The Livable Planet – A Revolutionary Concept Through Innovative Street Lighting And Surveillance System Based On Internet Of Things And Light Fidelity Communication

Akhil.Maheshwaram,Ashwin.M,Balaji.S
Bachelor of Engineering, 3rd Year, Computer Science and Engineering,
S.A.Engineering College, Avadi, Chennai, Tamil Nadu, India, 600077

Abstract—— **Street lights are the most unnoticed and ignored objects in our everyday life. Ever imagined that these standalone objects have the power to revolutionize our world and the way we live ? We see street lights as one of the most valuable public assets that have a powerful role to play in making cities energy-efficient, resilient and future-ready, and in turn making a liveable planet Earth. We propose a solution based on the new age technologies, the Internet of Things (IoT) clubbed along with Light-Fidelity (Li-Fi) and sensor solutions that help meet the goals going far beyond lighting, such as energy efficiency, traffic and crime monitoring and traffic management. This setup can come handy in emergency situations such as natural disasters like floods, thus saving numerous valuable human lives.**

Keywords—— Internet of Things (IoT), Light-Fidelity (Li-Fi),Cloud Based Architecture, Manjrasoft Aneka,Microsoft Azure ,Traffic Monitoring, Crime monitoring.

I. INTRODUCTION

At the heart of our revolutionary lighting approach is the patented presence-detecting technology that allows on-demand, adaptive lighting. This means that there's always just as much light as needed for the people to get around safely and enjoy the city during daytime and night time alike. Street lights brighten up when there's someone around and dim down when the streets are empty. You can be sure that there's not a Watt wasted on the lights that burn for nobody.

Most urban and semi-urban cities and towns are still using a combination of fluorescent, CFL, high pressure sodium lamps or metal halide bulbs, which are not designed to meet area-wise lighting needs. For instance, the lighting needs of vehicular traffic in high speed zones are different from low-speed high traffic zones. Likewise, lighting needs in road crossings are different from secondary roads. Then again, the lighting requirements of an area with vehicular traffic will vary from that of an area with high pedestrian traffic.

A one-size-fits-all approach to street lighting results in inefficient deployment of power resources and ends up in wasteful use of electricity that could have been better utilized elsewhere. Very often, one notices that the street lights stay on well past sunrise. This is because the lights are switched off based on a pre-decided time rather than lighting needs, which vary based on season and location of the city. There is a need for devising a well thought out way to prevent wastage of electricity.

II. LITERATURE SURVEY

Global trends in street lighting show that 18-38% of the total energy bill goes towards street lighting and therefore this is one domain that needs major attention if we look at improving efficiency of power consumption with an objective of saving energy.

There are almost 300 million streetlights installed around the world today and this is expected to grow to over 330 million by 2025. Generally, conventional street lights use technology that is more efficient than for lights we use in our homes, so you'd expect that the switch to LED street lights, because of the power efficiency and different requirements for illuminating our streets for driving and night time safety.

India has a total installed capacity of generating 255681.46 MW, as on 31 Dec 2014, as per CEA,

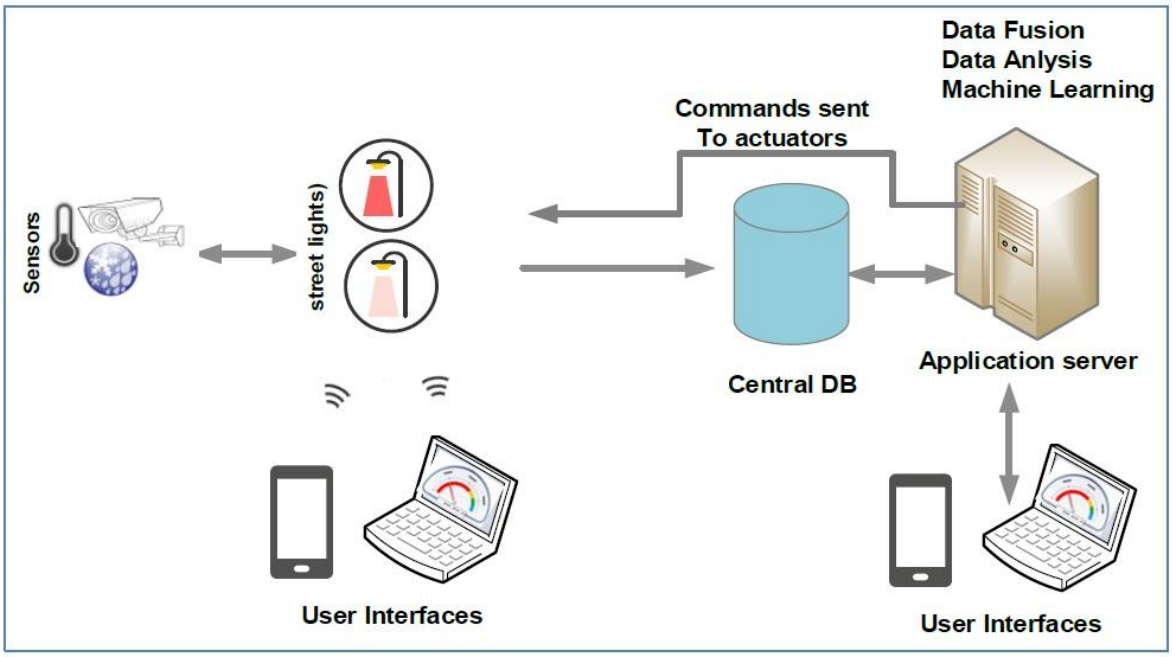

Figure 1 - Overall idea of the proposed system

Ministry of Power. In most cities, the street lights are installed and maintained by municipalities.
The combination of the most efficient LED street lights with ambient light sensors and smart lighting will achieve greater than 97% reduction in electricity requirements for new LED street lighting by 2020.

If all the world's lights were replaced it would be the equivalent of 25,000MW saved (including grid losses and PowerStation internal consumption) or about the same as Australia's entire overnight electricity demand being completely shut down every night of the year.

III. PROPOSED WORK

The main concepts behind this paper is to rely on a coordinate working of electronic equipments, ie. LED street light bulbs, a surveillance camera component ,and sensor network to measure certain environmental indicators like luminosity, visibility in order estimate the need for lighting intensity.

So from now on the street lights will glow in the maximum intensity mode when it detects the pedestrian and road traffic activities, and then go on to a minimum dim-mode so as to support the surveillance camera activity to monitor the area. The LEDs will then be turned off automatically when daylight is available and then the process repeats.

The accumulated surveillance camera footage has now to be encrypted to enhance security and then transmitted to a nearby base station so that it can be stored in a centralised database so as to monitor any area, anytime , anywhere.

This transmission however requires no additional wiring. Communication in between the street lights will have a Li-Fi architecture set up in between them. Thus the data can be sent over a wireless medium so its cheap,faster and efficient.

The whole setup is backed up by a battery bank, which is to be used in emergency cases when the power goes off , so as to provide an uninterrupted street lighting and camera monitoring service.

A wifi component is set on a open-portal so that it can be used in emergency cases like floods, where there is no electricity and no connectivity through cellular network. So an end user can take his mobile, and connect to the User Interface of the portal of the street light, which now will be operating on battery power, and thus the user can make his emergency need , and the signal will be transmitted to the nearest base station for help.

The surveillance camera will then be used to assess the damage in that area, and hence the emergency help can be provided instantly and more efficiently, leading to numerous human lives being saved.

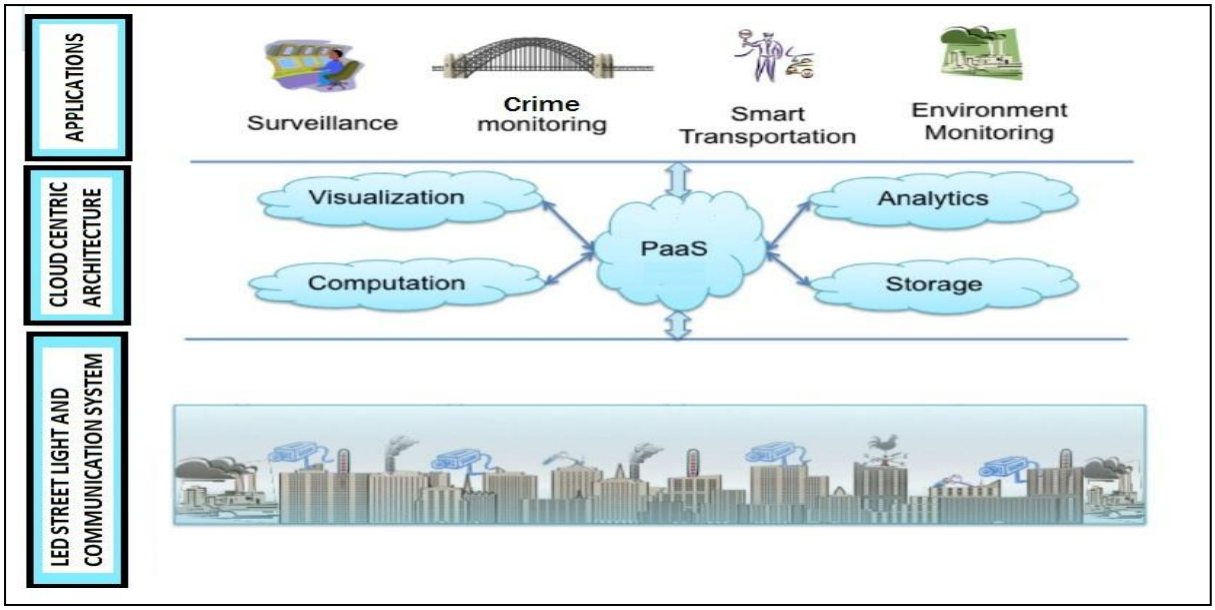

Figure 2 –Cloud centric architecture concept

IV. CLOUD CENTRIC - INTERNET OF THINGS ARCHITECTURE

We need to store all the camera footage and relevant data in a centralised fashion to have access from anywhere and anytime. The vision of IoT can be seen from two perspectives - Internet-centric and Thing-centric. The Internet centric architecture will involve internet services being the main focus while data is contributed by the objects. In the object centric architecture , the smart objects take the center stage.

In our work, we develop an Internet centric approach. i.e. a conceptual framework integrating the ubiquitous sensing devices and the applications. In order to realize the full potential of cloud computing as well as ubiquitous Sensing, a combined framework with a cloud at the center seems to be most viable. This not only gives the flexibility of dividing associated costs in the most logical manner but is also highly scalable.

We describe the cloud platform using Manjrasoft Aneka and Microsoft Azure platforms to demonstrate how cloud integrates storage, computation and visualization paradigms.

V .MANJRASOFT ANEKA AND MICROSOFT AZURE

Aneka is a .NET-based application development Platform-as-a Service (PaaS), which can utilize storage and compute resources of both public and private clouds . It offers a runtime environment and a set of APIs that enable developers to build customized applications by using multiple programming models such as Task Programming, Thread Programming and MapReduce Programming.

Aneka provides a number of services that allow users to control, auto-scale, reserve, monitor and bill users for the resources used by their applications. In the context of Smart Environment application, Aneka PaaS has another important characteristic of supporting the provisioning of resources on public clouds such as Microsoft Azure, Amazon EC2, and GoGrid, while also harnessing private cloud resources ranging from desktops and clusters, to virtual data centers.

Microsoft Azure is a cloud computing platform and infrastructure created by Microsoft for building, deploying, and managing applications and services through a global network of Microsoft-managed datacenters.It provides both PaaS and IaaS services and supports many different programming languages, tools and frameworks, including both Microsoft-specific and third-party software and systems.

For the application developer, the cloud service as well as ubiquitous sensor data is hidden and they are provided as services at a cost by the Aneka provisioning tool.

There are several advantages for integrating Azure and Aneka. Aneka can launch any number of instances on the Azure cloud to run their applications. Essentially, it provides the provisioning infrastructure. Similarly, Aneka provides advanced PaaS features. It provides multiple programming models (Task, Thread, MapReduce), runtime

execution services, workload management services, dynamic provisioning, and flexible billing.

Microsoft has made an industry-leading commitment to the protection and privacy of your data. Azure is the first cloud provider recognized by the European Union's data protection authorities for our commitment to rigorous EU privacy laws. Microsoft was also the first major cloud provider to adopt the new international cloud privacy standard, ISO 27018. Microsoft also launched Azure Government, a stand-alone version of Azure designed to meet the rigorous compliance requirements of U.S. public agencies.

For data analytics and artificial intelligence tools, the Aneka task programming model provides the ability of expressing applications as a collection of independent tasks. Each task can perform different operations, or the same operation on different data, and can be executed in any order by the runtime environment.

There are many interoperability issues when scaling across multiple Clouds. Aneka overcomes this problem by providing a framework, which enables the creation of adaptors for different Cloud infrastructures, as there is currently no ''interoperability'' standard.

These standards are currently under development by many forums and when such standards become real, a new adaptor for Aneka will be developed. This will ensure that the IoT applications making use of Aneka can seamlessly benefit from either private, public or hybrid Clouds.

VI. DATA TRANSFER THROUGH LI-FI

Light Fidelity or Li-Fi, is an exciting breakthrough in 5G visual light communication systems and the future of wireless Internet access.With Li-Fi, information hitches a ride along a spectrum of visible light. Light-emitting diode (LED) bulbs, transmit data when they are switched on and off so rapidly in nanoseconds, that the human eye cannot see it.

This data is registered by special equipment, making it possible to provide wireless communication. The vast availability of LED light bulbs will drive the future ubiquity of connectivity even in places where Wi-Fi fails-on an airplane and in submarines, for example.

Since we have used street lighting system based on LEDs, we can use the same bulbs to transmit this data over to the nearest base station. The data from one LED is first encrypted so as to enhance security and then transmitted over with this technology.

The advantages which LiFi gives us over the conventional Wireless transmission means of data :

Speed: In our tests, LiFi has produced speed of over 100 Gbps (in a controlled environment). These speeds can be achieved due to low interference (compared to radio frequencies), and high bandwidth due to the visible light spectrum which is 10,000 times more than the RF spectrum and allows for optimal users coverage no matter the number of users.

Security : The signals are fully secure – essentially eliminating the threat of data being hacked remotely. There is therefore no risk for remote piracy through the LiFi system. This solution is of great interest to sensitive operations such as R&D, defense, banks, security systems, etc.

Safety **:** Visible light wavelengths are harmless to humans, even beneficial at specific wavelengths. LiFi comes as an alternative to radio waves which is a key characteristic to sensitive environments such as hospitals, medical centers, schools, some industrial installations…

Data Density: The area covered by one Wi-Fi access point has 10s or 100s of lights. Each LiFi light can deliver the same speed or greater than a Wi-Fi access point. Therefore, in the same area, LiFi can provide 10x or 100x or 1000x greater wireless capacity. That is Mbps per squared meter.

Scalability: Li-Fi is zero electromagnetic interference, allowing connectivity even in areas where Wi-Fi isn't accepted - hospitals and nuclear plants among others.

VII.TRAFFIC MONITORING

Free and smooth movement of people and goods is an essential part of the city. In some cities, traffic intensifies only during the rush hours, in others it simply never stops. Luckily, technology is there to help. The camera component can now combine with sensor solution that is capable of monitoring traffic density and presenting the data in a user-friendly graphic form known as a "heatmap." Traffic and congestion heatmaps provide an insight into the existing traffic bottlenecks and road capacity.

Congestion on the roads in urban areas has a drastic effect on the environment and quality of life. But using this method, we would be able to redirect the traffic away from the overcrowded parts of the city,

Source of Light	Watt	Lumens	Lumens/Watt (Photopic Lumens)	S/P Ratio (correction factor)	Pupil Lumens	Pupil Lumens/Watt
Low Pressure Sodium	250	32500	130	0.2	9250	37
High Pressure Sodium	365	37000	101	0.62	25530	70
LED Light	15	1500	100	1.9	2475	165

Figure 3 – Benefits of LED lighting

by encouraging the drivers and the travellers to use alternative routes. Thus this makes our everyday travels faster, and tension free.

VIII.CRIME MONITORING

In case of the conventional road-monitoring CCTV cameras, we get only a small view of the roadway. But through this interconnected system of cameras, we can get the entire city ,and each centimeter of the city into surveillance.Hence any criminal activity, be it small or large in scale will be recorded and then stored in our database.The guilty person can be easily identified from the footage that each street light system is going to provide us, and thus preventing all domestic thefts to murders and large scale criminal crimes, and thereby making the city a happy, peaceful and crime-free one.

IX. EMERGENCY SITUATION HANDLING

The wifi open portal system comes handy during our day-to-day life and also in emergency situations.

The open portal once connected will show up a form wherein the user fills in his details, and the kind of emergency help that he needs. The location of the person is automatically determined since the street light is associated with an address, hence acting like an offline GPS system.

When severe floods strike the city, and cellular networks are down , an user can connect to the open wifi portal of the street light system and ask for help. This reaches the nearest help center immediately.

On the base station side, a software allows authorised persons to monitor the area through the cameras in area from where the request is received and then the help can be brought in immediately.

The roads outside the city area are prone to more accidents. In such areas where the cellular signal doesn't reach, first aid help can be seeked through this system. Since the message passed preserves its location, help can be located and sent to the exact location much faster than a conventional help seeked through a phone call.

Thus this technology altogether leads to a revolution in everyone's everyday life and sometimes turns out to be a life saviour in emergency cases.

X. BENEFITS FROM THIS IMPLEMENTATION

Cost Efficiency *:* Sensor street lighting enables energy savings of up to 80% and a reduction of maintenance costs of up to 50%. There's no need to replace existing lamps, because our products are compatible with all existing luminaires.

Livable Environment *:* Our products combat CO_2 emissions, energy waste, and light pollution. They ensure better safety on the streets through better lighting.

Full Control *:* Thanks to our software, you get to manage all of your street lights. Be aware of everything through a personal dashboard and take action yourself.

Effective Monitoring *:* Our lighting controllers offer excellent insights into the state of your lighting infrastructure and alert you to any maintenance needs.

Effortless Installation *:* All our controllers are plug-and-play products that are easily installed either inside the lamp or on the pole. Installation does not require groundwork or any other invasive technical interference.

Scalabilty *:* Our products are open for the integration of third-party applications. Build and expand your Smart City on top of our smart lighting platform!

Data Collection *:* Combined with CityManager, our lighting systems allow collecting and analyzing data such as burning hours, energy consumption, and maintenance needs.

Robust Communication *:* Our fail-proof wireless communication solution withstands harsh outdoor environments. The 2.4 GHz wireless network is self-configuring and self-healing.

XI. FUTURE WORK

The proposed Cloud centric vision comprises a flexible and open architecture that is user centric and enables different players to interact in the IoT framework. It allows interaction in a manner suitable for their own requirements, rather than the IoT being thrust upon them.

Lifi is in its developmental stage , and can still achieve greater levels and speeds clubbed with availability and more reliability along with enhanced security measures . Development in the Near field communication can be made through this.Also we may turn our street lights into potential modern age cellular towers, enhancing network opportunities.

Figure 4 – Today vs Future

XII. CONCLUSION

The paper presented a functioning dynamic street light management system based on an Internet of Things architecture clubbed with Lifi Technology. The current system is based on environmental and traffic indicators to estimate the needs for street light intensity. It then control the light intensity accordingly.

We believe that the adoption of such solutions can revolutionise the power sector, reducing energy wastage to a great extent and hence we can using that energy in rural development and other productive fields.

The emergency portals can come handy in case of natural disaster hence saving numerous valuable human lives. The camera monitoring option is another feather in the hat add-on which leads to revolutionary surveillance over traffic and crimes, leading to pleasing travels and reduced crimes.

On the whole the implementation of the ideas in this paper leads to smart and liveable planet Earth with peace and harmony.

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