



## **Internet of Things Development in Smart City**

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**Abstract** – Smart city is an advanced urban area that excels in the fields of economy, government, people and life through strong human capital, social capital and ICT infrastructure. This is a new approach to managing the complexity of city life, increasing efficiency, reducing costs and improving the quality of life of citizens. This paper is about potential smart city applications as applied to the domains of intelligent transportation, intelligent tourism and recreation, smart health, ambient assistance, crime prevention and community safety, governance, monitoring and infrastructure, disaster management, environmental management, garbage collection and sewer management, smart homes, and smart energy. This smart city application supports the vision of the future of cities, which aims to exploit ICTs, namely the internet of things technologies (IoT), for the provision of value added services. Furthermore, this paper presents technical solutions for energy control and comfort at home for proof of the concept of smart city infrastructure applications. The demonstration described here is about how smart applications can manage energy and comfort control in a room that has a number of people and electrical equipment, with each being a source of heat.

**Keywords** –Internet of Things, smart city, electrical equipment, ICT

### **I. INTRODUCTION**

The smart city concept highlights the importance of ICT to raise the city's profile. A city can be called 'smart' when investments in human and social capital and traditional and modern communication infrastructure promote sustainable economic growth and a high quality of life, with wise management of natural resources through participatory governance[1][2][3]. A smart city is also defined as a city that connects physical infrastructure, ICT infrastructure, social infrastructure, and business infrastructure to enhance the city's collective intelligence. The Internet of Things (IoT) is considered a major research and innovation stream leading to many opportunities for new services by connecting the physical and virtual worlds with a large number of electronic devices distributed in homes, vehicles, roads, buildings and many other public environments[2][4]. Urban IOT is designed to support the smart city vision, which aims to utilize the most advanced technologies to support value-added services for city administration and its citizens. Smart cities around the world live under a 'data flood' where big data generated by people and sensors is processed for decision making[5].

The aim of this paper is to showcase the role that IoT can play in smart cities[3][6]. This paper begins by reviewing the services and applications that support smart cities. These services fall into the domains of smart transport, smart tourism and recreation, smart health,

ambient-assisted living environment, crime prevention and public safety, governance, monitoring and infrastructure, disaster management, environmental management, waste collection and sewer management, housing smart and smart energy[7]. Finally this is proven through the example of a demonstrator as a proof of the concept of energy conservation and comfort in a room.

Rural-urban migration is likely to impact service delivery in cities due to limited resources. As a result, the smart city concept has been adopted to improve service delivery in urban areas. This research is about how cities can be compromised through the adoption of IoTs. A literature survey was carried out on what constitutes a smart city and what domains of each city can be made smart through IoT adoption. The domains of transport, tourism, health, assisted living environment, crime prevention, governance, infrastructure management, disaster management, environmental management and energy management were identified. Through literature sampling, IoT applications for these various domains are identified. In addition, in the laboratory environment, prototype technical solutions for energy control and home comfort for smart city infrastructure application proof of concept were developed. The demonstration described here is about how a smart app can manage energy and comfort control in a room that has a number of people and electrical appliances, with each being a source of heat.

## **II. STUDY OF LITERATURE**

This section offers examples of smart city applications for smart transportation, smart energy, smart health, ambient-assisted living environment, crime prevention and public safety, governance, condition monitoring and maintenance of infrastructure, disaster and emergency management, smart homes, tourism and recreation. and environmental management.

### **2.1 Smart Transport**

An integrated transport system will require a single ticket in the form of a smart card which can be loaded with cash and swiped at any point of entry into the transportation system using Near Field Communication (NFC) technology to transmit information from the card to a reader and back. Payment is deducted accordingly from the card for the trip made. In each parking lot there is a meter that detects the presence of parked cars by the markings on the license plates as soon as the cars enter the bay and starts calculating parking fees when they accumulate. Drivers register an etoll account with the road bureau and are issued with a radio frequency (RFID) enabled etoll card on the car. When the car goes under the etoll gate, the driver's details and details of the distance traveled are read by the card reader at the etoll gate, and forwarded to the server at the road bureau[8].

### **2.2 Smart Tourism**

A museum has added a reality system with QR codes placed at strategic points in the museum. Visitors use smart phones to take pictures of QR codes. Each QR code connects the phone to a URL that provides details on which section of the museum they are located in[9].

### **2.3 Smart Health**

Mobile applications, body area network sensors and personal health management ecosystems have been recognized as critical components of next-generation healthcare technology platforms because of their potential to enable citizens to play an active role in the management of their health. Mobile health apps (smartphones and tablets) can connect to medical devices or sensors (e.g. wristbands, smartwatches, patches, etc.) and provide personal

assistance and reminders. Through the use of sensors connected directly to mobile devices, it is now possible to collect large amounts of data[10].

#### **2.4 Assisted Environment**

To encourage the elderly to stay in their homes longer and not in nursing homes, they use body sensors to detect body parameters. These sensors connect to their caregivers wirelessly. If any of the parameters is out of range, an alarm to the caregiver is triggered[11].

#### **2.5 Crime Prevention and Community Safety**

Identification of criminals has been made easier through mobile biometric detection engines. The fingerprints of a suspect are captured onto a police handheld biometric machine. This data is sent through the network to a fingerprint database located at the Ministry of Home Affairs for comparison and returns the identity of the suspect[12].

#### **2.6 Governance**

The number of online services available, their level of effectiveness and usage and level of interaction are important indicators of e-government 'smart level' (Fioroni, 2014). Water, sewage, electricity and tariff bills each have an ID tag which is read by the tag reader on the counter and is automatically matched against the user's details in the database and updated with payment being made[13].

#### **2.7 Monitoring the Condition and Maintenance of Infrastructure**

Heavy duty trucks carrying cargo across the bridge which is their regular route tend to press on the bridge under their weight. Sensors that detect the structural integrity of bridges report to the road agency via a private network on the structural health of the bridges when trucks pass them[8][14].

#### **2.8 Disaster and Emergency Management**

The satellite detects heat signatures from a fire that has just started in an area. The satellite relays information to a control center which registers a fire in their system and dispatches a fire truck. The same control center triggers fire sirens placed at strategic points in the area to alert residents[15].

#### **2.9 Environmental Management**

City engineers installed sensors throughout the city that measure temperature, relative humidity, carbon monoxide, nitrogen dioxide, noise and particulate matter. If any of the parameters is above the set threshold, the GPS enabled sensor sends an alarm to the central node. The nodes in turn send information to the cell phones of the occupants.

#### **2.10 Refusal Collection and Sewer Management**

Municipalities have sensors placed in septic tanks that raise an alarm when the septic tank reaches a set level. Trucks are then sent to remove the waste from the septic tank. The municipality places waste in strategic positions in the city. Trash bins have sensors that raise an alarm when the bin is full and a garbage collection truck is dispatched to collect the waste.

## **2.11 Smart Home**

The homes we live in can be configured to identify individuals, whether they are ordinary family members, guests or unauthorized persons. Individuals are identified by what means they have on people, for example, smart phones are identified by radio waves. If an individual in the house does not have such an ID then they are identified as unauthorized and an alarm signal is routed to the relevant external body or to the home owner.

## **2.12 Smart Energy**

Applications running on cell phones allow individuals to remotely control home electrical devices. The user selects a tool from the app and turns it off. Request to disable GSM network traversal to home appliance IP address..

### **III. ARCHITECTURE**

#### **3.1 Overview of Using IR to Control Equipment**

Research was conducted to automatically control tools that are usually controlled by using a hand-held remote control. This controller relies on infrared (IR) radiation for communication with the device. Here, an IR light emitting diode (LED) on the remote controller transmits information which is picked up by an IR receiver in the device. Initially, the IR module on the device receives the infrared signal from the remote controller, demodulates and outputs the received code to the microcontroller embedded in the device. This received code triggers the logic circuit in the tool whenever a remote control button is pressed.

To automatically control the appliance using IR signals, we include a circuit containing a microcontroller. This microcontroller runs an IR library that receives and sends IR remote codes in several protocols. To control a tool with an IR LED connected to a microcontroller, the protocol used by the tool must be known by the microcontroller. This is done as follows: Using the remote control of the device, the IR receiver interprets the data generated from the remote button presses, copies it to the microcontroller and then sends it to the IR LEDs for transmission when required. Because protocols differ from manufacturer to manufacturer, the device manufacturer must be managed to properly use the libraries on the microcontroller.

Therefore the steps needed are:

- Get IR code from existing remote control,
- List these IR codes into the microcontroller e.g. arduino,
- When needed, the microcontroller transmits code via IR LEDs to run the tool,
- The IR receiver on the device accepts the code, and
- This tool performs the required action

#### **3.2 Controlling the Air Conditioner in the Room**

One of the features of a smart city is optimal control of energy consumption at home while still providing comfort at an ideal temperature. The method for maintaining comfort at home is to adjust the temperature through the air conditioner. This system architecture is an experiment in providing the right temperature for optimal comfort in a simulated indoor environment. It incorporates various sensors to detect whether people are in the room, whether windows or doors are open or closed, and whether the air conditioner should be turned on or off to maintain the ideal temperature. The human body generates heat, which

causes an increase in indoor temperature, thereby creating uncomfortable conditions. In addition, the room usually also stores electrical equipment such as computers which also generate heat.

### 3.2.1 System Components

The control system used in this research project consists of a microcontroller circuit called Arduino, a microcontroller circuit called Raspberry Pi, ultrasonic proximity sensors, passive infrared sensors, current sensors, window and door status sensors, middleware, infrared transmitters, air conditioners, data analytics components, and an app to control the system.

#### 3.2.1.1 Arduino

Arduino is an open-source prototyping platform based on flexible and easy-to-use hardware and software. It is a single-board microcontroller, designed to make the process of using electronics in multidisciplinary projects easier. The exposed connectors on the Arduino allow the processor to be connected to add-on modules. Arduino is capable of communicating with software executing on a connected computer. The Arduino system easily interfaces with the computer via USB when programming is required. Arduino on the other hand doesn't have significant permanent storage capabilities, but mostly incorporates volatile RAM. Arduino cannot directly connect to either a monitor or keyboard and does not usually host an operating system. In laboratory environments, and envisioned real-world applications, Arduinos in smart homes get IR codes from sensors in the home. Codes for rising temperature, falling temperature, turning the tool, and turning the tool down. The code obtained is then embedded into the Arduino to be transmitted when needed.

#### 3.2.1.2 Raspberry Pi

The Raspberry Pi is a single board computer developed by the Raspberry Pi foundation. It uses an operating system based on the Linux kernel. Compared to desktop computers, the Raspberry Pi is limited in RAM and CPU power. It can be connected to a monitor, keyboard and mouse. It is also connected to the internet directly and has storage facilities and an operating system.

#### 3.2.1.3 Middleware

Middleware is a system that enables easy communication between things and people via a number of protocols (or communication channels) such as email, Extensible Messaging and Presence Protocol (XMPP), Hyper Text Transfer Protocol (HTTP), Facebook, Jabber (instant messaging), MXit, Radio Frequency Identification Tag (RFID), Quick response (QR) codes, Short Messaging Service (SMS), Multimedia Messaging Service (MMS) and Twitter. The main component of middleware is the controller. The middleware is the interface between business services and channels. These business services can range from calculators, to tweets that return on dam levels or the temperature of an object, to plant moisture level determinations, etc. Service requests in middleware originate from users through any of the above mentioned channels. They are routed through the controller to business services.

#### 3.2.1.4 Data Analytics Components

Data analysis is the process of examining, cleaning, transforming and modeling data with the aim of finding useful information, suggesting conclusions and supporting decision making. In this case the system continuously monitors the room temperature according to the presence of people in the room and according to certain rules, controls the air conditioner. The

temperature in the room remains constant even when the number of people in the room varies. The resulting information is transmitted to the rules engine which then decides where to turn the AC on or off.

### 3.2.1.5 Application

The application component contains rules that govern the decisions taken on the control of the smart home[16]. It is envisaged that the app will also receive information from the electric utility regarding the provision of electricity, and information from the weather bureau. The application then makes decisions on rules such as "If the doors are closed and the windows are closed and the temperature is below a certain level, then adjust the air conditioning accordingly". The ideal is to eventually be in a position to control the entire smart home environment in this way.

### 3.2.2 System Architecture Controlling Air Conditioning in Rooms

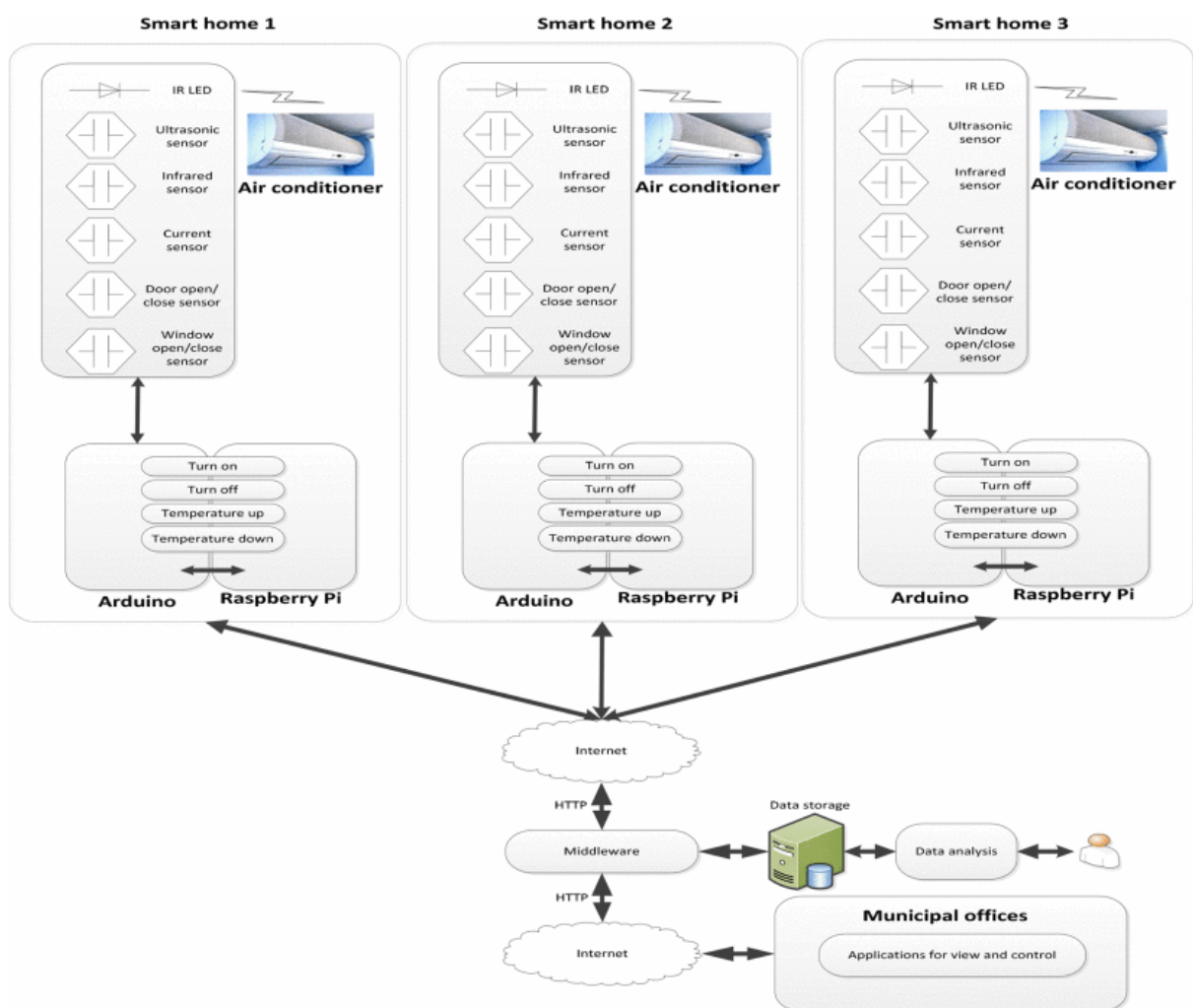


Figure 1 : The experimental room consists of the following sensors, as well as actuators.

- Passive infrared sensor to detect warm body once it is in range
- Current sensor to measure AC energy consumption
- Sensor to detect whether the door / window is open or closed
- Air conditioning that can be turned on/off, or the temperature can be increased or decreased

The goal is for the sensors in the house to be connected to the Arduino. The Arduino in turn is connected to the Raspberry Pi via a USB cable. At first glance Arduino and Raspberry Pi perform the same function. Both are connected with the physical world. The difference is that the Raspberry Pi requires a lot more effort when it comes to putting together electronic circuits to connect to the physical world compared to the Arduino. Arduino functionality can be enhanced with the addition of "shields". The Raspberry Pi, however, has quite a bit of processing power compared to the Arduino. The Raspberry Pi connects to the internet via an Ethernet cable, and then to the middleware. The middleware is software that translates between different protocols. On the other hand middleware is an application which consumes data and sends instructions to actuators controlling AC. Intelligence lies in the application for decision making and control of AC.

#### IV. CONCLUSION

This paper discusses the application of IoT in smart cities. The application of ICT in urban services and infrastructure has changed the way cities operate and deliver services. The application domains for ICT in smart cities range from transportation, tourism, health, ambient-assisted living environment, crime prevention, governance, infrastructure, disaster management, environmental management, smart homes to smart energy.

#### REFERENCE

- [1] K. N. Qureshi, "New Trends in Internet of Things , Applications , Challenges , and Solutions IoT," vol. 16, no. 3, pp. 1114–1119, 2018, doi: 10.12928/TELKOMNIKA.v16i3.8483.
- [2] S. Igder, S. Bhattacharya, and J. M. H. Elmighani, "Energy efficient fog servers for Internet of Things Information Piece Delivery (IoTIPD) in a smart city vehicular environment," *Int. Conf. Next Gener. Mob. Appl. Serv. Technol.*, pp. 99–104, 2016, doi: 10.1109/NGMAST.2016.17.
- [3] Saluky, "Development of enterprise architecture model for smart city," *ITEJ (Information Technol. Eng. Journals)*, vol. 2, no. 2, pp. 12–18, 2017.
- [4] Y. M. Saluky, "Penerapan Algoritma Deteksi Tepi Canny Menggunakan Python dan Opencv," *Smart-Techno (Smart Technol. Inform. Technopreneurship)*, vol. 5, no. 1, pp. 1–7, 2023.
- [5] A. S. City, "Smart City ' s Vehicle Login System With Sensor Chip," pp. 217–223, 2016.
- [6] F. F. L. Saluky, Suhono Harso Supangkat, "Moving Image Interpretation Models to Support City Analysis," *2018 Int. Conf. ICT Smart Soc.*, 2018.
- [7] Y. M. Saluky, "A Review: Application of AIOT in Smart Cities in Industry 4.0 and Society 5.0," *nternational J. Smart Syst.*, vol. 1, no. 1, pp. 1–4, 2023.
- [8] Z. Deng, W. Li, W. Dong, Z. Sun, J. Kodikara, and D. Sheng, "Multifunctional asphalt concrete pavement toward smart transport infrastructure : Design , performance and perspective," *Compos. Part B*, vol. 265, no. August, p. 110937, 2023, doi: 10.1016/j.compositesb.2023.110937.
- [9] Saluky, "Development of Enterprise Architecture Model for Smart City," *ITEJ (Information Technol. Eng. Journals)*, vol. 02, no. 02, 2017.
- [10] D. Gu, J. Li, X. Li, and C. Liang, "Visualizing the knowledge structure and evolution of big data research in healthcare informatics," *Int. J. Med. Inform.*, vol. 98, pp. 22–32,

2017, doi: 10.1016/j.ijmedinf.2016.11.006.

- [11] V. Sugumaran, *Technology : Management AM Intelligent Support Systems : Knowledge Management.* .
- [12] M. V. Singh, “A Proposed System for Security in Campuses using IoT Platform : A Case Study of A Women ’ s University,” *2017 Int. Conf. Curr. Trends Comput. Electr. Electron. Commun.*, pp. 305–310, 2017.
- [13] Saluky, “Tinjauan Artificial Intelligence untuk Smart Government,” *ITEJ (Information Technol. Eng. Journals)*, vol. 3, no. 1, pp. 8–16, 2018.
- [14] R. E. Hall, “The vision of a Smart City,” *Proc. 2nd Int. Life Ext. Technol. Work.*, 2000.
- [15] T. Papadopoulos, A. Gunasekaran, R. Dubey, N. Altay, S. J. Childe, and S. Fosso-Wamba, “The role of Big Data in explaining disaster resilience in supply chains for sustainability,” *J. Clean. Prod.*, 2015, doi: 10.1016/j.jclepro.2016.03.059.
- [16] Saluky, “A Survey on Abandoned Objects Detection from CCTV Surveillance,” *ITEJ (Information Technol. Eng. Journals)*, vol. 5, no. 2, pp. 105–118, 2020.