pin4);
  Servo1.write(90);
  Servo2.write(90);
  Servo3.write(0);
  Servo4.write(0);
  mls = millis();
  (!side) ? curr = interval1 + mls - millis() : curr = interval2 + mls - millis();
}

void loop() {
  while (Serial.available()) {
    Input = Serial.readStringUntil(10);
    f = Input.toInt();
  }

  (!side) ? curr = interval1 + mls - millis() : curr = interval2 + mls - millis();

  if (curr <= 0) {
    side = !side;
    Servo1.write(90 * (side == 0));
    Servo2.write(90 * (side == 0));
    Servo3.write(90 * (side == 1));
    Servo4.write(90 * (side == 1));
    digitalWrite(led[0], (side == 0));
    digitalWrite(led[5], (side == 0));
```

It sets up ESP-NOW for wireless communication as it needs to receive the button status of the emergency vehicles to send it to python so that python can send readings to port based on the emergency vehicle's button status. There are 4 servos attached to pins 19,22,23,15 which will be used to control the spikes. The LEDs are on pins 13,17,4,27,16,18 which will be used for the traffic lights.

```
    ESP.restart();
  }
  ledcSetup(BUZZER_CHANNEL, 2000, 8);
  ledcAttachPin(buzzerPin, BUZZER_CHANNEL);
}

void loop() {
  bool buttonPressed = !digitalRead(pbPin);
  myData.b = buttonPressed;
  if(!digitalRead(toggleswitch)){
    myData.id = 90;
    if(millis()- pms > 500){
      hlo = !hlo;
      digitalWrite(redLedPin, hlo);
      digitalWrite(blueLedPin, !hlo);
      pms = millis();
    }
  }
  else{
    myData.id = 11;
    digitalWrite(blueLedPin, 0);
    digitalWrite(redLedPin, 0);
  }
  esp_now_send(peerAddress, (uint8_t *)&myData, sizeof(myData));
  delay(100);
  Serial.println(buttonPressed);
```

It sends an emergency signal using ESP-NOW receiving both normal and emergency signals and handles them differently. For normal signals where the button status is pressed, it turns on its buzzer, and the tone depends on the number of vehicles in its range. For emergency signals where the button status is pressed, if it is the first time the vehicle is sending the signal, it plays a special alarm and turns on an LED. For subsequent signals from the same vehicle, it only turns on the LED.

```
  else{
    ledcWriteTone(BUZZER_CHANNEL, 0);
  }
  Serial.println(myDatar.b);
}

void OnDataRecv(const uint8_t *mac, const uint8_t *incomingData, int len) {
  memcpy(&myDatar, incomingData, sizeof(myDatar));
  uint8_t rcvId = myDatar.id;
  bool rcvB = myDatar.b;

  if (rcvId >= 1 && rcvId <= 12) {
    if (rcvB) {
      addOrActivateNormal(rcvId);
    } else {
      removeNormal(rcvId);
    }
  } else if (rcvId >= 90 && rcvId <= 92) {
    handleEmergencySignal(rcvId, rcvB);
  }
  updateEmergencyLed();
}

void addOrActivateNormal(int id) {
  for (int i = 0; i < normalCount; i++) {
    if (normalCarIDs[i] == id) {
      normalCarActive[i] = true;
      return;
    }
  }
```

The code sends a normal signal every 100 milliseconds using ESP-NOW. It also receives both normal and emergency signals and handles them differently. For normal signals where the button status is pressed, it turns on its buzzer, and the tone depends on the number of vehicles in its range. For emergency signals where the button status is pressed, if it is the first time the vehicle is sending the signal, it plays a special alarm and turns on an LED. For subsequent signals from the same vehicle, it only turns on the LED.

```python
        Results = Model(Frame)
        if Results[0].boxes.data is not None:
            Boxes = Results[0].boxes.xyxy.cpu()
            Class_Indices = Results[0].boxes.cls.int().cpu().tolist()
            Confidences = Results[0].boxes.conf.cpu()
            for Box, Class_Indice, TensorConfidence in zip(
                Boxes, Class_Indices, Confidences
            ):
                Confidence = float(TensorConfidence)
                if Confidence > 0.80:
                    X1, Y1, X2, Y2 = map(int, Box)
                    CircleX = (X1 + X2) / 2
                    CircleY = (Y1 + Y2) / 2
                    Class = Class_Names[Class_Indice]
                    for Road, (XMin, XMax, YMin, YMax) in Roads.items():
                        if XMin <= CircleX <= XMax and YMin <= CircleY <= YMax:
                            cv.rectangle(Frame, (X1, Y1), (X2, Y2), (255, 255, 0), 2)
                            cv.putText(
                                Frame,
                                f"Class: {Class}   Confidence: {Confidence*100:.2f}%",
                                (X1, Y1 - 5),
                                cv.FONT_HERSHEY_COMPLEX,
                                0.6,
                                (0, 0, 255),
                                2,
                            )
                            Counts[Road][Class] += 1
        RoadPoints = {}
        for Road, Vehicles in Counts.items():
            RoadPoints[Road] = (
                Vehicles["Ambulance"] * 10 * data
                + Vehicles["Firetruck"] * 12 * data
                + Vehicles["Car"]
Video = cv.VideoCapture(Camera)
while True:
    Flag, Frame = Video.read()
    if not Flag:
        break
    Frame = cv.flip(Frame, 1)
    Road1_X1, Road1_X2, Road1_Y1, Road1_Y2 = 0, 0, 0, 0  # Real Road1 Coords
    Road2_X1, Road2_X2, Road2_Y1, Road2_Y2 = 0, 0, 0, 0  # Real Road2 Coords
    Road3_X1, Road3_X2, Road3_Y1, Road3_Y2 = 0, 0, 0, 0  # Real Road3 Coords
    Road4_X1, Road4_X2, Road4_Y1, Road4_Y2 = 0, 0, 0, 0  # Real Road4 Coords
    Roads = {
        "Road1": (Road1_X1, Road1_X2, Road1_Y1, Road1_Y2),
        "Road2": (Road2_X1, Road2_X2, Road2_Y1, Road2_Y2),
        "Road3": (Road3_X1, Road3_X2, Road3_Y1, Road3_Y2),
        "Road4": (Road4_X1, Road4_X2, Road4_Y1, Road4_Y2),
    }
    for Road in Counts:
        for Vehicle in Counts[Road]:
            Counts[Road][Vehicle] = 0
```

A Python Code to Send Importance Disparity Between the Two Roads to the Port. This code reads the number of each class of vehicles present on each road (Car, Ambulance) and multiplies them by predefined weights. The urgency of a vehicle determines its weight. Then it calculates the disparity between the two main roads and sends it to the port, where it is used to determine the traffic light's changing interval.

Social Implementation

Our traffic control system is designed to ensure a safe and sustainable environment, regulating noise and reducing the dependency on human labor. This Smart Traffic Infrastructure System reduces the need for manual labor, assisting traffic workers immensely. It also helps to reach critical patients in time, almost saving them from the brink of death.

- Better Urban Livability Due To Noise & Pollution Control.
- Reduced Traffic Congestion & Lower Emissions.
- Enhanced Emergency Response.
- Improved Road Safety & Accident Reduction.
- Minimized Need for Manual Labor.
- Enhances Community Well Being.

Through this system, we can achieve smoother traffic flow with reduced congestion, cutting travel times for a cleaner, quieter city. The system also reduces noise pollution by replacing horns with visual alerts, receiving first priority, making urban spaces more livable. Emergency vehicles gain faster passage, saving lives by ensuring timely medical and rescue responses. Automation reduces the need for manual traffic control, easing the workload on traffic workers while improving efficiency. Smart parking management minimizes the time drivers spend searching for spots, reducing stress and fuel waste. Safer intersections and adaptive control help lower accident rates, protecting both drivers and pedestrians.

It promotes social equity by improving access to reliable transport across communities and supports public health by encouraging safer, more active, and environmentally friendly urban lifestyles.

Cost of the Prototype

Components	Unit	Cost	Total
Esp32	11	3.68$	40.48$
Led	12	0.041$	1.722$
Button	18	0.041$	1.476$
Switch	2	0.70$	1.4$
Buzzer	20	0.12$	2.4$
Servo	4	1.11$	4.44$
Battery	15	0.57$	8.55$
Ldr	1	0.04$	0.04$
Laser	1	0.21$	0.21$
Transistor	2	0.04$	0.08$
Boost	10	0.53$	5.3$
Others			36$
Total			102.098$

Smart Traffic Infrastructure Lean Canvas

Key Partners

- Dhaka City Traffic Authority & BRTA.
- Hospitals & emergency service providers.
- IoT hardware suppliers & software developers.
- Municipal authorities (parking, enforcement).
- Law enforcement agencies.
- Hospitals & emergency service providers.
- IoT hardware suppliers.
- Municipal authorities for parking & enforcement
- Software/AI developers for adaptive traffic control

Key Activities

- Develop and maintain traffic signal system.
- Implement Silent Horn + In-Vehicle Alert System.
- Integrate retractable spike enforcement for rule violations.
- Collect and analyze real-time traffic data.
- System testing and scaling across intersections.

Resources

- IoT hardware.
- Cloud-based traffic control platform.
- Skilled manpower in IoT, AI, and embedded systems.
- Partnerships with hospitals & traffic police.
- Funding from government or private smart city initiatives

Value Propositions

- Real-time, adaptive traffic management.
- Noise-free “Silent Horn” + alerts.
- Emergency vehicle preemption at signals.
- Automated parking with RFID-based payment.
- Mechanical spike enforcement for violations.
- Reduced human labor → fully automated system.

Customer Relationships

- Partnership-based with city authorities
- Awareness campaigns for drivers.
- Support & maintenance contracts with government agencies
- Automated notifications to drivers via LEDs/alerts

Channels

- Government contracts & smart city programs.
- Pilot deployment in selected intersections.
- Public awareness & training campaigns.
- Partnerships with hospitals & traffic authorities.

Customer Segments

- Government & municipalities (primary adopters).
- Hospitals & emergency service providers.
- General commuters & drivers.
- Law enforcement & traffic police.
- Urban planners & smart city initiatives.

Cost Sectors

- IoT hardware.
- Software/AI development & maintenance.
- Infrastructure setup & installation.
- Server/cloud for data processing.
- Maintenance, repairs & upgrades.
- Awareness programs & staff training.

Revenue Streams

- Government & municipal contracts.
- Subscription/maintenance fees.
- Parking management revenue (RFID auto-charging).
- Data analytics services (traffic & parking insights).
- International Funding and Grants for Smart Cities.

Dumb Potatoes

Availability of Similar Content

Through our research, we found various similar systems designed to address specific challenges in traffic control. Some of them include systems like:

In Bangladesh:

• E-Jam (Electronic Jam) in Chattogram, in Dhaka.

Other Countries:

• SURTAC (Scalable Urban Traffic Control) in Pittsburg, United States.

• SCATS (Sydney Coordinated Adaptive Traffic System) in Sydney, Australia**.**

• SCOOT (Split Cycle Offset Optimization Technique) in United Kingdom.

The above system focuses on live traffic signals and ensures that emergency vehicles reach their destinations on time. However, their functionalities often fall short of addressing rule benders and maintaining a less chaotic environment.

Our innovation, **Smart Traffic Infrastructure**, sets a new standard by seamlessly integrating multiple functionalities into one advanced system. Not only does it gather real-time data of vehicles, but it also delivers an immediate consequence and maintains a sound free environment. Additionally, our system enables to collect a specific amount for parking depending on the duration of stay. Furthermore, a smooth and silent communication between vehicles is established, eliminating the need for blaring horns. All this ensure a safe driving experience as well as plays and efficient role in improving our surroundings.