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Realization of IoT Solution for Smart Agri and ITS using Cloud

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Abstract
Internet of Things (IoT) is an evolving communication technology. Sensing, Analyzing and Transmitting the data are the major aspects of the IoT. Technology plays a very important role in all aspects of modern-era, such as education, agriculture, business, sales, transportation, communication health care and etc. Advances in technology allow the substitution of human and animal labor with automated labor, thus reducing production costs, decreasing production time and increasing efficiency. This paper gives the insight on implementing the IoT applications and different cloud platforms for the same.

Keywords: IoT, raspberry Pi, arduino Uno, data analytics

Introduction

Internet of Things [1] is a collection of different types (Vehicles, Home Appliances, devices deployed on the road side and etc.) of connected devices which share the data among themselves. IoT enables lots of opportunities to solve many of the day's today problems such as traffic, vehicle parking issues, Health monitoring and etc. Based on the requirements the smart devices can attach to the network and detached from the network. The number of smart devices connecting to the internet is increased exponentially and data generated by these smart devices reaches 40 trillion gigabytes by 2020.

Data plays very important role in IoT applications in order to make decisions [2]. Since IoT is a heterogeneous collection of smart devices, the data generated by these smart devices are huge and unstructured; to take decisions based on the data generated by IoT applications Data Analysis is required [3]. Figure 1 depicts the Data Analysis in IoT.

Applications developed using IoT has the following characteristics such as Volume, Variety and Velocity, which means that the data generated by these applications are huge, the data may be of different patterns such as structured, Semi Structured and unstructured data and processing of data should be fast. Data analysis includes extraction of useful information from knowledge base. The goal of data analysis is to constitute an efficient predictive algorithm [4]. Data analysis has following steps: Data Preparation, Data Planning, and Data Visualization. Data generated by IoT applications can be analyzed in two different ways, 1. As soon as data captured from the smart devices 2. Once data captured from the smart devices, load the data into the cloud and the analysis can be done.

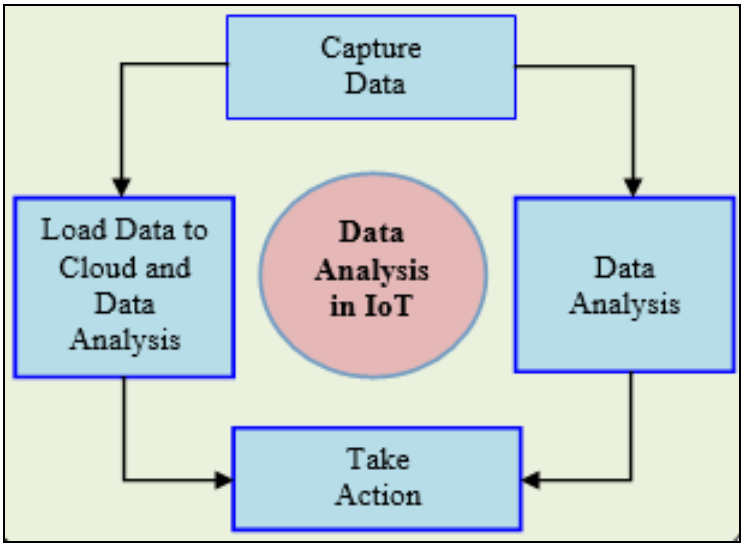

Fig 1: Data Analytics in IoT Implementation of IoT

Raspberry Pi, Arduino Uno, Beagle bone, Intel Galileo are the development boards used to implement IoT applications. This paper highlights on the development of IoT applications using Raspberry Pi and Arduino Uno boards.

Raspberry Pi is a tiny board, where devices like monitor, keyboard, Wi-Fi, Ethernet cable, Web cam, audio jack, and Memory card can be connected. The memory card is used to load an Operating System (OS). Depending upon the application the required OS can be used. Some of the common used OS are NOOBS, RASPBIAN, PIDORA, OPENELEC, RASPBMC, and RISC OS [5]. The Raspberry

pi can be used in many areas such as Games, Audio - video applications and IoT applications. Figure 2 depicts the Raspberry Pi board with interfaces.

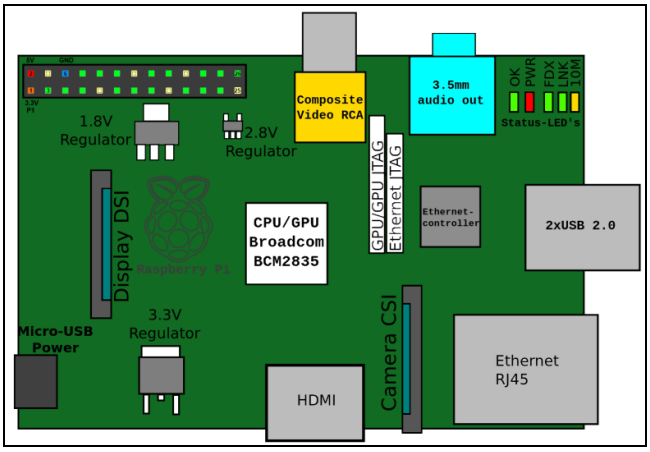

Fig 2: Raspberry Pi Board with Interfaces

Arduino Uno is a credit card sized micro controller board based on the ATmega328P. Figure 2 depicts the Arduino Uno board with interfaces. It has 14 digital input and output pins. Out of 14, 6 pins can be used as a Pulse Width Modulation (PWM) outputs and 6 analog inputs. Arduino also equipped with reset button, a USB connection, a power jack, an In-Circuit Serial Programming (ICSP) header. The power supply to the board is via USB cable connected to computer or smart phones. As Arduino Uno is a micro controller loading Operating System is not possible. Arduino UNO has an Integrated Development Environment (IDE) which acts as an interface to deploy application's code on to the microcontroller [6].

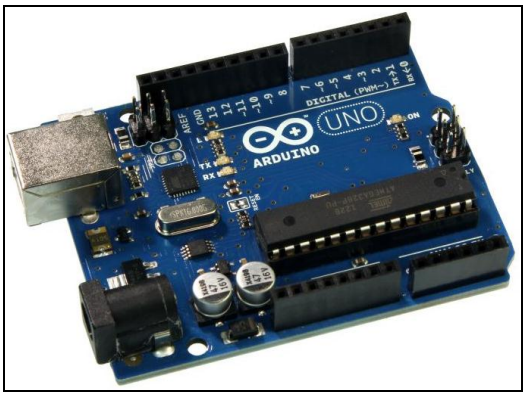

Fig 3: Arduino Uno Board with Interfaces

Applications of IoT

IoT applications play most important role in solving many of the everyday problems like Traffic Management, Smart Agricultural, Health care, Industry automation, Smart Grid and Etc. This paper gives the comprehensive knowledge on IoT applications by considering Intelligent Transport System (ITS) and Smart Agriculture as case studies.

Intelligent Traffic Management System (ITMS)

Most of the metropolitan cities suffer from heavy traffic and traffic related problems. Manual management of the traffic is becoming difficult to the traffic police. Technologies like IoT can be used to solve the traffic related problem [7].

The real time traffic data is used to perform the analysis on incoming traffic flow and predict the future traffic flow. The real time traffic data is collected, analyzed and shared among the travelers to select the feasible path in ITMS. Building the intelligent transportation system has the lots of advantages such as less traffic management risk, avoid the accidents and traffic jams, a traveler can select the optimal path during the bad weather [7].

In order to build ITMS the infrastructure like roads, bridges, tunnels, railway signals, traffic signals should be connected with the traveler. These infrastructures send the real time traffic data to the travelers; based on the data received by the traveler they may select the feasible paths. Figure 4 depicts the block diagram of ITMS.

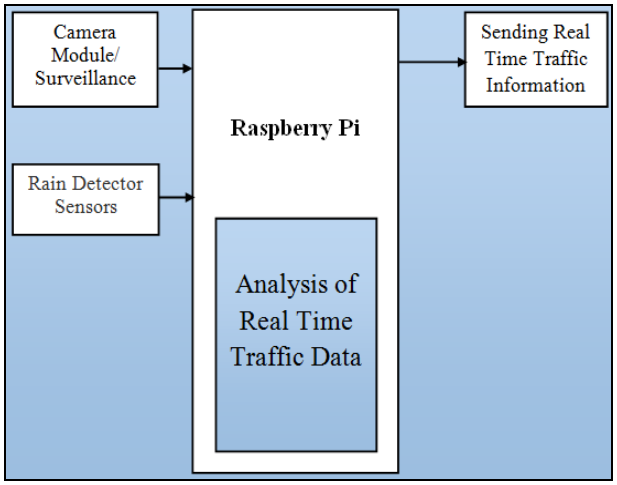

Fig 4: Block Diagram of Intelligent Traffic Management System

In Figure 4 camera module is used to capture the traffic flow on the roads. This captured data can be used to analyze to know about existence of congestion, traffic jams on the roads. This analyzed data can be send to the other travelers and traffic control boards, so that proper precautions can be taken. The rain detector sensor module can be attached to monitor the rain during the rainy season, through which any undue incidence like increase in the wind speed which intern may cause falling of trees can be known. These also may cause for occurrence of traffic issues. Thus with the help of IoT and smart devices proper precautions and measures related to traffic can be taken.

Smart Agriculture

Agriculture plays a significant role in Indian economy because over the 58% of the population depends on the agriculture and related occupation. India is the largest exporter of Spices and its products and second biggest producer of fruits. Demand for food is met by raising the food production.

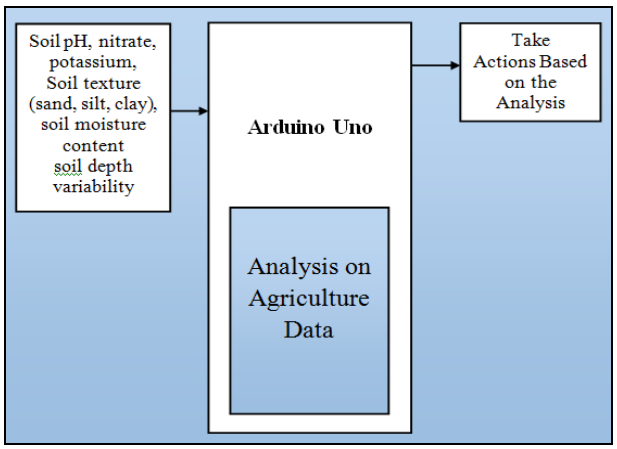

Fig 5: Block Diagram of Smart Agriculture

IoT can be used efficiently in agriculture applications to increase crop production [8]. Soil plays key role in agriculture because soil is the source of nutrients for the plants. Healthy soil increases the crop production. The soil is said to be Healthy soil only when the soil contains the nutrients like potassium, nitrogen and phosphorus. Crops also require some amount of other nutrients such as iron, manganese, zinc, copper, boron and molybdenum. To get information about these nutrients Nitrogen, phosphorus, potassium (NPK) sensor can be used [9]. In Addition to this Electro chemical sensors, Optical and radio metric acoustic sensors and Mechanical sensors can be used to sense the soil pH value, nutrients in the soil and moistness in the soil. Real time monitoring of these properties increases the yield. Figure 5 depicts the use of IoT in Agricultural applications. The PH level in the soil and the Temperature in the environment are the two parameters used to predict whether the plant needs water or not. Smart agriculture an IoT application uses the Arduino Uno as the development board. In this application Arduino Uno is equipped with Soil Moisture Sensor, Humidity and Temperature Sensor and Light Emitting Diode(LED) to indicate whether the plant require water or not.

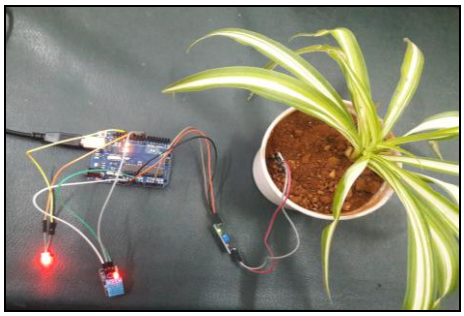

Fig 6: Arduino Uno Setup Showing

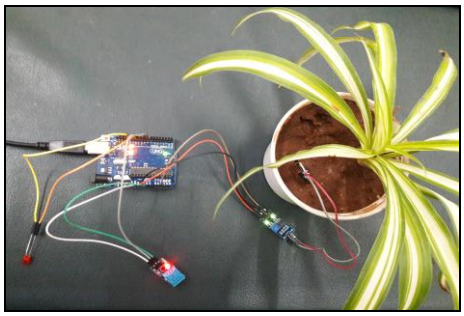

Fig 7: Arduino Uno Setup Showing

Table 1: Different types of Sensors used in Agriculture

Sensor Type	Example applications
Electrochemical Electrical and Electromagnetic	Soil pH, nitrate, potassium Soil texture (sand, silt, clay), soil moisture content soil depth variability (depth of topsoil, depth to hard pan), cation exchange capacity
Optical and radio metric acoustic	Soil organic matter, soil moisture Soil texture (sand, silt, clay), soil bulk density (compaction) soil depth variability (depth of topsoil, depth to hardpan)
Mechanical	soil depth variability (depth of topsoil, depth to hardpan) Soil compaction, compacted soil layers

To make Agriculture IoT more effective the microprocessors and micro controllers can be equipped with the different kinds of sensors to find Nitrate, Potassium values in Soil, Soil texture (sand, silt, and clay). Above properties of the soil is very important to increase the yield of crop and to take better decision. Once the data has been collected from the different sensors, analysis can be done and decisions can be taken. The Camera module can also be connected to the board, to monitor the trespassing of Humans and animals. Table 1 List the sensors available for agriculture purpose [10].

Cloud Platforms for IoT

IoT generates huge volume of data and this in turn increases the load on the internet infrastructure. As a result, companies are forced to find solutions, to minimize amount of data transferring over a network. The features provided by the IoT platforms includes managing, analysing, visualizing of Data [11].

Thing Speak

Thing Speak is an Open IoT cloud platform used to store real time data, analysis and visualization. This platform is a part of MATLAB. Thing Speak consists of eight channels to store real time data. The data generated by sensors are stored in the channels. Thing Speak provides the functionalities such as Time control, Tweet control and Talkback. This platform does not have enough space to store the large data but it is the good visualization tool available for IoT.

Oracle IoT

Oracle IoT provides complete end to end solution over the cloud. The end to end solution includes faster develop and deployment of the applications, manage and analysis of large volume of data, integrate and automate by using device data to make better decisions, the end to end security and high-speed data sharing among the users. Oracle IoT provide the facility to store data in the database.

ThingWorx

ThingWorx is the enterprise-ready technology platform that enables the developers to swift development and deployment of the IoT applications. This platform provides simple drag-and-drop GUI development environment to create mobile and web applications, Data analysis can be done to take better decisions. ThingWorx can be access using Representational State Transfer (REST) APIs. Device management, Remote access, Software management are some of the other features provided by the ThingWorx. The key advantage of the ThingWorx is faster development of applications but it supports for limited amount of devices.

Plotly

Plotly is a cloud service provider (https://plot.ly) developed using python and Django frame work, which provides the services like, data storage, data analysis and data visualization for IoT applications. R, MATLAB, Python application interfaces are available to access plotly. To make data visualization more effective, it uses ggplot2, matplot libraries and MATLAB. This cloud platform provides the different visualization methods to understand and visualize the data.

Microsoft Research Lab of Things

Lab of Things (LoT) is an open IoT cloud platform

developed by Microsoft. This platform developed for research purpose mainly for academic institutions. Typically LoT meant for connecting smart devices. HomeOS is a home automation operating system developed by Microsoft. HomeOS enables the researchers to deploy and monitor devices located at different locations. HomeOS supports different types of devices like Z-Wave devices, IP cameras, and custom smart devices manufactured using prototyping platforms such as .NET Gadgeteer and Arduino. The LoT cloud platform suitable for home automation.

Conclusion

In this paper need for IoT and need for Data Analytics in IoT discussed efficiently and also highlights the use of Single board computer like Raspberry Pi and micro controller like Arduino Uno to build IoT applications. This paper also gives the comprehensive knowledge on different types of sensors used in agricultural application and Traffic management applications. This paper also discuss about the different setup used in building the IoT applications for different domains like Traffic, Agriculture. Apart from these domains, data generated by any sensor based systems can be used to analyse.

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