

Conceptual Model for Smart Cities: Irrigation and Highway Lamps using IoT

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Abstract—Keeping in mind the need to preserve energy as well as utilize the available at its best the need was felt to develop a module that would be able to sort out the problem where resources such as water and electricity were wasted, in urban as well as rural area. Resource (electricity) was wasted as beside the point operation of Highway & High Mast Lamp; while wastage of water followed by improper trends and methodologies imparted for watering of city park, road side plantation and highway plantation. Thus as per Energy survey statistics of a City (Lucknow, India) it was found that major portion of resources (water and electricity) were being wasted due to negligent activities of officials who were in charge of resource management. So to facilitate energy saving trends and to completely modernize it to autonomous system, module below is proposed which incorporates modern technological peripheral and has its base ingrained in IoT (Internet of Things) which when put into consideration would result in large scale resource and energy saving. This developed module incorporates the peripherals such as Arduino, Texas Instruments ultra low power kits etc. in accordance with software technology including Lab View which help to monitor as well as control the various operation from the base station, located far away from the site. Lab View Interface interacts with all the module located at various city parks, subways and highway lighting modules. Later below in several section a detailed pattern and application frame has been put up.

Keywords — Smart City, Arduino, Lab-View, Automatic Irrigation System, (Highway lamp / High Mast Lighting) Operation and Control.

I. INTRODUCTION

As per the growing rate of population with spontaneous consumption of resources, creates in the need for the managing the available resources at its best. So a need was felt to manage the outflow of the two major resources i.e. water and electricity and to formulate out, that's how it can be protected from getting wasted and could be utilized at its best. [1]

As during the survey study, it was found that (Lucknow, in India) the practices were manual and a major portion of resources was wasted due to slothful and unconcerned behavior leading to plant death and unwanted operation of the lights.

So using modern technology, and statistical, survey based study it was found that that major portion of the resources (water and Electricity) could be managed out and preserved by managing their controlled flow in an allocated area/city/state/territory with channelized Irrigation system and employing modern means for control of Highway lamps and High Mast Lighting. [2,3]

- Primarily, this module would be capable to help, rule out the problem faced with irrigation process, which was carried out manually, and improper trends were practiced which were either

resulting in resource (water) wastage or when not followed properly resulting in plant dying out indirectly unfavorable habitat.

- Secondly the module helps in controlling the Lamps of Various Highways based on collection of data from weather forecast report (such as visibility, mist, fog etc.) and toll plaza as per the traffic density so that accordingly the lights/lamp/ high mast lamp could be operated.

II. TECHNOLOGY ADOPTED

The developed module, thus incorporates the solution for both of the issues:

I.) Advanced Irrigation System for Parks and Road Side Plantation: It includes grouping together of various peripherals together using IoT which help in:

- Data accusation (such as: Status of fountain Running/Idle position; Water Level in the Tank; Soil Moisture Content: rated b/w 0 to 100) [4,5,6]
- Remote Operation Enables to control the various operations such as Operation of Lights, Operation of Fountain Pump, Operation of Sprinklers of City Parks and Road Side Plantation.

II.) Advanced Highway and High Mast Lighting System: Provides automatic control of the lights of the Highway and High Mast Light based on the:

- Weather Forecast (Visibility, Fog etc.): As it was found that during bad weather less visibility, fog affected condition it is necessary to operate all the lights at its full.
- Traffic Density: Data from the Toll Plaza has to be collected so accordingly the operation of Lamps if necessary could be operated in the available modes. (Alternate Mode, Full Mode operations)

III. PROBLEM FORMULATION

The module at base station includes the Lab-View platform installed PC enabling:

- Highway lamps to be controlled as per the requirement through remote access [7]
- Irrigation related functioning such as: Water Level in Tank, Operation of Sprinkler, and Operation of Fountain Lights can be achieved [8].

In the schematic figure below Fig.1 represents the base station in continuous communication link with the discrete module i.e. Highway / High Mast Lamp and Irrigation module with on sites comm. through 30 ft Rx Tx Weatherproof Communication Link Network (SPN2dp8 for 5Km radii Communication range with 0 obst.)

At center lies the base station where Lab view platform based Host PC is installed while on to left half depicts the Highway and high mast Lighting control module where Arduino set's connected to

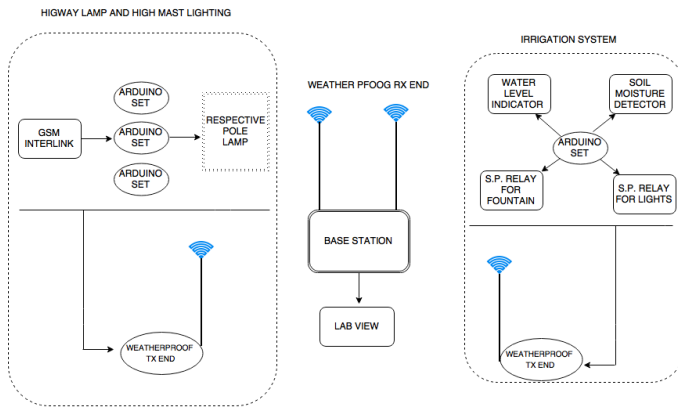


Fig. 1. Working Module describing the concept of interlink network and peripherals of Advanced Highway and Irrigation System in Smart City

sensor for feedback are inter-connected through GSM link via (SIM com900A module for Indian telecom) and giving resultant feed up to weatherproof TX. Whereas on to right-half irrigation module with sub-discrete peripheral such as Water level Indicator, Soil moisture detection, Fountain operator, and fountain light operator connected for data exchange to Arduino mega 2560 and then to weather proof TX end to base Rx end.

IV. ADVANCED HIGHWAY AND HIGH MAST LIGHTING

Problem Observed: Over the course of time it was observed that much of the energy was wasted as these highly energy rated lamps remained to “ON” state, being in operation, although there was no requirement, this was the result of negligence of officials/engineers in-charge of controlling the operation.



Fig 2. A layout of current employed system as per for installation of High Mast Lighting and Highway lamps.

Thus as a measure of substitute to existing system (as solution) module is proposed that is completely automatic and highly efficient. This would help to prevent the losses, will help in better saving and optimal utilization of resources. [9,10,11]. Fig. 2 depicts current trends of a city installed with manually controlled Highway and High Mast Lights. Fig3. Presents IOT based solution using Lab view as a running base platform to manage the lighting system of Highways as per the following aspect into consideration:

- User end Software Controlled
 - Visibility on the road
 - Traffic density on the road

In this at base station a trained operator or engineer controls the

light as per stats and data from live footages as per the traffic density ratio.

- Autonomous via software control

In this mode data from servers of toll plaza and weather forecast are considered and as per initialized threshold value the respective light are operated, complete activity being autonomous.



Fig 3. Lab View VI Module for Controlling of Highway Lamp's (can be controlled Manually through switching from Base Station as per the data received from Toll Plaza , and weather forecast report) (simulation based result).

V. OPERATIONAL FRAMEWORK

Requirement:

- Data from the Toll Plaza [12,13]

Data from the toll plaza is collected through server based channels at the Smart City and Security base station, where a systematic study is carried out about the traffic density on that particular Highway.
- Data from weather Forecast[14]

Weather forecast data is required for the keeping in the record of the weather as well as the visibility, that depends on rain, fog, mist etc.
- Arduino Kit:

Build type: Arduino UNO

Purpose: Receive the signal form sensors such as Moisture detector or water level indicator and transfer the data to GSM module for transmission to Smart City baseStation [15,16,17]

Work Type: It performs both digital as well as analog collection of data and develop digital codes and results that can be manipulated and transferred or recorded.
- Weatherproof 300 ft. TX. Kit for video Link [18,19]

Purpose: Long range Video System, Birthing and Livestock Footage (transmission Type)

Work Type: (a.) Real time footage capture (b.) Digitalization (Encoding) for Easy Transmission
- Weatherproof 300 ft. RX. Kit for video Link [20]

Purpose: Long range Video System, Birthing and Livestock Footage (Receiving Type)

Work Type: (a.) Real time footage, receiving (b.) Decoding of receiving Data

VI. IRRIGATION SYSTEM

In order proper maintain lush green plants / trees in smart city have to be watered regularly, i.e. watering of fields of city parks and road side plants. Earlier practices involved either water channeling or manual irrigation, thus when proper care is not undertaken or not properly practiced leading to plant death. Apart from this manually operating water pumps for tank filling and sprinkler operation led to water as well as electrical energy wastage as beyond the need operation. [21]

This IOT based module enables to maintain the well suited condition for the plants so that, they can grow at best to provide in shed and also maintain the natural beauty. [22,23]

The moisture content in the soil can easily be measured using the Soil Hygrometer Detection Module, which is buried in the soil and gives the continuous reading. As per the plant requirement the operation of sprinkler can be operated manually or automatically obtain the required results and maintain the best suitable condition for growth of plants. And for maintaining proper level of water in water tanks water level indicators are being employed to maintain the subsequent water for irrigation purpose. [24,25]

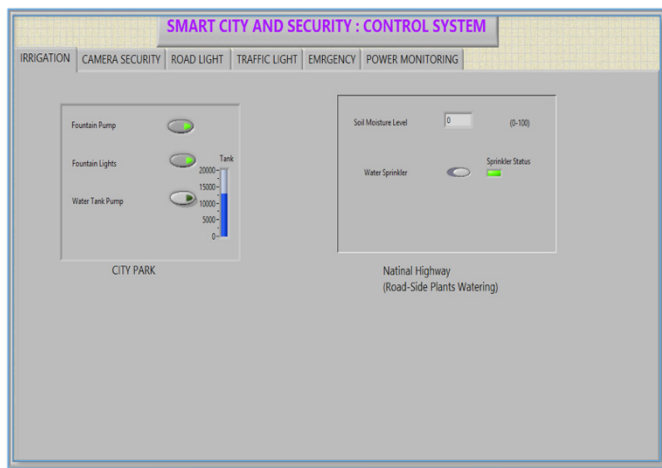


Fig 4:Lab View VI Module for Advanced Irrigation System help to control as well as for Data Accusation of Water Tank Level, Operate Sprinkler, Fountain and Fountain Lights.

Fig. 4 depicts the Lab View module for various condition such as:

- Control and status of water sprinkler
- Soil moisture level at time of sprinkler operation (rated 1% - 100 %)
- Control and status of water pump
- Control and status of fountain pump
- Control and status of fountain lights
- Amount of water level in heavy capacity water tank

VII. OPERATIONAL FRAMEWORK

Requirement:

- Soil Moisture Detector:
Build Type: PIC Atmel Based
Purpose: To collect the data about the moisture content of the soil
Work Type: The results are obtained in form of resistance, between two electrodes giving the conductivity

lesser the moisture: more the resistance
more the moisture: more the conductivity

- Arduino Kit:
Build type: Arduino UNO
Purpose: Receive the signal form sensors such as Moisture detector or water level indicator and transfer the data to GSM module for transmission to Smart City base Station
Work Type: It performs both digital as well as analog collection of data and develop digital codes and results that can be manipulated and transferred or recorded.
Ñ Texas Instruments MSP430G2553:
Purpose: Ultra low power with booster pack plug in module, mainly for frequency decoding, serial interport , relay board power, segment display
- GSM Kit: (Rx and Tx)
Build Type: SIM 900 Module for Data TX and RX
Purpose: The digital data received form the Arduino has to be transmitted to base station of the Smart City and Security to operate the sprinkler located
- Water Level indicator:
Build Type: SD512 Resistive (Non Corrosive)
Purpose: Water level is also a resistive type basically modeled to carry out and note down the capacity of the water tank.
- Relay Single Pole:
Build Type: JQC3F 5 Pin SPDT
Purpose: Controlling and Switching of Fountain Lights and Sprinkler

Fig 5. Depicts the simulation based operation of various pump set with indicator repressing overflow state and power status. In case of detection of high signal value either at over flow or at moisture level beyond threshold operation the relay card in Fig 6. Carries out the necessary operation i.e. to bring back the pump to OFF state. In other words, the relay card can be regarded as main functioning unit for operation of heavy motors. Below is simulation based study carried out with single relay to drive up a single motor. While implementing this circuit in practical use repeated number of relay cards have to be connected to drive each motor for desired purpose.

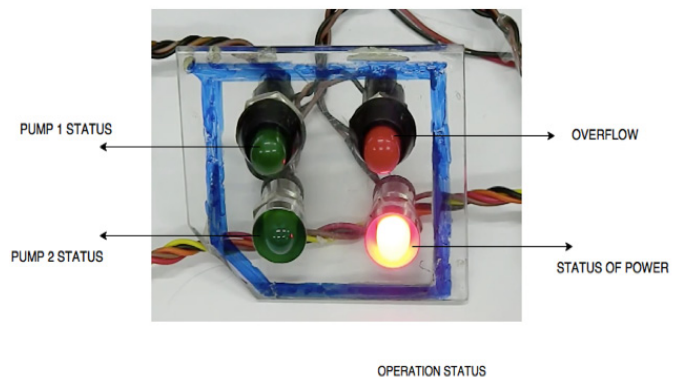


Fig 5:Operation Status display (Real Time) installed at operating end.

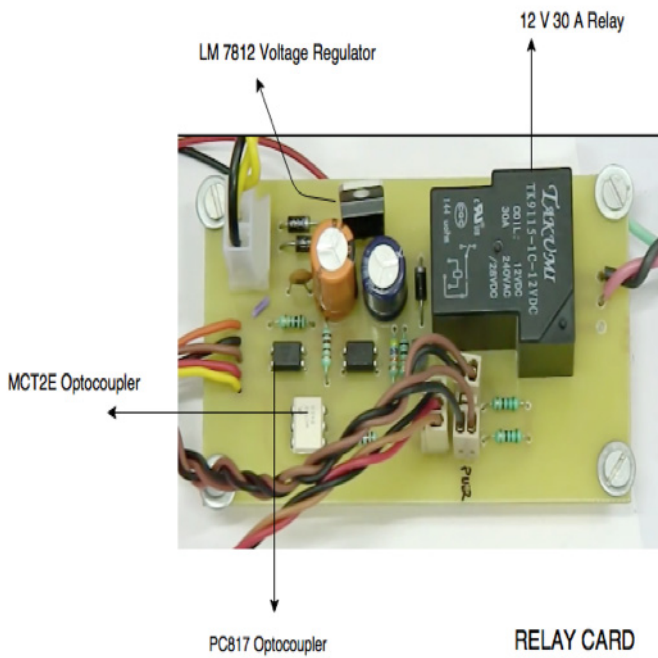


Fig. 6: Relay card for Driving Motor: for water pump set, and sprinkler operation.

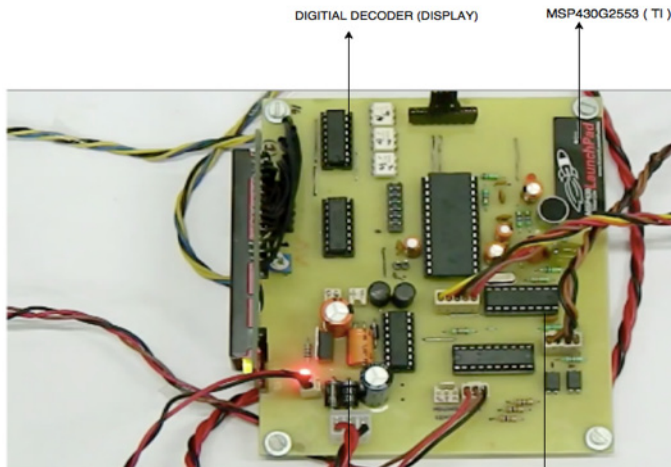


Fig. 7: Master Card driver for Serial channel interface, relay card driving and peripheral operation.

While the min processing units where received signals from base station are received is decoded at master card shown in Fig. 7 which carries out necessary calculation as well as decoding of received data and serves the signal to relay card for specific motor operation.

VIII. FUTURE WORK

The developed module has been tested on simulation and works well with android platform. But currently its pejorative to iOS platform due to intricacy involved. Apart from this future work is more focused toward maintaining the accuracy and precision for a particular task to be carried up. Such as detecting moisture in soil is limited because of limited analog pins in Arduino so future work would incorporate analogous sensor data collection and working on precision and accuracy.

The major achievement could be attained by modulating the signal frequency over a single band for high bit-rate data communication, using advanced data communication devices.

IX. RESULT AND CONCLUSION

- After installation of the module to city better controllability of sprinkler's, tracking level of water and simultaneously operate the water pump could be successfully achieved which are being tested, and thus resources both water and electricity could be managed and saved unto a great extent.
- Apart from this major portion of electrical energy which was initially wasted as beyond the point operation of Highway lamps and High mast lamps would now be avoided and better safe and saving operation could be carried out.
- Data form both the sources are gathered up and studied both manually and technically and according to the comfort the lights can be operated.
- Table below depicts the study of operation of Highway lamps (Lab View VI software based simulation result) for Comparative study of the saving made after installation. The trends and values are as per weather condition (in Lucknow) 26.30 : 27.10 North latitude : : 80.30 : 81.13 East longitude (India). As per day pattern and natural light availability.

TABLE I STUDY OF OPERATION HIGHWAY LAMPS

	OLD Installation	Modern Installation	Savings
Jan	13 Hrs.	9 Hrs.	4 Hrs.
Feb	12.5 Hrs.	8 Hrs.	4.5 Hrs.
May	10 Hrs.	7 Hrs.	3 Hrs.
July	9 Hrs.	7 Hrs.	2 Hrs.
Sep	8 Hrs.	7 Hrs.	1 Hrs.
Nov	9 Hrs.	8 Hrs.	1 Hrs.

The graphical statics of the above Table 1 is Chart 1 which helps to comprehend it better.

Chart 1: Stats showing the difference if energy consumption or in words savings made after installation of the module, data to related chart form Table 1.

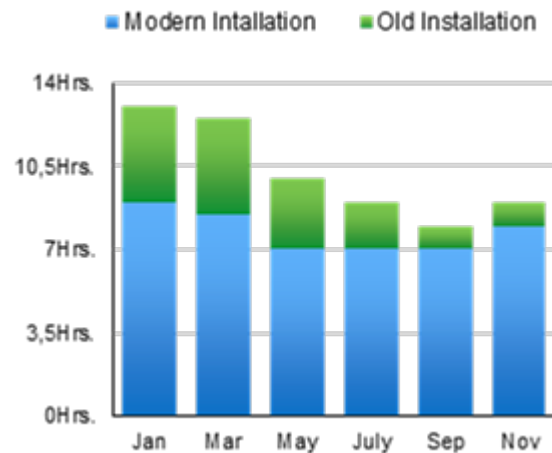


Table 2 here shows an outline of appliances installed, their wattage rating, and approx. consumption of Electric Power in a single day.

TABLE II. OUTLINE OF APPLIANCES INSTALLED

Appliance	Wattage rating(kW)	Installation (No.)	Hrs. of Operation (Hrs)	Power Consumption (kWh)
Air Conditioner	3.3	1	6 *Conditional	3.3 *6 =19.8
Ceiling Fan	0.73	5	8 *Conditional	0.73*5*8 =17.2
Florescent Lamp	0.4	7	4 *Conditional)	0.4*28 =11.2
Geyser	1.2	1	-/ **Occasional	--
Outdoor Lamp	0.80	2	4 *Conditional	0.8*8 =6.4
Garden Lamp	0.6	8	-/ ***Optional	--
Garden Sprinkler	0.43	2	2 ***Optional	0.43*4 =1.72
Desktop Computer	0.145	1	8 *Conditional	0.145*8 =1.16
Fridge	0.433	1	9 *variable	0.433*9 =3.897
Total:	-			61.377 Units

Hrs. of Operation:

*Conditional: Appliance operation may vary, example is just mend to illustrate

**Occasional: These appliances are not that frequent as others

***Optional: These appliances/equipment's are not commonly installed in every home

Table 2 help us to comprehend that the saving made from data of table 1 and help to drive loads of domestic utility.

Illustrative Example: Combining the data from Table 1 and Table 2 it can easily be comprehended that let say for a day in Jan per day saving made is of 4 Hrs. Now,

Taking case of 2 Km road having 22 Road Lamps of 500W (Model :Havells LSH10050099) installed

So,

No. of Lamps * Wattage Rating * No. Hrs of Operation = Power Consumption in Units

$$N * W * Hr = kWhr (Units)$$

$$O_i \quad 22 * 0.500W * 13 = 143 kWh \quad \{old \text{ Installation } O_i\}$$

$$M_o \quad 22 * 0.500W * 9 = 99 kWh \quad \{modern \text{ installation } M_o\}$$

$$O_i - M_o = 143-99 = 44kWh\{saving \text{ made}\}$$

: Since in table 2 on an avg. a domestic appliance utilizes (61.377 ~ 62) units per day from which 44 units can be supplied from savings made and thus their remains only 18 units to be met.

Therefore, from above statics, savings made from operation Highway lamp and High mast lamp can be studied and compared to per day domestic utility to frame out savings. Thus if this system brought up and is employed it would definitely help to make enormous savings and serve out domestic users.

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