CHAPTER 6.

RESULTS AND CONCLUSIONS

6.1 Simulated Testing

The simulation software creates a virtual emergency vehicle. This vehicle sends GPS values to the server which imitates the values sent by an actual ambulance. Several rounds of testing was conducted using these simulated values. In every round, the small scale miniature model of the traffic signal showed a smooth transition between Normal mode and Emergency mode, when the simulated location was in proximity of the traffic signal. The model also transitioned back to normal mode once the simulated vehicle crossed the signal.

<PHOTO>

6.2 On Road Testing

The small scale model of the traffic signal was installed, and real time on-road testing was conducted using the actual Android app to send real-time location to the web server. In every test, the miniature model of the traffic signal transitioned to emergency mode when the vehicle was in proximity. The model also smoothly returned to normal mode once the vehicle crossed the intersection.

<PHOTO>

6.3 Cost of implementing the System

The costs of implementing the system is listed below.

* By using an android based phone, the cost of implementing hardware on each and every emergency vehicle is greatly reduced. The cost of owning a smart phone is being lowered with newer and more economic models entering the market every week. As of May 2013, the cheapest android phone with GPS available in the Indian Market is Videocon A15 which comes at a price of Rs 3200. Higher end models are also available. Hospitals and other emergency services can purchase any phone based on their budget and requirements. The android app can work on any phone or tablet which runs on Android OS. The phone can be used for other purposes by the hospital or dispatcher to know the status of the patient and other details.
* In Bangalore City, all traffic signals are automated and connected to a Central Server via a private LAN. Thus, there is no additional expenditure to install microcontrollers at every location. The algorithm used for the traffic controller in this model can be easily translated to the programming language used by the existing microcontroller.
* Integrating the Webserver and Administration Panel in the existing Traffic Management hub is a simple task. Once installed the system will need to be tested. Minor cost may be involved.

* Minor one time cost of training emergency personnel, administrators and dispatchers.

Thus the only substantial cost of implementing the system is the cost of providing phones or tablets to every emergency vehicle which can roughly be estimated to Rs 5000 per vehicle.

6.4 Merits and Demerits of the proposed System.

The proposed model offers several Merits listed below.

* Minimal cost of implementing the system as explained in the previous section.
* Easy implementation and Integration with existing technology in use at Bangalore City.
* GPS technology has come a long way and provides accurate location. Accurate atomic clocks in GPS satellites provide a way to calculate location that can be precise to the closest millimeter.
* Due to accuracy of GPS there is very little chance of false triggering of preemption. In contrast, Radio and Acoustic based systems can easily trigger preemption in the opposite direction or at an intersection a few feet away.
* The entire system will have all the security benefits of a centralized secure web server. Illegal hardware that can preempt signals cannot be purchased, as these will not be recognized by the central server. In contrast, other systems such as Acoustic, Line of Sight and Radio based implementations do not provide any kind of security against illegal access.

There are minor demerits to the following system.

* The only demerit of the proposed system is that in densely populated cities, tall buildings may prevent satellite signals in reaching the GPS receiver. This demerit doesn’t pose much threat as Android smart phones are capable of computing location based on mobile tower triangulation and also close range wi-fi signals.
* A good and steady mobile internet connection is required. In case of no connection, the Emergency Vehicle driver will have to follow the normal protocol when preemption is not present, which is to request right-of-way by using the siren.

These demerits will not be major threats in the near future since GPS and Mobile Internet technology is improving tremendously.

The benefits and demerits of the proposed model as well as other implementations are tabulated in Table 1.

<TABLE>

6.5 FUTURE ENHANCEMENTS

There are other possible emergency vehicle traffic signal priority characteristics that can be considered for future research. These include:

* Multiple vehicles per pre-emption event.
* Varying the distance from which an emergency vehicle preemption request can be received by the traffic signal controller.
* Using Google maps and its services to provide more enhanced traffic statistics.

The project can be extended to add additional features in several ways.

The Arduino microcontroller once installed can be used for various other purposes:

* Smart Traffic Management: Using traffic data obtained from various sources such as Google Traffic and Traffic updates from ground controllers, the same server centric model, using the same microcontroller can be used to slightly manipulate and vary traffic signal timings to ease congested roads.
* The same microcontroller can also be used to display traffic updates on LED screens at traffic signals, so commuters can avoid congested routes. Cameras, speed detecting sensors and other sensors can also be connected to the same controller and violations can be viewed automatically at the Central Traffic Management Center.

Since the Arduino microcontroller can be used with a variety of hardware, this servercentric model using Arduino and GPS can also be used for similar applications such as:

* Automated closing and opening of railway gates.
* Dynamic display of bus arrivals and bus timings at bus stops for passenger convenience.
* Anti-collision systems in railways.

6.6 CONCLUSION

Our project presents a solution for the easy passage of emergency vehicles by means of preemption of signals at intersections. The merits of implementing a traffic signal preemption system are numerous. In a large city like Bangalore, implementation of this model in real time will benefit thousands of patients and victims. Traffic Signal Preemption if implemented can reduce emergency response times and increase road safety with minimum inconvenience to regular traffic.