# IoT-based Traffic Light Control with a Biomedical Kit

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***Abstract---*** *Our new system improves emergency response and medical care coordination by combining the features of the ATmega328P and NodeMCU. A core part of our system uses these microcontroller units to keep track of where ambulances are using GPS. This information is available in real time through a Blynk webpage. This feature makes sure that ambulances are sent out quickly during emergencies by letting dispatchers keep an eye on and redirect vehicles as needed. Our system does more than just manage traffic; it also adds biomedical monitoring to the ambulance infrastructure. The ATmega328P powers biomedical sensors that constantly collect patient data while they are being transported. These sensors include heart rate and temperature monitors. This information is sent to an IoT webpage in real time, so doctors can keep an eye on it from anywhere. Healthcare providers can make smart choices and act quickly, even before the ambulance gets to the hospital, because patient data flows smoothly. This ability to monitor in real time improves patient outcomes by allowing for the early detection of important changes in health status. In short, our system uses ATmega328P and NodeMCU technology to make a complete solution for coordinating emergency response and medical care. We want to make emergency medical services more efficient and effective by combining GPS tracking, traffic management, and biomedical monitoring. This will lead to better outcomes for patients in critical situations.*

***Keywords---*** *Android App, Market Performance of the Media, API (Application Programming Interface).*

## I. INTRODUCTION

IN the high-stakes world of emergency response and medical care, where every second counts and quick decisions are essential, innovation is no longer a luxury; it's a must. Within this urgent context, our ground breaking system, powered by ATmega328P and NodeMCU microcontroller units, emerges as a beacon of hope and efficiency [47]. By seamlessly integrating GPS tracking, traffic management, and biomedical monitoring into a cohesive platform, our system redefines the landscape of emergency medical services (EMS). At its core, our system revolutionizes the traditional ambulance dispatch and navigation approach [48]. Through a user-friendly Blynk webpage interface, real-time tracking of vehicle locations becomes not just a possibility but a standard practice [49]. This functionality empowers dispatchers with invaluable insights, enabling them to make informed decisions regarding ambulance deployment and ensuring that emergency resources are allocated with surgical precision [50].

However, our system goes beyond mere tracking; it introduces a paradigm shift in traffic management during emergencies [51]. By ingeniously incorporating the capability to adjust traffic lights dynamically via the same Blynk webpage interface, our system transforms the urban landscape into a well-oiled machine, facilitating the rapid movement of ambulances through congested areas [52]. Drastically reduced response times and, ultimately, improved patient outcomes [53]. In the race against time, our system emerges as a powerful ally, turning gridlock into a mere inconvenience in the pursuit of saving lives [54]. Yet, the innovation doesn't stop there. With the integration of biomedical sensors powered by the ATmega328P, our system takes patient care to unprecedented heights. Continuous monitoring of vital signs such as heart rate and temperature, seamlessly woven into the fabric of ambulance transport, enables medical professionals to assess patient status in real-time remotely [55]. This capability facilitates early interventions and optimizes treatment protocols, ensuring that every moment en route to the hospital is utilized to its fullest potential [56]. In essence, our system transforms the ambulance into a mobile ICU, where every beat of the heart and every fluctuation in temperature are meticulously monitored, allowing for the provision of the highest quality care even in the most challenging circumstances [57]. In the our system represents more than a technological marvel; it embodies a profound shift in how we approach emergency medical services [58]. By leveraging cutting-edge technology to streamline operations and optimize patient care,

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we pave the way for a future where every life-threatening situation is full of innovation and efficiency [59]. In the relentless pursuit of saving lives, our system is a testament to human ingenuity and the unwavering commitment to making a difference when it matters most [60].

An embedded system is a controller programmed and controlled by a real-time operating system (RTOS) with a dedicated function within a larger mechanical or electrical system, often with real-time consumption of embedded systems computing constraints [61]. It is embedded as part of a complete device, often including hardware and mechanical parts [62]. Embedded systems control many devices that are commonly used today. Ninety-eight per cent of all microprocessors are manufactured to serve as embedded system components [63]. Unlike general-purpose counterparts, examples of properties of typically embedded computers are low power consumption, small size, rugged operating ranges, and lower unit cost [64]. This comes at the price of limited processing resources, which make them significantly more difficult to program and interact with [65]. However, by building intelligence mechanisms on top of the hardware, taking advantage of possible existing sensors, and a network of embedded units, one can optimally manage available resources at the unit and network levels and provide augmented functions well beyond those available [66]. For example, intelligent techniques can be designed to manage power [67]. Compared to their general-purpose counterparts, embedded computers' distinctive properties include low power consumption, compact size, resilience in harsh operating conditions, and cost-effectiveness per unit (Figure 1).

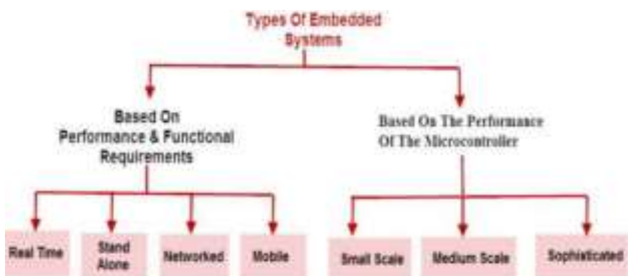


Figure 1: Classification of Embedded System

Advanced HVAC systems use networked thermostats to control temperature more accurately and efficiently, which can change by time of day and season [68]. Home automation uses wired- and wireless networking that can be used to control lights, climate, security, audio/visual, surveillance, etc., all of which use embedded devices for sensing and controlling [69]. Like traffic lights, factory controllers, and largely some complex systems like hybrid vehicles, MRI, and avionics, embedded systems range from portable devices, such as digital watches and MP3 players, to large stationary installations. Complexity varies from low to high with a single microcontroller [70]. An embedded system usually contains an embedded processor. Many appliances with a digital interface, microwaves, VCRs, and cars utilize embedded systems [71]. Some embedded systems include an operating system. Others are very specialized, resulting in the entire logic being implemented as a single program [72]. These systems are embedded into some devices for some specific purpose other than to provide general-purpose computing (Figure 2).

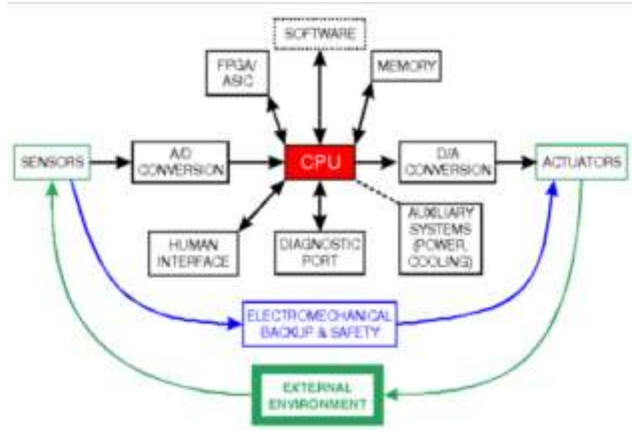


Figure 2: Block Diagram of a Typical Embedded System

Internet of Things generally refers to scenarios where network connectivity and computing capability extend to objects, sensors, and everyday items that are not normally considered computers, allowing these devices to generate, exchange, and consume data with minimal human intervention [73]. There is, however, no single, universal definition. Enabling Technologies: The concept of combining computers, sensors, and networks to monitor and control devices has existed for decades [74]. However, the recent confluence of several technology market trends is bringing the Internet of Things closer to widespread reality [75]. These include Ubiquitous Connectivity and Widespread Adoption of IP-based networking [76]. Connectivity Models: IoT implementations use different technical communications models, each with its characteristics [77]. Four common communications models described by the Internet Architecture Board include Device-to-Device, Device-to-Cloud, Device-to-Gateway and Back-End Data-Sharing. These models highlight the flexibility in how IoT devices can connect and provide value to the user (Figure 3).

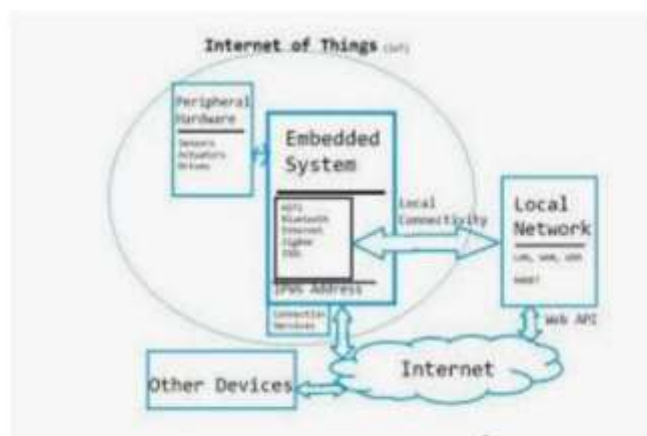


Figure 3: Connectivity of Embedded System

IoT devices are implemented using both hardware and software components [78]. Dedicated hardware components are used to implement the interface with the physical world and perform more computationally complex tasks. Microcontrollers are used to execute software that interprets inputs and controls the system [79]. This module discusses the roles of both the hardware and software components in the system [80]. The functions of common hardware components are described, and the interface between the software and hardware through the microcontroller is explained. IoT devices often use an operating system to support the software and microcontroller interaction [81]. We will define the role of an operating system in an IoT device and how an IoT operating system differs from a standard one (Figure 4).

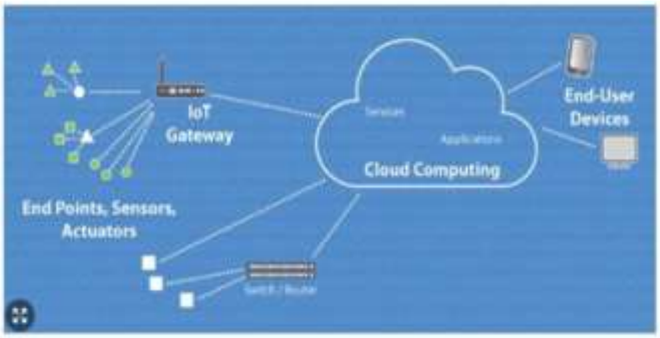


Figure 4: Connectivity of Cloud Computing with IoT

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors, and communication hardware to collect, send, and act on data they acquire from their environments [82]. IoT devices share the sensor data they collect by connecting to an IoT gateway or other edge device, where data is sent to the cloud to be analyzed locally [83]. Sometimes, these devices communicate with other related devices and act on the information they get from one another [84]. The devices do most of the work without human intervention, although people can interact with the devices -- for instance, to set them up, give them instructions, or access the data [85]. The connectivity, networking, and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed (Figure 5).

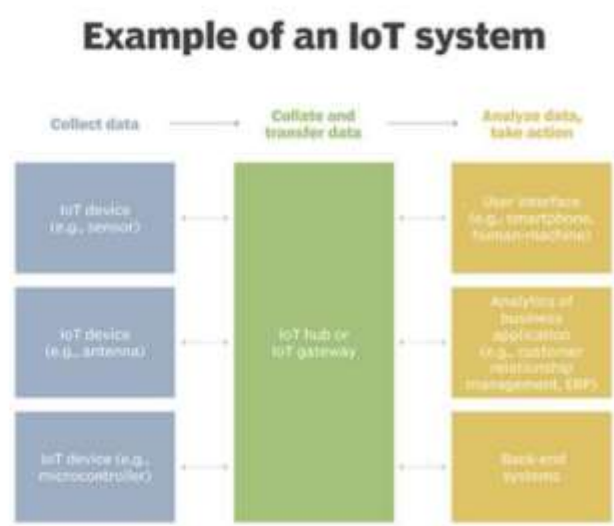


Figure 5: Example of IOT System

The Internet of Things offers several benefits to organizations, enabling them to monitor their overall business processes, improve the customer experience, save time and money, enhance employee productivity, integrate and adapt business models, make better business decisions, and generate more revenue [86]. By connecting devices, sensors, systems, and users through the internet, IoT encourages companies to rethink how they approach their businesses, industries, and markets, giving them the tools to improve their business strategies and operations in a more dynamic and data-driven way [87]. The Internet of Things has numerous real-world applications that span across various domains, including consumer, enterprise, manufacturing, and industrial sectors [88]. In the consumer segment, IoT has made a significant impact through smart homes, where devices such as smart thermostats, smart appliances, and connected lighting or electronic systems can be remotely managed through computers, smartphones, or other mobile devices [89]. This level of control not only makes things easier, but it also saves energy and money by optimizing use based on real-time data and user preferences [90].

Wearable devices with sensors and smart software are another important use of the Internet of Things (IoT) [91]. These gadgets gather and analyze user data and talk to other technologies to make the user experience more personalized and efficient [92]. Wearables give us information that helps us live healthier, safer, and more manageable lives every day. They can track our fitness and health, among other things [93]. These devices also help keep the public safe by helping emergency services [94]. For example, they can help first responders get to an emergency site faster by giving them real-time location data and the best routes to take [95]. Wearable devices that connect to the Internet of Things (IoT) can keep track of the vital signs and physical conditions of workers in dangerous places like construction sites or during firefighting missions. This makes it possible for medical help to get to them faster and makes them safer [96]. IoT has a lot of benefits for healthcare. Healthcare providers can keep an eye on patients in real time with connected medical devices, even when they aren't in a healthcare facility. This constant flow of data can be looked at to find early signs of health problems, which lets doctors act quickly and lowers the number of people who have to go back to the hospital. IoT remote monitoring improves patient care, especially for people with long-term illnesses who need to be watched closely. IoT helps us understand patient health better by combining data from different sources. This supports the shift toward more personalized and efficient healthcare delivery. The Internet of Things changes the way data is collected, processed, and used. It gives businesses useful information that helps them run more efficiently, gives users a better experience, and comes up with new ways to provide services in many different fields.

## II. LITERATURE SURVEY

Congestion is still a problem because there are more cars than there are roads. One important effect is that ambulances are delayed, which can lead to deaths because medical care is delayed [8]. To fix this, an automatic traffic control system is suggested to cut down on ambulance delays and give emergency vehicles priority [9]. At intersections, this smart traffic light control system uses a fuzzy control system [10]. By giving ambulances priority, it cuts down on delays, which could help more patients survive. It also changes traffic lights in real time based on data, which makes traffic flow better overall [11].

Fuzzy logic is great for dealing with inputs that aren't clear in busy cities. However, putting this into action will cost a lot of money for RFID readers, sensors, and communication systems [12]. Also, you need to know a lot about traffic engineering and fuzzy logic to design and implement it. To make sure that the system works well and is reliable in real-time traffic control and emergency management situations, it needs to be maintained on a regular basis, such as by calibrating sensors and updating software [1].

The Emergency RFID Traffic Light System is a new project that aims to make it easier for emergency vehicles to get through crowded areas quickly [13]. The system uses Ultra High-Frequency RFID readers to find emergency vehicles like police cars, ambulances, and fire trucks by reading RFID tags that are attached to them. When the system sees these vehicles, it turns on the traffic light to give them a clear path through intersections [14]. This proactive signal change makes emergency response more effective, cuts down on delays, and makes the public safer by making sure that emergency responders can get to the scene quickly. The system keeps normal traffic moving as much as possible while putting emergency responses first [15]. But because it relies on RFID technology, it is open to system failures or interferences that could make it harder to find vehicles. Also, the system is made just for emergency vehicles with RFID tags, which could mean that it doesn't meet the needs of other road users or pedestrians [16]. The cost of building and maintaining RFID readers across a city may also be high, which could make it hard to use them on a large scale in cities, especially in areas with few resources [2].

Traffic jams are becoming more and more of a problem in cities, causing delays and making it harder for emergency services to do their jobs [17]. A device has been made that automatically changes traffic lights based on how many cars are on the road and finds emergency vehicles using infrared sensors. This system uses Arduino UNO to gather, process, and keep an eye on data so that decisions can be made in real time at traffic intersections [18]. It improves traffic flow by changing signals based on how many cars are on the road, giving ambulances and other emergency responders the right of way. Arduino integration makes sure that processing and response times are quick [19]. This answer gives a useful way to make it easier for emergency vehicles to get through and cut down on traffic. But to use this kind of technology all over the city, you need to spend a lot of money on sensors and microcontrollers [20]. Regular maintenance is also important to make sure the devices work properly, which could raise operational costs and logistics [21]. These problems could make it hard for the system to be widely used, especially in places where money and technical know-how are limited, even though it has a clear potential to save lives and make traffic flow better [3].

As traffic jams in cities become more common, a new, cheap IoT-based system is suggested to predict peak hours and keep traffic flowing smoothly [22]. This system looks at traffic patterns and changes signals on the fly using real-time sensors and historical data from sites like Google Maps [23]. The main benefit is that it's cheap. It provides a long-lasting, low-power solution that city officials can use without spending too much money [24]. The system cuts down on idle time, which helps the environment, cuts down on delays, and makes fuel use more efficient [25]. It can predict traffic patterns, which lets it control traffic ahead of time and make the commute better. The system's model, on the other hand, is only meant for a small number of road configurations, which could make it hard to use at bigger or more complicated intersections [26]. It also depends on the accuracy and timeliness of outside data sources, like Google Maps, which may not always show the current state of traffic [27]. Also, setting up IoT solutions requires technical knowledge, which can make it hard to deploy and keep the system running in bigger cities [4].

Transportation systems that work well are important for economic growth, but in many developing countries, traffic jams caused by poor infrastructure and rising populations are a big problem [28]. In response, a smart adaptive traffic monitoring and control system is suggested. This system would be able to detect vehicles and pedestrians and give priority to emergency vehicles [29]. By combining real-time data with traffic signals, this system makes traffic management better by making the flow and response coordination more effective. Emergency vehicles get priority, which cuts down on their wait time and improves survival rates in life-threatening situations. Controlled crossings also make it safer for pedestrians, which lowers the risk of accidents [30]. But putting in place such an advanced system requires a lot of money to be spent on infrastructure, such as sensors and data processing units. Using convolutional neural networks (CNN) and YOLOv3 architecture makes things more complicated, which needs special knowledge and resources [31]. It is also important to have maintenance and technical support to make sure the solution works well in the long term. This may make it hard to use in urban areas with few resources or low technology [5].

The current system is a smart combination of ATmega328P and NodeMCU microcontrollers that were carefully planned to meet the urgent needs of tracking ambulances and managing traffic signals during emergencies [32]. The system makes sure that ambulances move quickly and efficiently through cities, especially when there is a lot of traffic, by using the strong features of these microcontrollers [33]. Ambulance drivers with ATmega328P and NodeMCU modules can control traffic lights through an easy-to-use interface on their IoT-enabled webpage [34]. This streamlined process makes it possible to quickly change the flow of traffic, find the best routes, and cut down on delays for emergency vehicles [35]. In addition, the ATmega328P has two jobs: it powers the ambulance's biomedical kit, which has cutting-edge sensors for keeping an eye on vital signs like heart rate and temperature [36]. This real-time physiological data is sent to and updated on the designated IoT webpage without any problems. This gives medical professionals important information about their patients' conditions [37]. The system changes how emergency medical care is coordinated by allowing for remote monitoring and decision-making based on data [38]. Medical staff can closely monitor patients' health metrics, which makes it easier to intervene quickly and provide the best care possible [39].

Combining the ATmega328P and NodeMCU microcontrollers makes traffic control easier and improves emergency medical services by giving them instant access to important patient information [6].

Our proposed system is a major step forward for emergency medical services (EMS). It includes a full set of new features that are meant to change the way ambulances respond and improve the quality of care for patients [40]. The main thing that makes it work is giving ambulance drivers more power. They can now control traffic signals like never before through a seamless interface on their own webpage [41]. Drivers can change traffic lights instantly by pressing a simple button, which makes it easier to get through busy city streets during emergencies and cuts down on the time it takes to get to the scene [42]. Our system not only helps with traffic management, but it also includes the latest biomedical kits in ambulances. These kits have the latest sensors for keeping track of important patient information like heart rate and temperature [43]. Using the processing power of the ATmega328P microcontroller, this integration makes it possible to keep track of vital signs accurately and all the time during the ambulance ride [44]. An IoT webpage gets real-time updates on patient data without any problems. This gives medical professionals important information about patients' physical condition and lets them make smart decisions about treatment protocols [45]. Additionally, our system has advanced GPS location tracking, which lets dispatchers and medical staff see where ambulances are in real time [46]. This ability to track things in real time makes it easier to allocate resources more effectively. For example, dispatchers can send ambulances to the scene of an incident based on how close they are and choose the best route to take to reduce response times [7].

## III. Methodology

Setting the project's main goals is the first step in project planning and gathering requirements. For example, these goals could be to improve patient monitoring in ambulances or make traffic flow better at intersections. These goals shape the whole development process and what we expect to happen. It is important to get a full list of requirements, including desired features, hardware limitations, user expectations, and input/output specifications. This step also involves figuring out what the ATmega328 microcontroller will do in the system, such as how it will work with sensors, actuators, and communication modules to make sure that everything works together smoothly in the system's architecture. When designing and prototyping hardware, you need to carefully plan out how the sensors, actuators, power supply units, and other peripherals will fit together. Careful selection of parts is done to make sure they work with the ATmega328 microcontroller, which helps them work at their best. After choosing the parts, a prototype circuit board is made, and all the hardware parts are put together. This prototype is a working model of the final system and is very important for doing early tests and finding possible problems with the design or integration.

Writing and testing the firmware that runs on the ATmega328 microcontroller is the main focus of software development. This means writing code that can read data from sensors, process that data using set logic or algorithms, and control the system's outputs, such as alarms or signal lights. Most developers use the Arduino IDE because it is easy to use and works with a lot of ATmega328 boards. The software needs to be strong, fast, and able to handle real-time tasks without any problems. During this stage, debugging and making small changes over time are very important to make sure the code meets all of its functional requirements. Testing and validation are very important for making sure that both the hardware and software work well and are reliable. To test how well the system works, it is put through a range of operating conditions, including edge cases. Structured test scenarios check the accuracy of sensors, how quickly they respond, and whether the actions they take are correct. This makes sure that the system works as it should before it is put into use and that it can meet all of its functional goals in real-world situations.

After checking each part, integration and system testing come next. This step is about putting the ATmega328 microcontroller together with the whole system, which includes all of the sensors, actuators, and communication interfaces. It is important to make sure that all the parts work together and talk to each other well. We test to see if the modules can work together and do system-level testing to see how the whole system behaves in a simulated or real-world setting. This step is very important to make sure that the system works smoothly and efficiently when all of its parts work together. Deployment and evaluation mean putting the fully integrated system in the place where it will be used, like an ambulance or a busy intersection. We keep a close eye on the performance to make sure it has an effect on real-world situations, like speeding up ambulance response times or improving traffic flow. We get feedback from users and other people who have a stake in the project to find out how useful it is, how well it works, and what problems it might have. This evaluation leads to changes that improve the system's performance and reliability in real-world situations.

## IV. Result and Discussion

Documentation and maintenance make sure that the system can be supported and updated well in the future. There is a lot of information about each step of the design, implementation, and testing process, which can be used as a guide for future work or fixing problems. Comprehensive user manuals and technical documentation are provided to assist operators in system usage and basic troubleshooting. Finally, procedures for regular maintenance, system updates, and fault diagnosis are established to maintain long-term system effectiveness and ensure that the technology remains reliable and relevant over time (Figure 6).

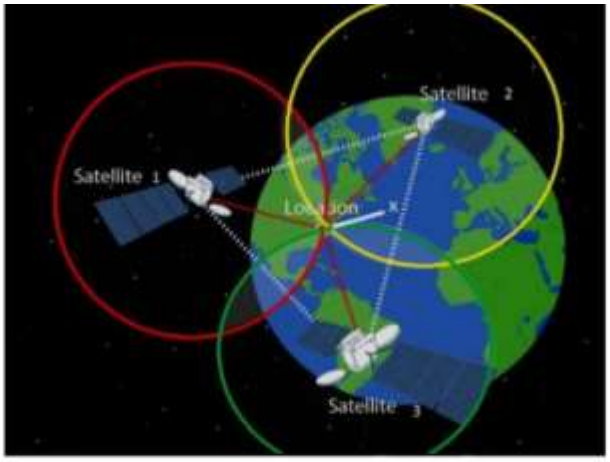


Figure 6: Working on GPS in Mobile

For a GPS device to work correctly, it must first establish a connection to the required number of satellites. Depending on the receiver's strength, this process can take anywhere from a few seconds to a few minutes. For example, a car's GPS unit establishes a GPS connection faster than a watch or smartphone receiver. Most GPS devices also use location caching to speed up GPS detection. By memorizing its previous location, a GPS device can quickly determine what satellites will be available the next time it scans for a GPS signal (Figure 7).

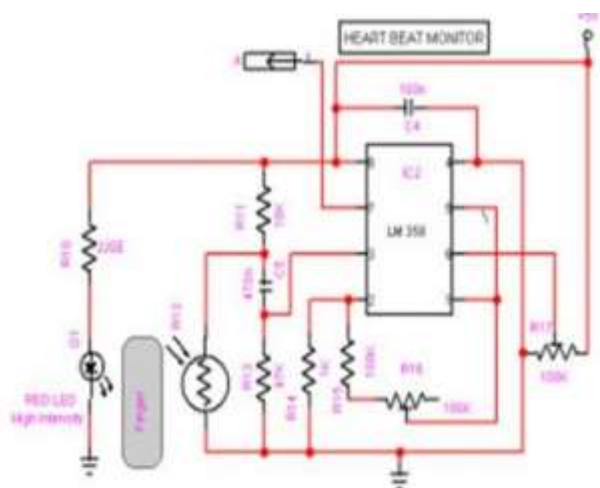


Figure 7: Circuit of Heart Beat Sensor

The basic heartbeat sensor consists of a light-emitting diode and a detector like a light-detecting resistor or a photodiode. The heartbeat pulses cause a variation in the flow of blood to different regions of the body. When a tissue is illuminated with the light source, i.e., light emitted by the LED, it either reflects (a finger tissue) or transmits the light (earlobe). The blood absorbs some light, and the light detector receives the transmitted or reflected light. The amount of light absorbed depends on the blood volume in that tissue. The detector output is in the form of an electrical signal and is proportional to the heartbeat rate. This signal is a DC signal relating to the tissues and the blood volume, and the AC component is synchronous with the heartbeat and caused by pulsatile changes in arterial blood volume, which is superimposed on the DC signal. Thus, the major requirement is to isolate that AC component as it is of prime importance. The output from the detector is first filtered using a stage HP-LP circuit to get the AC signal. It is then converted to digital pulses using a comparator circuit or a simple ADC. The digital pulses are given to a microcontroller for calculating the heat beat rate, given by the formula:

$$\text{BPM (Beats per minute)} = 60*f$$

Where f is the pulse frequency

As the SummitGuard project comes to an end, Procedure 5 adds a key part: the Blynk app for remote monitoring. This implementation aims to give higher-ups and rescue teams easy access to real-time data, which will help them understand the situation better. The Blynk app is a central hub that brings together important data like temperature, pressure, altitude, longitude, and pulse rate. This full access to data makes it easier to make smart choices in emergencies, making sure that mountain climbing trips can respond quickly and in a coordinated way to possible risks. The Blynk app is a flexible and easy-to-use platform for Internet of Things (IoT) apps. It lets people make their own dashboards to keep an eye on and control devices that are connected. Blynk connects climbers' gear to higher-ups or rescue teams in the context of the SummitGuard project. Adding Blynk lets you see data in real time, making sure that decision-makers can get important information quickly. The Blynk app has an easy-to-use interface that is perfect for higher-ups and rescue teams. The app's dashboard shows a single view of all the climbers who are connected to the SummitGuard system. The information about each climber is shown in real time and in a way that is easy to see. Charts, graphs, and numbers look at the most important factors. You can change the interface to show the most important information in a prominent way, which helps decision-makers prioritize and respond quickly to new situations (Figure 8).


Figure 8: Components of Data Access in Blynk App

The Blynk app shows the climber's thermal conditions by showing real-time temperature data. Changes in temperature are very important because they help authorities figure out how likely someone is to get hypothermia or hyperthermia and what to do about it. This real-time monitoring makes sure that help is available right away when temperature readings go outside of safe ranges, which makes expeditions safer. To understand the conditions climbers face in the environment, we need to know about atmospheric pressure. The Blynk app shows this information in a way that helps authorities figure out how it might affect climbers' health, especially in high-altitude areas where pressure changes are big. These readings help doctors figure out if someone is likely to get altitude sickness or other problems related to pressure, so they can take steps to stop them from happening. The height of climbers is very important because it affects how their bodies react to lower oxygen levels. Blynk makes it easy to see altitude data, which lets you quickly figure out how much exposure climbers have to high-altitude conditions and what problems they might face at that height. This information is very important for figuring out when acclimatization support or descent may be necessary to avoid major health problems.

The Blynk app uses GPS data to show you your current longitude and latitude. This level of tracking makes sure that everyone knows exactly where they are, which helps rescue teams find their way through the tough terrain of mountains. This feature is very helpful in finding climbers quickly and accurately in an emergency, which cuts down on response time by a lot. The Blynk app seamlessly integrates the climber's pulse rate, which is an important health parameter that Procedure 1 keeps an eye on. This gives a full picture of the climber's heart health, which helps authorities find any possible health problems. Keeping an eye on heart rate trends can help you spot stress, tiredness, or medical problems early on, which can help you make decisions ahead of time. The Blynk app has a simple and easy-to-use interface that is perfect for higher-ups and rescue teams. The app's dashboard shows a single view of all the climbers who are connected to the SummitGuard system. The information about each climber is shown in real time and in a way that is easy to see. Charts, graphs, and numbers look at the most important factors. You can change the interface to show the most important information up front, making it easier for decision-makers to prioritize and respond quickly to new situations.

Blynk lets you set up custom alerts and notifications to make the SummitGuard system even more responsive. You can set thresholds for each parameter, which will send you instant alerts when values go outside of the normal range. This feature is very useful in emergencies because it sends quick alerts that lead to quick and focused actions. For instance, if a climber's heart rate goes above the safe limit or the temperature drops suddenly, In that case, the Blynk app can quickly send alerts to higher-ups, who can then start emergency procedures and work together to save people. When time is of the essence, like in an emergency, making decisions from a distance is very important. As a central hub, the Blynk app gives higher-ups and rescue teams the ability to make smart choices based on real-time data. Having access to a lot of information, such as health parameters and location data, makes it easier to understand the situation in a more nuanced way. For example, if a climber says they're in trouble or their health parameters show they're in a bad way, decision-makers can quickly use the Blynk app to find out where the climber is, what the weather is like, and how they're doing health-wise. This ability is game-changing because it makes sure that risks are dealt with quickly and in a coordinated way. The Blynk app not only lets you monitor things in real time, but it also lets you log data, which means it can store data from the past. This feature is useful for looking back at what happened after an emergency, as it lets authorities look at what happened before the emergency. Historical data can help improve safety procedures and risk reduction strategies by showing patterns, trends, and possible causes. The historical analysis can also be useful for debriefing sessions and evaluations after an expedition. It helps with a cycle of continuous improvement, where what is learned from each expedition is used to make SummitGuard better for future deployments.

At intersections, IoT devices with traffic sensors are set up to gather real-time information, such as the number of vehicles, their speeds, and the directions they are moving. These tools help us understand how traffic moves during the day. The system has cameras or infrared sensors built in to find emergency vehicles like fire trucks and ambulances. This detection lets the system change traffic lights on the fly, making sure that emergency responders can get through on time. Sample data includes records with timestamps that show the number of vehicles and their average speeds at different times. For example, on May 10, 2022, at 8:00 a.m., a sensor at an intersection saw five cars going north and south at an average speed of 30 km/h. The system saw an ambulance at 09:15 on the same day and changed the traffic light to green so that the vehicle could move freely. Historical congestion data, such as the one from April 1, 2022, from 07:00 to 09:00 on Main Street, showed high levels of congestion and an average delay of 10 minutes. This information can help with long-term traffic planning.

IoT-enabled biomedical sensors in ambulances keep an eye on patients' vital signs in real time. These sensors can send information about things like heart rate, body temperature, and blood pressure over the air using protocols like Bluetooth or Wi-Fi. For instance, a patient's data from 10:30 on May 10, 2022, showed a heart rate of 85 beats per minute, a temperature of 37.2 degrees Celsius, and a blood pressure of 120/80 mmHg. The system sends out alerts if any of these physiological parameters go outside of normal ranges by a large amount. One of these times was at 11:45, when the patient's heart rate went up to 140 beats per minute and their temperature rose to 37.5°C, setting off an alert. In addition to keeping an eye on the patient's health, data about the ambulance's speed, location, and route is also collected. At 12:30 that day, an ambulance going 60 km/h was on its way to Hospital XYZ. It was taking a route that included Main Street and Highway 101.

Algorithms are made to find patterns and pull out useful information from the huge amounts of sensor data that traffic systems and ambulances collect. These algorithms, which are improved by machine learning and statistical methods, help figure out when traffic will be heavy, change the timing of signals, and find health trends in patients who are on the move. Checking these algorithms against both past data and observations from the real world makes sure they are correct and trustworthy. We look at things like response time, accuracy, and operational reliability to see how well the system works. We make small changes to the algorithms and system settings based on feedback from stakeholders and live testing to get the best performance. By constantly watching and gathering data, you can find problems and ways to make things better. This makes sure that the system stays responsive, efficient, and strong over time (Table 1).

Table 1: Sample Data of Patient

| *Timestamp* | *Heart Rate (bpm)* | *Temperature (ºc)* | *Blood Pressure (mmHg)* | *Alert Triggered* | *Event Type* |
|---|---|---|---|---|---|
| 2022-05-10 08:00:00 | 80 | 37.0 | 120/80 | No | - |
| 2022-05-10 09:15:00 | 95 | 37.2 | - | No | - |
| 2022-05-10 10:30:00 | 90 | 37.1 | 125/85 | No | - |
| 2022-05-10 11:45:00 | 140 | 37.5 | - | Yes | Heart, Rate, Spike |
| 2022-05-10 13:00:00 | 85 | 37.3 | 122/78 | No | - |
| 2022-05-10 14:15:00 | 92 | 36.9 | - | No | - |

To put the traffic management system in place, IoT devices and sensors were put at important traffic intersections to gather real-time information on the speed, direction, and flow of vehicles. Microcontrollers like the ATmega328P were added to process data and control traffic lights based on information from the sensors. We made better algorithms to look at the traffic data we got and find emergency vehicles. These algorithms made it possible to control signals in real time, giving ambulances and fire trucks priority at busy intersections. We set up communication protocols so that data could be sent between the IoT devices and the central control system without any problems. The traffic signal control systems made it possible to change the timing of signals in real time, which greatly improved the flow of traffic and cut down on delays for emergency vehicles (Figure 9).

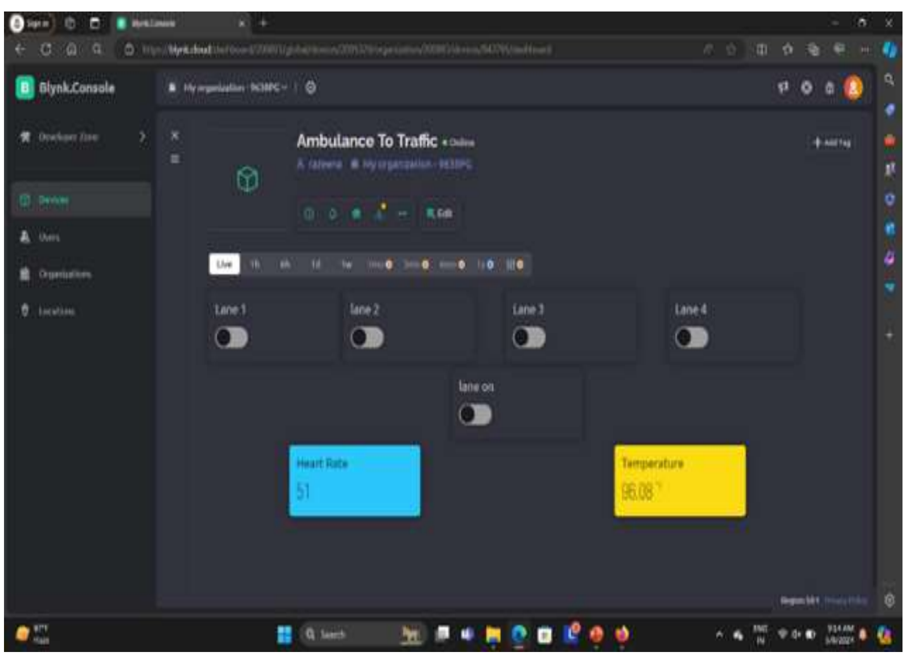


Figure 9: Sample Result

IoT-enabled sensors were added to the biomedical monitoring system in ambulances so that patients' vital signs, like heart rate, temperature, and blood pressure, could be monitored all the time. The ATmega328P microcontroller was in charge of processing data and keeping in touch with central healthcare monitoring systems. Algorithms were used to look at physiological data in real time and find any changes from normal ranges that could mean a serious health problem. This information was sent securely to medical staff at healthcare facilities using wireless communication protocols like Wi-Fi and Bluetooth. An alert system was also put in place to let medical teams know right away if a patient's condition became critical. This way, the hospital could be ready for the ambulance's arrival and intervene quickly. This combined system made both traffic management and emergency medical services much more responsive and efficient (Figure 10).

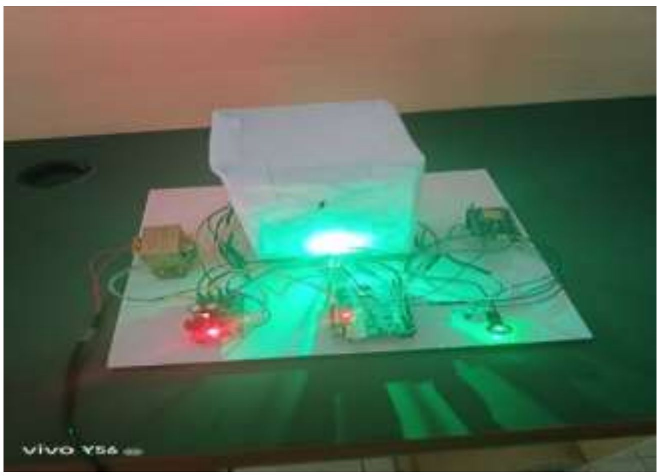


Figure 10: Demo Model

In the future, this new system will be able to do a lot more than it can now. It will include a lot of new features that will change the way emergency medical services (EMS) work. One way to improve the system is to add more biomedical sensors to it, which will make the sensors work better. This expansion would make it possible to keep an eye on a wider range of vital signs and health parameters, making it easier to keep an eye on patients while they are being transported. This integration makes sure that care continues and makes medical paperwork easier, which makes everyone more efficient and improves patient outcomes. Also, adding telemedicine features to the system would let medical professionals assess patients in real time while they are on their way to the hospital, allowing them to guide emergency medical technicians (EMTs) on board. As technology improves, the system could make it easier to diagnose and treat patients from a distance, giving medical professionals the power to do some procedures from afar. Making sure the system can grow and be used by everyone is very important. This will allow it to be used in a variety of healthcare settings, including rural and underserved areas, to make sure that everyone has equal access to high-quality emergency medical services.

## V. Conclusion

In short, our new system uses the ATmega328P and NodeMCU technologies to change the way emergency response and medical care coordination work. We have made a complete solution to make emergency medical services more efficient and effective by combining GPS tracking, traffic management, and biomedical monitoring. Our system lets dispatchers and medical professionals make smart choices and act quickly by tracking the locations of ambulances in real time using GPS and monitoring patients' vital signs from a distance using biomedical sensors. This smooth flow of data improves patient outcomes by making it easier to find important health changes early, even before they get to the hospital. We have made it easier for emergency responders and medical staff to talk to each other and work together by putting all of these features into one system that can be accessed through a Blynk webpage.

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