**<PROJECT**

**NAME>**

**SOFTWARE REQUIREMENTS**

**SPECIFICATION**

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5. **Introduction**

This project report is a document, which gives an account of the project proposal to ascertain the prospects of the proposed activity. The project report contains detailed information about the entire process undertaken to complete the proposed Project. It is the place where the thinking, process, creation are brought and summarized together that helped to complete the project.

* 1. **Objective of the Project**

A smart cityis an urban development vision to integrate multiple information and communication technology (ICT) and Internet of Things (IoT) solutions in a secure fashion to manage a city's assets – the city's assets include, but are not limited to, local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. The goal of building a smart city is to improve quality of life by using urban informatics and technology to improve the efficiency of services and meet residents' needs. ICT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, how the city is evolving, and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data are collected from citizens and devices – then processed and analyzed. The information and knowledge gathered are keys to tackling inefficiency.

Information and communication technology (ICT) is used to enhance quality, performance and interactivity of urban services, to reduce costs and resource consumption and to improve contact between citizens and government. Smart city applications are developed with the goal of improving the management of urban flows and allowing for real time responses to challenges. A smart city may therefore be more prepared to respond to challenges than one with a simple 'transactional' relationship with its citizens.

The project is developed using Arduino Uno Board, Bolt IoT Board, and various types of Sensors. This report covers software and hardware requirements details, data flow diagram details, flow chart, sequence diagram, explanation of each module and its functionality.

* 1. **Purpose of the Project**

Smart Cities are, or at least will have to be, much more than mere technological ostentation, where the giants of the computer industry distribute their sophisticated systems among towns, supported by millions of useful or fun applications. Smart Cities have (at least) 5 obligatory and urgent functions, which include: making towns more inhabitable, more efficient, more sustainable, healthier and better prepared to cope with change. And all that is not achieved just by introducing technology to towns. It is necessary to look on that technology as a powerful tool so that we can first of all understand the towns we live in, understand and define their needs not only today but also in 5, 10 or 20 years time. Then we can intervene in the field of town-planning and building and from there, create sustained solutions in the information networks formed. It is part of the town’s work to transform all the information acquired by all types of sensors and convert it into useful knowledge for its own management and for its inhabitants.

* 1. **Scope of the Product**

With the integration and implementation of this technology, a smarter way would be produced to manage the various aspects of the life of human beings as well as their surrounding environment.

Various modules such as the smart parking service are based on road sensors and intelligent displays that direct motorists along the best path for parking in the city. The benefits deriving from this service are manifold: faster time to locate a parking slot means fewer CO emission from the car, lesser traffic congestion, and happier citizens.

Smart lighting system which would provide a way to manage the lights being operated which will help a lot to save the resources. The waste management system aims at detection of rubbish levels in containers to optimize the trash collection routes. An urban IoT can provide means to monitor the quality of the air in crowded areas, parks, or even streets. It will also help in prevention of rising of the pollution level in city.

Smart transportation of the project using a gps module will help serve with people with real time tracking system; improve traffic congestion, and better way to manage the traffic. With the help of vibration sensors around the buildings, this system would make aware the surrounding communities about an earthquake and would make aware citizens and notify evacuation forces. This would save lot of lives as well as resources which are prone to danger.

A service would be also available to measure the temperature and humidity. This would provide an easy forecast of the weather and can be warned to the public for any unreasonable change in the weather.

Services would be able to provide with security to people such as prevention from intrusion, burglary; theft. This would make people more secure. Measures can be taken so that local police can be alarmed in case of any mishappening in the house of people.

This project when incorporated will bring lot of benefits to society and city as whole in terms of security, comfort, flexible, inexpensive and proper manageability of resources available.

As national governments increasingly focus on national issues, cities must take greater advantage of the most advanced technologies to update service delivery. New business models target the creation of radical new efficiencies for long-standing challenges.

* 1. **References**

Following are the documents or Web addresses to which this SRS refers to.

* + 1. **Smart Cities**- <http://www.makeinindia.com/article/-/v/internet-of-things>
    2. **Smart Urban Solutions For Transition and Developing Countries**- <https://www.unece.org/fileadmin/DAM/hlm/projects/SMART_CITIES/United_Smart_Cities_Project_Document.pdf>
    3. **IEEE Publications on Smart Cities**-

<http://smartcities.ieee.org/articles-publications.html?start=3>

1. **OVERALL DESCRIPTION**

Cities today are challenged with a competitive landscape as they are tasked with managing population growth, increasing energy demand and decreasing budgets, all while complying with aggressive local and international environmental regulations. Greenhouse gas emission reductions, improved energy and fuel usage and the impact of climate change demand cities design resilient energy networks for greater awareness of consumption.

With a methodical approach to establishing near-, mid- and long-term goals, a city can radically advance energy and sustainability initiatives while ensuring efficiency, resiliency and improved quality of life for its citizens. The key to prosperity is providing a window that helps a city manage its portfolio of disparate buildings, infrastructure and systems. The integration of both Operation Technology (OT) and Information technology (IT) processes will allow for true, real-time visibility into a city’s energy data to provide actionable information and results.

* 1. **Product Perspective**

An ideal smart city is the safe, secure, environmentally green and efficient urban centre of the future. It possesses advanced infrastructures such as sensors, electronics and networks to stimulate sustainable economic growth and a high quality of life. A high-tech intensive and advanced city connects people, information and urban elements using new technologies to create a sustainable environment, competitive and innovative commerce and a higher standard of living. A smart city is developed by coordinating “smart” governance, buildings, energy, mobility, business, city planning, information technology and citizens.

Information regarding ISO 37120 standards for framework of smart city and smart city readiness guidelines has been drafted. Comparison of some smart cities has been made and commonalities noted: more job creation, cultural facilities, public health conditions, individual safety, housing quality, educational facilities, tourism opportunities and social cohesion. These comparisons demonstrate that “smart” cities should be smaller, compact and more efficient.

The product would replace the current traditional method of managing city and build completely a new face of the smart city wherein each thong that would be managed and used will be more significant and productive in many aspects. People belonging to each class would benefit from this, and it would definitely allow and promote growth of the society as well as country in a more rapid manner.

According to a report from India's Ministry of Urban Development, currently 31 percent of the country's population is living in urban areas and contributes 60 percent of India’s GDP. Thus, smart cities are needed to strengthen the Indian economy by reducing expenses and increasing efficiency.

* 1. **Product Functions**

* + 1. **Smart Parking System**

The smart parking service is based on road sensors and intelligent displays that direct motorists along the best path for parking in the city. The benefits deriving from this service are manifold: faster time to locate a parking slot means fewer CO emission from the car, lesser traffic congestion, and happier citizens. This module can be integrated in various buildings requiring a lot of space foe parking system, malls, shopping complexes and many public as well as tourists spots. It can be integrated in all such places which requires lot more management of parking spaces and systems.

* + 1. **Smart Street Lighting System**

This project works with cities and utilities to cut energy costs, improve safety, increase citizen engagement and ensure economic control through smart lighting. Cities can increase operational efficiency, enhance public safety and accelerate environmental initiatives. Utilities can extend the value of existing smart grid investments and streamline operations through integration with existing back-office systems—eliminating the need for multiple networks .Power consumption and energy costs can be significantly reduced with "Smartification". Simultaneously, maintenance processes are cut as well as the effort of planning the complete lighting infrastructure and controlling this on a daily basis. System expansions are also possible at any time. This means that you place your trust in systems that expand together with you in the future.

In particular, this service can optimize the street lamp intensity using LDR’s (Light Dependent Resistors). The street lights would glow to a maximum intensity particularly at nights in order to provide better vision on the street and security as well

* + 1. **Traffic Congestion System**

This module helps in eliminating unwanted congestion in traffic. Congestion in traffic kills lot of time of people travelling which hamper their work as well as daily work. It also leads to unsmooth running of vehicles and sometimes most importantly emergency services such as ambulances, fire brigade and police vans

Proximity sensors would be installed on roads and would be programmed to find the density of vehicles and then depending upon the results the traffic signal lights would automatically function.

* + 1. **Waste Management System**

This system aims at detection of rubbish levels in containers to optimize the trash collection routes. Using a proximity sensor we can detect if the garbage dump in the local landfills have reached a warning limit or not thereby initiating the action of quick removal of the dump through garbage disposal fleet. Sometimes, due to lack of proper communication and information many areas remain littered and create lot of health hazards, effects environment negatively as well as inconvenience for people.

This module can be integrated in all areas especially in those which have lot more population and needs the most efficient way to manage waste.

* + 1. **Flood Detection System**

This module uses a water level sensor to measure the water level in water storage tanks. This can be incorporated in homes especially where the people can be alarmed and immediate action can be taken to stop flowing of water. This service aims at alarming the concerned authorities about the rising water levels in the city reservoir systems in order to prevent over flowing or flooding. This will help to prevent loss of water and save water for usage of resources in general.

* + 1. **Temperature and Humidity Monitoring System**

To provide services such as air quality management, weather monitoring and automation of homes and buildings in a smart city, the basic parameters are temperature and humidity. This service aims at providing the temperature levels of the area where they are installed and warn the specific authorities about the rising levels if any. Any insignificant rise in temperature and humidity leading to adverse effect on environment can be checked and sensed to prevent any damage to living beings and their surroundings.

* + 1. **Smart Homes and Offices System**

This system aims at remotely switching of lights and other electrical appliances in order to lower down energy levels. This will help in saving lot of electricity and prevent over usage of electricity. This can be installed in personal houses, building as whole and offices.

Also, this system aims at providing access control to restricted areas and other areas including homes and offices in order to detect the presence of unauthorized persons focusing mainly towards the goal of a secure environment. This module can be incorporated both in house as well as offices.

* + 1. **Air Quality Monitoring System**

This module would detect rise in pollution levels in environment in forms of smoke, dirt, suspended particles and protect the people and environment from pollution and its forthcoming health hazards. The management and controlling of air pollution would become much easier. Even the levels of pollution in each and every area can be detected and prevented from further rise.

* + 1. **Structural Health of Buildings**

This module would be incorporated in areas which are prone to climatic instability, and unforeseen weather conditions and to places which lies in red zones of earthquakes, strong winds and too much of heavy rainfall, floods, storms which effects the structure of the buildings being constructed.

- The practical realization of this service, however, requires the installation of sensors in the buildings and surrounding areas and their interconnection to a control system.

* 1. **User Classes and Characteristics**

Smart Parking System can be used by parking management system and one time configuration is required by the technical expertise. User need not to install anything on their vehicle as it will be managed by parking management itself. It would display the message if spaces are available which will help in efficient parking of the vehicles.

Smart street lighting system would be installed one time in the street lights and sensors would detect the light intensity and correspondingly lighting of lights would be managed. This will be installed by experts once and benefits can be taken by people in general as it will help in saving electricity.

Waste Management System would be managed by municipal corporations and their management team. The message displaying the waste level would be received by the management and further operations would be taken my management itself with the help of their employees.

Air quality monitoring system will use the sensors to detect the pollution level and message for the pollution level would be received by management team. The same procedure would take place for the noise detection.

Sensors providing information about earthquakes would be managed by meteorological department and any further action would be taken by them. The same message would be informed to people residing in that area and the evacuation forces would take steps to prevent loss of lives. Temperature and humidity monitoring system would follow the same procedure and be managed by weather department.

Intrusion detection system would be installed in home as well as offices and buildings. People residing in houses can install these systems and message regarding the intrusion would be received by them. A message to take action will be received by local police to take any further action.

Flood Detection system can be installed in homes where motors are used to fill water in tanks. As soon as water level reaches the maximum limit an alarm would be present to tell about the same and the respective user can take the appropriate action.

Automatic switching off appliances is a part of smart home and these can be installed in homes and the management of control of appliances would not be hectic for the user as it will be automatically incorporated.

For the all above modules and their installations one time installation expertise is required and rest can be managed by basic knowledge of people.

* 1. **Operating Environment**

The sensors would work in accordance with Arduino UNO and the programming of the Arduino would control the functions and working of the sensors used. Arduino are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. The LED display installed would be able to display messages. Different sensors such as gas sensors, infrared sensor, proximity sensors, water level sensor, temperature sensors, and ultrasonic sensors are used in different modules in accordance with their need. The programming of led as well as led display is controlled through programming done on Arduino. Users will have available devices to view the messages. Buzzers are used for alarming purposes. Gas sensors are used to detect the level of air pollution or alarming authorities in case of any kind of fire. It will also be incorporated in module where detection of alcohol is needed. An infrared sensor is an electronic instrument which is used to sense certain characteristics of its surroundings by either emitting and/or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion. A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. Water level sensor is used to detect the level of water. A level sensor can sense the level of any flowing liquid. A temperature sensor measures the hotness or coolness of an object. It determines the degree of hotness or coldness in environment. An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. A proximity sensor gives a digital output whereas ultrasonic sensor gives an analog output. Led display would be installed on devices that will be used for purpose of reading messages. The programming of Arduino Uno uses a set of C/C++ language functions, the Arduino language is merely a set of C/C++ functions that can be called from your code. Your sketch undergoes minor changes (e.g. automatic generation of function prototypes) and then is passed directly to a C/C++ compiler (avr-g++). All standard C and C++ constructs supported by avr-g++ should work in Arduino. It needs a direct voltage supply of almost +5V connected with the help of an USB plug

* 1. **Proposed Design/Structure**

1. **Interface Requirements**
   1. **User Interfaces**

A user interface is designed for the user to manage these system functions. An interface is present especially in modules which need to be controlled by user itself. The user with help of these interfaces is able to manage the different functions provided with this module. The user has a led display for showing messages and controls for turning on or off the module whenever needed. The programming part of the module and the hardware to be used and software is implemented by the architect of the module itself, the user only needs an interface to control and make use of the functions available for the module.

* 1. **Hardware/Software Use and Description**
     1. **Arduino Uno Board**

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Arduino Software (IDE) allows you to write programs and upload them to your board. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.



Fig 3.2.1- Arduino Uno Board

* + 1. **Proximity-Infrared Sensor**

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. It provides with a digital output.

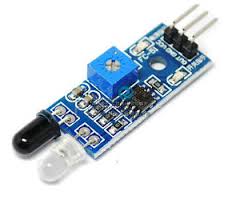
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Fig3.2.2- Proximity-Infrared Sensor

* + 1. **Gas Sensor-**

A gas detector is a device that detects the presence of gases in an area, often as part of a safety system. This type of equipment is used to detect a gas leak or other emissions and can interface with a control system so a process can be automatically shut down. A gas detector can sound an alarm to operators in the area where the leak is occurring, giving them the opportunity to leave. This type of device is important because there are many gases that can be harmful to organic life, such as humans or animals. Gas detectors can be used to detect combustible, flammable and toxic gases, and oxygen depletion. As detectors measure a specified gas concentration, the sensor response serves as the reference point or scale. When the sensors response surpasses a certain pre-set level, an alarm will activate to warn the user. Electrochemical sensors or cells are most commonly used in the detection of toxic gases like carbon monoxide, chlorine and nitrogen oxides. They function via electrodes signals when a gas is detected. Generally, these types of detectors are highly sensitive and give off warning signals via electrical currents.



Fig 3.2.3- Gas Sensor

* + 1. **Ultrasonic Sensor**

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object. The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (like a tiny speaker), the other receives them, (like a tiny microphone).The speed of sound is approximately 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object. Ultrasonic sensors make accurate measurements in many difficult environments and unusual materials.

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Fig 3.2.4- Ultrasonic Sensor

* + 1. **Temperature Sensor**

A temperature sensor measures the hotness or coolness of an object. The sensor’s working base is the voltage that’s read across the diode. The temperature rises whenever the voltage increases. The sensor records any voltage drop between the transistor base and emitter. When the difference in voltage is amplified, the device generates an analogue signal that’s proportional to the temperature. These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), bimetallic strips (like in some home thermometers or stoves), nor do they use thermostats (temperature sensitive resistors). Instead, they use the fact as temperature increases, the voltage across a diode increases at a known rate. By precisely amplifying the voltage change, it is easy to generate an analog signal that is directly proportional to temperature

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Fig 3.2.5- Temperature Sensor

* + 1. **Water- Level Sensor**

A water detector is an electronic device that is designed to detect the presence of water and provide an alert in time to allow the prevention of water damage. A common design is a small cable or device that lies flat on a floor and relies on the electrical conductivity of water to decrease the resistance across two contacts. The device then sounds an audible alarm together with providing onward signaling in the presence of enough water to bridge the contacts. These are useful in a normally occupied area near any infrastructure that has the potential to leak water, such as HVAC, water pipes, drain pipes, vending machines, dehumidifiers, or water tanks.

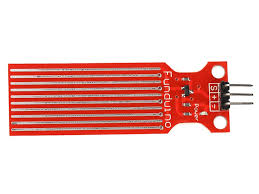


Fig 3.2.6- Water level Sensor

* + 1. **Light Dependent Resistor (LDR)**

A photo resistor (or light-dependent resistor, LDR, or photocell) is a light-controlled variable resistor. The resistance of a photo resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photo resistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. A photo resistor is made of a high resistance semiconductor. In the dark, a photo resistor can have a resistance as high as several megohms (MΩ), while in the light; a photo resistor can have a resistance as low as a few hundred ohms. If incident light on a photo resistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their whole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photo resistor can substantially differ among dissimilar devices. Moreover, unique photo resistors may react substantially differently to photons within certain wavelength bands.

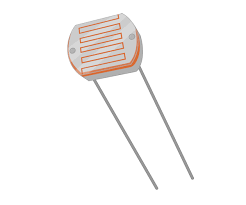
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Fig 3.2.7- LDR

* + 1. **Liquid Crystal Display (LCD)**

A liquid crystal cell consists of a thin layer (about 10 u m) of a liquid crystal sand­wiched between two glass sheets with transparent electrodes deposited on their inside faces. With both glass sheets transparent, the cell is known as transmittive type cell. When one glass is transparent and the other has a reflective coating, the cell is called reflective type. The LCD does not produce any illumination of its own. It, in fact, depends entirely on illumination falling on it from an external source for its visual effect.

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Fig 3.2.8 LCD

* + 1. **Piezo Buzzer**

A buzzer or beeper is an audio signaling device. It is used for alarming or signaling purposes

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Fig 3.2.9- Piezo Buzzer

* + 1. **Arduino Programming Module**

It is a module where all the sensors and devices connected in the module can be programmed and controlled. The program is written and compiled in C/C++ environment. The syntax is quite simple and to implement and understand.

* 1. **Communication Interfaces**

A communication mechanism is required in the above module where there is a significant way needed to communicate between users and officials and management to communicate with each other. In alcohol detection system a communication interface is needed between the officials to take certain actions. In detecting earthquakes or any foreseen changes in environment a transparent communication is needed between the management team and the workers who need to take immediate steps to evacuate that area or plan something different for that particular area. Similarly, in waste management system, when level of waste rises same should be communicated between the waste management officials as well as workers who need to clean up the particular area. The intrusion detection systems installed in houses also need a communication platform so that the message is exchanged between the people and local authorities rapidly at same time. In case of air and noise detection system a communication is required between the officials and management team who need to plan steps to control the noise and air pollution. Thus, it is seen that an effective communication is needed between managers, officials, workers and people in general at each particular level for each module to work efficiently and properly

1. **Non-Functional Requirements**

A non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. They are contrasted with functional requirements that define specific behavior or functions. The plan for implementing functional requirements is detailed in the system design.

The proposed product stands well on every aspect including Availability, Deployment, Interoperability, Manageability, Modifiability, Reusability, Robustness, Scalability and Testability.