Senior Design Project Proposal for Year 2023

***Real-Time Traffic Monitoring System***

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1. **Introduction**

Traffic congestion is a complex issue that exists in every metropolitan area around the world. According to the INRIX 2022 Global Traffic Scorecard, Las Vegas was ranked as the 22nd most congested city in the United States. The average Las Vegas driver spent on average 41 hours last year sitting in traffic [1]. A 2019 study conducted by the Texas Transportation Institute (TTI) found that nationwide cost of gridlock had grown to 153 million [2]. Traffic congestion not only wastes time and money but increases the likelihood of car crashes.

The Real-Time Traffic Monitoring System automatically detects vehicular and pedestrian traffic in city roads and sends the traffic information to a central location where algorithms are designed to help estimate traffic congestion and adjust the traffic lights based on real-time road congestions.

The main goal of the system is to minimize congestion and promote traffic flow, which will save time and money for individuals, as well as having a lesser impact on the environment. Improving traffic congestion will improve an individual’s ability to maximize their time in other activities, which can lead to higher productivity and happiness.

The Real-Time Traffic Monitoring System’s main functions are using computer vision to detect and count the number of motorized vehicles and pedestrians traversing a given road. A microcontroller is used to automatically control the traffic lights depending on traffic flow.

There are existing infrastructures that exist today, such as induction loops and cameras capable of monitoring traffic, but the Real-Time Traffic Monitoring System uses AI to determine the best way to keep traffic moving.

The main advantage of this system over the others is the ability to optimize traffic flow adapt to unexpected changes of traffic in a cost-effective manner.

1. **Proposed Design**

*Function description and breakdown*

The Real-Time Traffic Monitoring System utilizes the YOLOv5 model, a repository used for object detection. The YOLOv5 model will operate on a Raspberry Pi 4 Model B connected to a Raspberry Pi Camera Module 3. The motivation for choosing the Raspberry Pi 4 Model B to host the YOLOv5 model is due to its versatility and low power consumption compared to desktops. The Raspberry Pi Camera Module 3 is used to capture visual data of traffic flow and differentiate between four-wheel and two-wheel vehicular traffic and pedestrian traffic. due monitor traffic flow of both vehicles and pedestrians commuting through a given intersection. A microcontroller is used to adjust the traffic lights based on the data provided by the Raspberry Pi. The traffic data gathered from the Raspberry Pi is sent to a central location where the AI software reads the traffic data and determines the optimal flow of traffic through an intersection by changing the lights to keep traffic moving. Ultimately, the goal of this project is to improve city traffic by minimizing congestion and improving traffic flow.

List all the functions in two levels:

* Camera counts the number of vehicles and pedestrians commuting through a particular intersection.
* Microcontroller changes traffic lights depending on traffic flow.
* Machine learning algorithm to determine optimal traffic flow.

Baseline/Fundamental functions (must implemented):

Upgraded functions (optional):

Breakdown the entire project to feasible modules. Draw the system schematic/diagram and/or data flow for each functional module.

Skills needed for the project.

The skills needed for this project require electrical and computer engineering concepts such as machine learning for developing the AI to make traffic management decisions, computer vision for monitoring the flow of traffic and determining, and embedded systems.

*Specification and design constraints*

Describe the specification of the entire project and each module in details, including (if applicable) but not limited to the following:

* Inputs and outputs of the entire project and each module
* Power/voltage/current requirements of each module
* Mechanical power/workload (if applicable) requirements
* Data transmission protocol/standard among each module
* Responding time/delay, data throughput, etc.
* Measurement range, sensitivities, etc.
* Safety standards, etc.
* Medical/Biological standards, etc.
* Physical dimensions, weight, etc.

*Table of employed standards:*

|  |  |
| --- | --- |
| Standard | Link or References |
| ATC 5201 (ITE ATC Controller) Advanced Transportation Controller (ATC) | https://www.standards.its.dot.gov/Standard/304 |
| ATC 5301 Advanced Transportation Controller (ATC) Cabinet Version 02 | https://www.standards.its.dot.gov/Standard/302 |
| ITE ATC API Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC) | https://www.standards.its.dot.gov/Standard/301 |
| NTCIP 1102 Octet Encoding Rules (OER) Base Protocol | https://www.standards.its.dot.gov/Standard/334 |
| NTCIP 1103 Transportation Management Protocols (TMP) | https://www.standards.its.dot.gov/Standard/355 |
| NTCIP 1201 Global Object Definitions | https://www.standards.its.dot.gov/Standard/340 |
| NTCIP 1202 Object Definitions for Actuated Traffic Signal Controller (ASC) Units | https://www.standards.its.dot.gov/Standard/345 |
| NTCIP 1209 Data Element Definitions for Transportation Sensor Systems (TSS) | https://www.standards.its.dot.gov/Standard/344 |
| NTCIP 1210 Field Management Stations (FMS) - Part 1: Object Definitions for Signal System Masters | https://www.standards.its.dot.gov/Standard/350 |

1. **Major Components/Parts**

Investigate the datasheet of each component to make sure the interface specifications (e.g., digital/analog signal? Data transmission protocol? Voltage/current ratings?, etc.) are compatible among your components.

**Hardware**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| part description | function | amount needed /  unit price | subtotal | purchase link | datasheet link |
| Raspberry Pi 4 Model B | Central controller used to perform operations and control traffic flow. Uses MQTT to transmit data to cloud. | 1/$152.00 | $152.00 | https://www.amazon.com/Raspberry-Model-2019-Quad-Bluetooth/dp/B07TC2BK1X?th=1 | https://datasheets.raspberrypi.com/rpi4/raspberry-pi-4-datasheet.pdf |
| Raspberry Pi Camera Module 3  Standard  NoIR  Wide | Camera module used for visual detection of two and four-wheel motorized vehicles and pedestrians within traffc. | 1/$25.00 | $25.00 | https://thepihut.com/products/raspberry-pi-camera-module-3?src=raspberrypi | https://datasheets.raspberrypi.com/camera/camera-module-3-product-brief.pdf |

1. **Responsibilities of Team Members**

List the responsibilities of each member

1. **Timeline and Milestones**

The timeline should be planned for every two weeks (full proposal, or each month for brief proposal) both EE 497 and EE 498, and should be followed and checked to ensure the project completeness. It should be reasonable and certain flexibility is allowed. Yet too much delay will result in lower grades.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Weeks (xx/xx - xx/xx) | Team member 1’s tasks | Team member 2’s tasks | Team member 3’s tasks | Team member 4’s tasks |
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1. **References**

[1] INRIX, “Scorecard,” *Inrix*, 2022. https://inrix.com/scorecard/

[2] “New Study Underscores Economy/Traffic Jam Link,” *Texas A&M Transportation Institute*, Aug. 22, 2019. https://tti.tamu.edu/news/new-study-underscores-economy-traffic-jam-link/