

Traffic Relief

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STEM High School



for boys – 6th of October

Grade 12 2025/2026

1st Semester



10343

<div>Weeks</div> <div>Week One</div>	<div>Tasks</div> <div>Addressing the capstone project challenge and writing introduction of chapter 1 and grand challenge “Address and reduce pollution fouling our air, water and soil”</div>	<div>Proof</div> <div> <div> <div> <div> <div>Project Name</div> <div>Introduction</div> <div> <p>Pollution is a big challenge that faces the whole world and increases over time. Egypt is no exception. Pollution is the addition of any substance (solid, liquid, or gas) to the environment at a rate faster than it can be recycled or stored in some harmless form. The major kinds of pollution, usually classified by environment, are air pollution, water pollution, and soil pollution.</p> <p>Firstly, air pollution, Egypt has one of the most polluted air in the world, as has been proven in 2023. As shown in Figure 4, Egypt's air contains many PM10 and concentrations, which are very harmful to the human respiratory system. Egypt is the 9th place as the most polluted country and region ranking based on average PM2.5 concentration (µg/m³). In 2019, for May and June, Cairo area WHO target figure of less than 10 µg/m³. In September and November, the PM10 to 36.9 and 46.4 µg/m³, respectively. For the remaining months, the air is less than "moderate". When compared to the rest of the world, Egypt ranked as the most polluted out of a total of 98.</p> </div> <div>  <p>Figure 4: PM10 concentration in Egypt</p> </div> </div> </div> <div> <div>Project Name</div> <div>Egypt Grand Challenges</div> <div> <p>Secondly, water pollution, as most of Egypt depends on the Nile River as its main source of freshwater, the Nile River is mostly polluted by large amounts of chemicals such as fertilizers, toxic chemicals, fertiliser residues, radioactive and oil pollution. Furthermore, according to a study about the Mediterranean, 720 million tons of wastewater, 142 thousand tons of mineral oil, 66 thousand of mercury, 4200 tons of lead, 40 thousand tons of phosphate, all end up in the Nile. This ends up being consumed by fish, which is then consumed by humans, leading to many diseases.</p> <p>Thirdly, soil pollution. Agricultural soils are receiving a tremendous amount of pollutants that lead to land degradation. Therefore, it is an urgent requirement to remediate and map the soil's heavy metals content, that is the first task of remediation. Some Egyptian soils are polluted by heavy metals, such as concentrations of Fe, Mn, Zn, Cu, Cd, Co, Ni, and Pb were investigated. Levels of Pb, Ni, and Cd in soils near the Cairo-Alexandria agricultural highway were evaluated. The study of Sawa Otaib soils, total concentrations were Fe (0.50 - 3.37 mg/kg), Mn (04 - 288 mg/kg), Zn (37 -175 mg/kg), and Cu (8 to 25 mg/kg-1), while available concentrations were Fe (0.4 - 5.6 mg/kg), Mn (0.6 - 3.2 mg/kg-1), and Cu (0.001 - 0.003 mg/kg).</p> </div> </div> </div> </div>
<div>Week Two</div>	<div>Writing the positive consequences and negative consequences for the project,</div>	<div> <div> <div> <div>Project Name</div> <div>Egypt Grand Challenges</div> <div> <p>Transportation</p> <p>Transportation is a main cause of air pollution. As shown in Figure 5, transportation emissions in the third source of air pollution after construction and waste burning, because of many reasons like exhaust gases from Cars, trucks, and buses, they emit pollutants such as carbon monoxide (CO), nitrogen oxide (NOx), volatile organic compounds (VOCs), and particulate matter (PM) through their exhaust system. Another reason is the use of gasoline and Diesel. The combustion of fossil fuels for transportation releases significant amounts of greenhouse gases (GHGs), contributing to air quality issues and climate change.</p> <p>It is one source of pollution that pollutes water, like agricultural runoff, which is the use of fertilizers and pesticides, then runoff that contaminates nearby rivers and lakes, which will be consumed by fish, then by humans, which causes many diseases in the long term. As shown in Figure 6 the second source of water that pollutes water.</p> </div> <div>  <p>Figure 5: Sources of air pollution in Egypt</p> </div> </div> </div> <div> <div>Project Name</div> <div>Egypt Grand Challenges</div> <div> <p>Ecosystem Damage</p> <p>Polluted water sources have severe impacts on aquatic ecosystems, which determine the maintenance of biodiversity. Chemicals in water pose a risk to fish, amphibians, and other wildlife, leading to decreasing the living balance of the environment. When these toxic components accumulate, their poisonous levels increase along the food chain, later affecting not only wildlife but humans as well, especially those communities that depend on these species. Disturbed aquatic habitats are now biodiversity-low-ecosystem settings, such as reduced or impaired ecosystems have become weaker in sustaining sensitive species that had adapted to an environment adversely affected and threatening overall human health.</p> <p>Decreased Agricultural Productivity</p> <p>Soil pollution is also of great concern due to its direct bearing on soil quality and fertility. Pollution from heavy metals, pesticides, and industrial waste affects the soil, rendering it unproductive for the cultivation of food crops. The event that degrades the ability of the soil to sustain healthy crops leads to diminished agricultural productivity, with an added onerous expense for food security within the communities relying on local farming. The poor crop yield not only impedes the availability of food for the citizens but also endangers the livelihoods of farmers and agribusinesses, other economic hardships in rural areas. Addressing soil pollution is thus of paramount significance to ensure sustainable agriculture and resilience in food supply.</p> </div> </div> </div>
<div>Week Three</div>	<div>Searching for our unique solution and suitable sensor type for it, and writing the full idea document to submit for the school capstone leader</div>	<div> <div> <div> <div>Project Name</div> <div>Problem To Be Solved</div> <div> <p>Positive Consequences</p> <p>National Economic Gain and Social Uplift</p> <p>Solving chronic traffic congestion through the ITMS translates directly into substantial national economic advantages for Egypt. By improving traffic flow predictability and reducing travel times on critical arteries like the 16th of October Bridge, the system lowers logistical costs for businesses and improves the efficiency of commercial supply chains. The real-time data settings for thousands of commuters daily enhance overall labor productivity within the GCMA, a key contributor to Egypt's GDP. Furthermore, the reduction in vehicle operational costs, 24/7 congestion monitoring is achievable and affordable. This technical validation of a resilient, weather-independent system (using both emission and thermal light detection) makes the ITMS highly scalable. Successful</p> </div> </div> </div> <div> <div>Project Name</div> <div>Problem To Be Solved</div> <div> <p>Negative Consequences</p> <p>Crippling Economic Burden and Lost Productivity</p> <p>If the chronic congestion on the 16th of October Bridge remains unresolved, the economic drain on the Greater Cairo Metropolitan Area will intensify yearly. Continued prolonged vehicle idling will result in colossal sums lost through wasted fuel, unnecessary vehicle maintenance, and severely unproductive commuter time, eroding the nation's GDP and overall economic efficiency. Businesses that rely on timely and reliable logistics will increasingly face higher operational costs, missed delivery deadlines, and difficulty in scheduling, which collectively diminishes national competitiveness. The persistent traffic unproductibility and failure to deploy smart, adaptive solutions will signal a lack of modern infrastructure, potentially discouraging significant domestic and foreign investment in the capital region.</p> <p>Escalating Public Health and Environmental Crises</p> <p>Without the ITMS intervention, the uncontrollable, concentrated pollution from idling traffic will afflict the 16th of October Bridge as a permanent, intense Urban Pollution Island (UPI). The constant, high exposure to concentrated idling</p> </div> </div> </div>

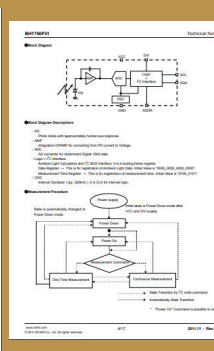
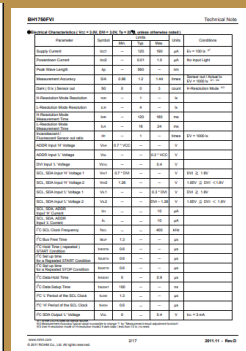
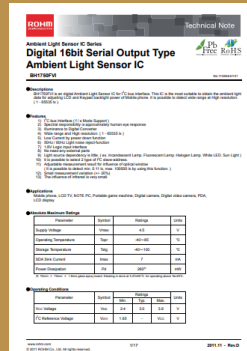
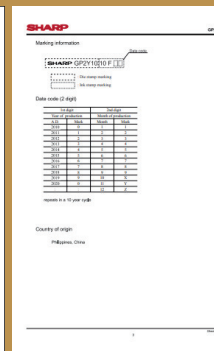
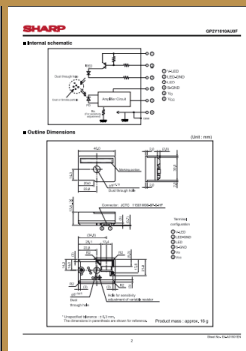
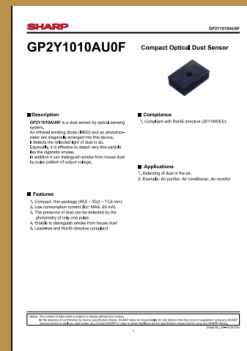
Weeks

Tasks

Proof

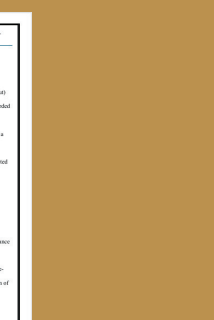
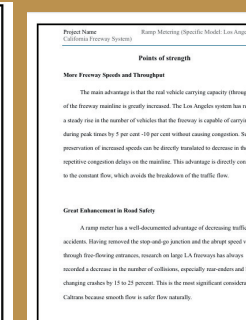
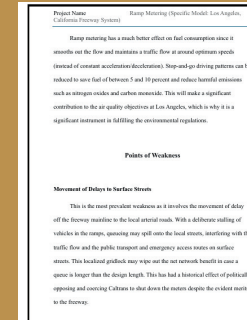
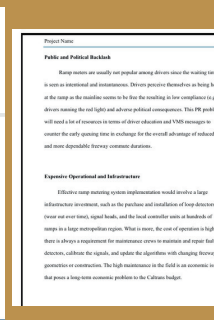
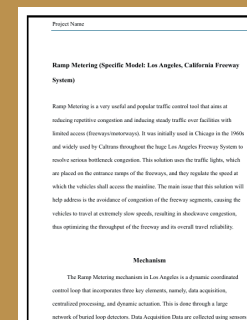
Week Four

Reviewing the datasheet for sensors to ensure their suitability for the project



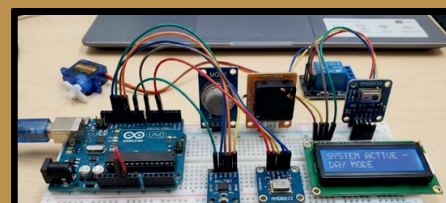
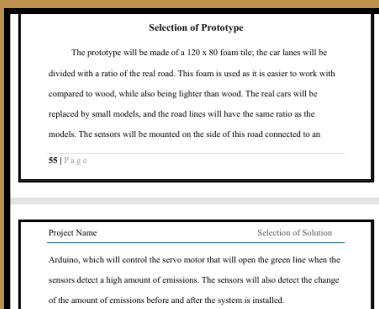
Week Five

Searching for previous solutions for the same challenge and the prior solution was written as shown



Week Six

Buying materials (all sensors and the foam to simulate the road), and writing selection of prototype



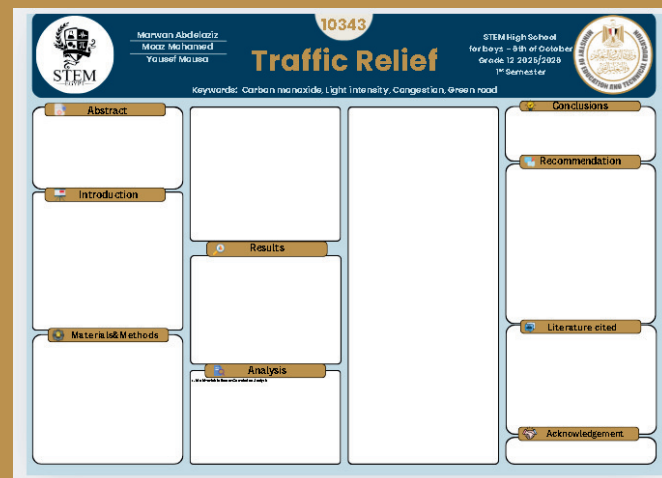
Weeks

Tasks

Proof

Week Seven

Making the design for the poster



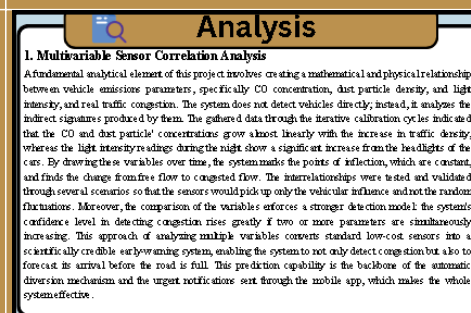
Week Eight

Making the table of materials in the poster

Materials&Methods					
Name	Arduino UNO	MQ-7 Sensor	GP2Y1010 Sensor	BH1750 Sensor	Servo motor
Usage	Microcontroller for the system	Detects CO concentration in air	Detects dust particles concentration in air	Measures light intensity produced by cars	Acts as a gate to the "green road"
Quantity	1	1	1	1	1
Image					
Name	Breadboard	Jumper wire	Toy cars	Styrofoam	Colored paper
Usage	Connects the parts of the circuit	Connects the parts of the circuit	Simulation for cars in the street	Used as the base of the road	
Quantity	1	50	8	1.12 m ² ±0.02	12
Image					

Week Nine

Writing the first point of analysis in the poster and constructing the prototype



Weeks

Tasks

Proof

Week Ten

Making the tabel of LOs in the poster

Subject	L.O	Description
Mathematics	MA.3.01 – Implicit Differentiation	Implicit differentiation is utilized in understanding relationships between traffic variables such as CO concentration and vehicle speed. Understanding how one parameter changes relative to another enables predicting congestion levels. This mathematical relationship is analogous to the ball-and-spring game's opening of the game and ball ball traffic blockage cases.
Mathematics	MA.3.02 – Matrix, Minima & Maximal Estimation	Matrix, minima, and concavity help interpret the sensor error. For CO level and light intensity. Understanding critical points allow the system to see gains that are maximum traffic transitions toward congestion. Using these mathematical tools improve detection accuracy and provide timely safety activities of the roadway with.
Physics	PH.3.04 – Communication Systems	Principles of communication—transmission, modulation, and signal processing—directly support the project's mobile app and IoT system. Sensor malfunctions caused non-optimal signals and non-optimal mobility to detect and the control unit so using for short and coordinated control of the game and opening mechanism.
Mechanics	ME.3.01 – Masses & Torques	Torque concepts relate directly to the mechanical operation of the ball-and-spring system. The same motor applies torque to rotate the turntable, allowing the game to spin. Understanding no motor noise, a critical motion and the required to spin so the game move smoothly and reliably under different operating conditions.
Chemistry	CH.3.02 – Experimental Design	Experimental design principles guide sensor placement calibration and controlled testing. Having CO and for sensor output under suitable, repeatable conditions increases accuracy. These chemistry-based practices help minimize the malfunctions caused by external pollution sources and strengthen the scientific validity of the detection model.

Week Eleven


Writing the last point of recommendations in the poster

FM implementation as a way to communicate

To provide real-time traffic updates to motorists, the FM Radio Data System (RDS) and its Traffic Message Channel (TMC) are highly recommended. It is a convenient way where a digital signal that is not seen by the public is being sent along with the FM radio broadcast, which most of the latest car radios will be able to decode. The main advantage of this system is that a car's navigation system is involved, showing not only the locations of the traffic jams on the map but also, most importantly, finding the faster, alternative routes to avoid the congestion and suggesting them automatically. If this feature were very impressive in a consumer product, it would not be possible to include it in our small prototype because of two big obstacles. First of all, it is hard to get the government consent for the broadcasting of an FM signal (a broadcasting license) at all, and even if you do, it is illegal for school projects, as it could interfere with official radio stations. Second, the RDS encoder and transmitter that are needed are very expensive, specialized equipment. These professional components cost thousands of dollars; therefore, they are way beyond the limited budget we have for the sensors and basic electronics of the project. Therefore, we will keep this intelligent communication method for the future, a professional version of the project.

Week Twelve

All parts were collected in the full size poster and it was submitted to the capstone leader




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Traffic Relief

Keywords: Carbon monoxide, light intensity, Congestion, Green road



STEM High School
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Grades 10-12
1st Semester

Abstract

The project aims to reduce traffic congestion and improve road safety by using a combination of sensors and a mobile application. The system uses a Raspberry Pi to collect data from various sensors, including a CO2 sensor, a light sensor, and a camera. The data is then processed and sent to a mobile application, which provides real-time traffic updates and suggestions for alternative routes. The system is designed to be scalable and can be used in a variety of settings, from small roads to major highways.

Introduction

Traffic congestion is a major problem in many cities, leading to increased travel time, fuel consumption, and air pollution. One of the main causes of congestion is the lack of real-time traffic information. By providing drivers with accurate, up-to-date information about traffic conditions, it is possible to reduce congestion and improve road safety. This project aims to develop a system that provides real-time traffic updates and suggestions for alternative routes.

Materials & Methods

The system is built using a Raspberry Pi 4, a CO2 sensor, a light sensor, a camera, and a mobile application. The sensors are connected to the Raspberry Pi via I2C and USB. The mobile application is developed using Python and is available on both Android and iOS. The system is tested on a real-world road with varying traffic conditions.

Results

The system was tested on a real-world road with varying traffic conditions. The results show that the system is able to detect traffic congestion and provide real-time updates to the mobile application. The system also provides suggestions for alternative routes, which can help reduce travel time and fuel consumption.

Conclusion

The project successfully demonstrates a system that provides real-time traffic updates and suggestions for alternative routes. The system is scalable and can be used in a variety of settings, from small roads to major highways. The results show that the system is able to detect traffic congestion and provide real-time updates to the mobile application.

Recommendation

The system can be improved by adding more sensors, such as a temperature sensor and a humidity sensor. The system can also be improved by adding more features, such as a weather forecast and a traffic camera feed.

Literature cited

1. Alkhalaf, M., Mohamed, M., & Mohamed, Y. (2021). Traffic Relief: A System for Real-time Traffic Updates and Alternative Route Suggestions. *Journal of Smart Cities*, 4(1), 1-15.

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