Design and Implementation of IoT Technology of a Smart Campus with Visual Simulation Tool

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Abstract: This research aims to design and implement IoT (Internet of Things) technology using the visual simulation tool Cisco Packet Tracer. The study focuses on the development of a smart campus with some smart IoT devices available in Cisco Packet Tracer. This simulation tool allows system designers to model different scenarios and identify potential issues prior to physical implementation. Through this research, we were able to develop an effective model for the design, integration and implementation of IoT technology alongside visual simulation tools and packet tracers. Visual simulation can provide an overview of how the device works and set conditions according to the organisation's needs. The built design can be the basis for the real implementation, especially in relation to the need for IoT tools to support the realisation of a smart campus at xyz university.

1 INTRODUCTION

Higher education continues to evolve towards the use of more advanced technologies to create a more efficient, connected and responsive learning environment. The modern era demands greater speed, efficiency and quality in all aspects of life (Basant Kumar et al., 2023). The smart campus is an emerging concept enabled by digital transformation opportunities in higher education (Polin et al., 2023).

Today, the term IoT (Internet of Things) has become extremely important in our lives. Computer networks are very complex and difficult to implement and operate. In addition, with IoT (Internet of Things) technology, we connect all kinds of devices to the Internet, such as refrigerators, air conditioners, fans, etc. (THERA, 2020).

In an era where digital connectivity is the backbone of transformation, IoT technology has opened the door to endless possibilities in connecting and managing various aspects of operations in a campus environment. This technology is being used in many areas such as smart homes (Alfarsi et al., 2019; Ashok et al., 2020; Basant Kumar et al., 2023; Kumar et al., 2019; Praveen Kumar & Krishna Assistant Professor, 2019; THERA, 2020; Tripathi et al., 2023) and also in higher education (Lei et al., 2022; Polin et al., 2023; Sari et al., 2017).

The use of IOT innovation has changed new developments in horticulture, industry and vitality distribution by incorporating significant data with the help of different types of sensors (Kumar et al., 2019).

The integration of connected devices, sensors and systems governed by IoT technology enables extensive data collection and in-depth analysis, providing a better understanding of behaviours and needs in the campus environment.

This research aims to design and implement the IoT technology of a smart campus using a visual simulation tool. Cisco Packet Tracer will be the tool used to simulate and create virtual networks. Cisco Packet Tracer (CPT) is a multi-tasking network simulation software to perform and analyse various network activities such as implementing different topologies (Jain et al., 2015).

Through this research, it is expected to develop an effective model for the design, integration and implementation of IoT technology alongside visual simulation tools in a campus environment. The research case study will be conducted at xyz campus. This is expected to make a significant contribution to changing the educational paradigm and creating a more adaptive, dynamic and technology-enabled learning environment in the future.

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2 METHODS

In this study, a smart campus system is designed, implemented and simulated through a simulation framework based on Cisco Packet Tracer (version 8.2). Cisco packet tracer (CPT) is a multitasking network simulation software to perform and analyse various network activities as implementation of different topologies (Jain et al., 2015). We add all the smart IoT devices available in Cisco Packet Tracer such as fire monitoring, fire sprinkler, smoke detector, siren, camera, smart door, RFID reader, lawn sprinkler and smart window connected to the hub gateway. The next step is a visual simulation, which is expected to provide an overview of how the tool works and set conditions according to the needs of the organisation, case study XYZ University.

3 RESULTS AND DISCUSSION

Xyz University is one of the colleges in North Jakarta. This research limitation is we designed three areas in the college is corridor college building, the classroom and the courtyard. To implement a smart campus using Cisco packet tracer, we used some types of smart devices in packet tracer to make the college smarter. Figure 1 shows the smart campus architecture, which was wired together. We used the wired connection to make sure that the connection of all devices was stable, especially when we tried to remotely control the IoT monitors.

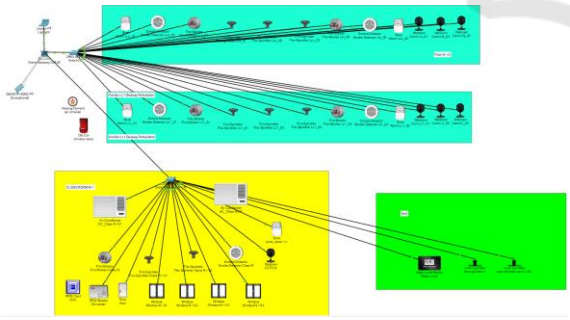

Figure 1: Smart Campus Architecture.

The college building has 8 floors, the length of the college building corridor is about 60 metres on each floor level. In the college building, each floor of the building must have mitigation against disasters, be it fire or other. we put some smart devices like two smoke detectors, two fire monitoring and two sirens to detect a fire disaster. We also installed three security cameras to monitor and improve the security of the college. Figure 2, shows the IoT architecture that we have implemented in the college buildings.

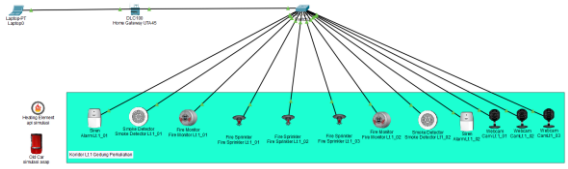

Figure 2: IoT Architecture of College Building.

To enable all devices, we set all smart devices to connect to the hub gateway and could remotely control them with a laptop or smartphone. Figure 2 shows the connected IoT devices that could be remotely controlled by a notebook.

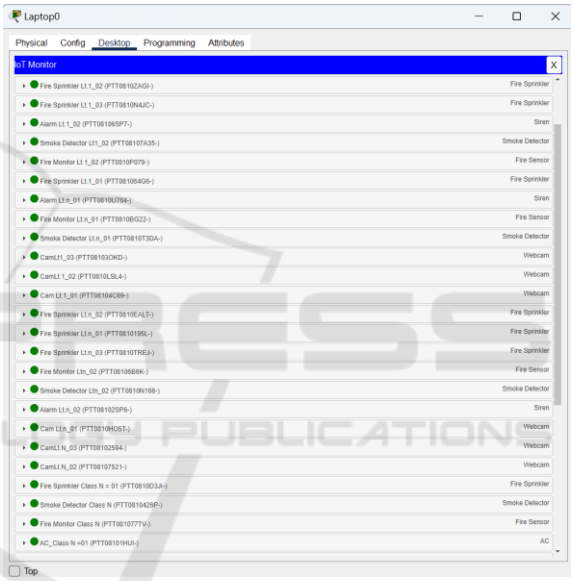

Figure 3: IoT devices connected remoted by notebook.

When all the devices are connected, we set the condition for each device to automatically activate when something happens. The sprinkler will be activated and the water will come out if the fire monitor detects a fire or if the smoke detector detects smoke. Figure 4 shows the condition we have set. The siren will also be active.

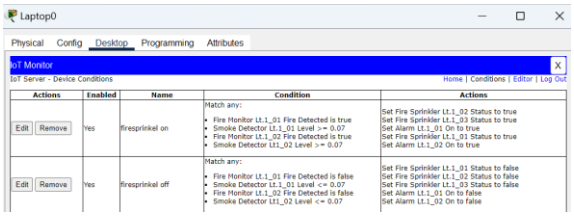

Figure 4: Conditions for activate fire sprinkler and siren.

For the simulation, we will try to use a fire device in Packet Tracer to trigger a fire monitor, then when the fire monitor detects a fire, the fire sprinkler will release the water and the siren will be activated. Figure 5 shows when the sprinkler and siren are active.

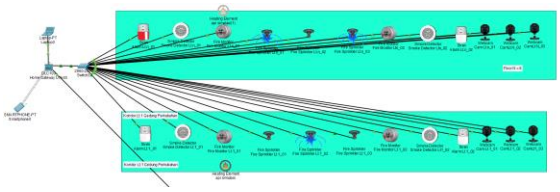

Figure 5: Conditions fire sprinkler and siren are active.

If we implement the architecture for each floor, with the number of floors in the college building N = 8, the devices required for the corridor area in the college building are shown in Table 1.

Table 1: Devices need for corridor are in college building.

No	Device Name	Amount
1	Smoke Detector (2 @floor)	16
2	Fire Monitor (3 @floor)	24
3	Siren (2 @floor)	16
4	Fire Sprinkler (3 @floor)	24
5	Security Camera (3 @floor)	24
Total		**104**

The total number of smart devices required is 104.

The second area we have designed is the classroom. In the classroom we placed 1 smoke detector, 1 fire monitor, 1 siren, 2 sprinklers, 1 security camera, 2 air conditioners, 4 smart windows, 1 smart door and 1 RFID reader. Figure 6 shows the architecture we have implemented in the classroom.

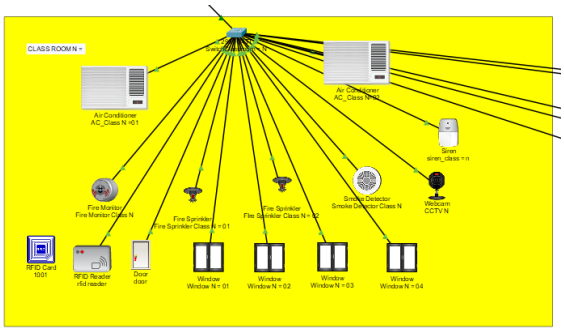

Figure 6: IoT Architecture of Classroom.

We activate all the devices from the IoT monitor. The windows can be opened remotely, the air conditioning can be turned on remotely, the security camera can be turned on remotely. The sprinklers are activated when the fire monitor detects a fire or the smart detector detects smoke. The door could also open if the RFID reader detects the RFID card. Figure 7 shows the conditions for activating devices in the classroom.

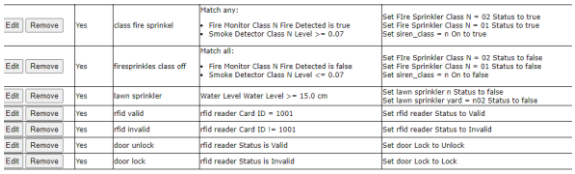

Figure 7: Conditions for activate devices in classroom.

Xyz University has 8 floors and each floor has about 10 classrooms, so we have 80 classrooms in the college building. To implement the architecture, the equipment needed for classrooms in college buildings is shown in Table 2.

Table 2: Devices need for classroom are in college building.

No	Device Name	Amount
1	Smoke Detector (1 @classroom)	80
2	Fire Monitor (1 @classroom)	80
3	Siren (1 @classroom)	80
4	Fire Sprinkler (2 @classroom)	160
5	Security Camera (1 @classroom)	80
6	AC (2 @classroom)	160
7	Windows 4 @classroom	320
8	Smart door 1 @classroom	80
9	RFID Reader 1 @classroom	80
Total		**1120**

The total number of smart devices required for the classroom is 1120.

The last area we designed was the garden area. In this area we placed a water level monitor and 2 sprinklers. We were able to activate the lawn sprinkler from the IoT monitor and set the condition to automatically turn off when the water level monitor reads the specific value that we set. Figure 8 shows the architecture in the garden and Figure 9 shows the condition that is configured. We are only using 2 devices to simulate how the device works in the yard, the number of devices required can be adjusted according to the needs of the organisation.

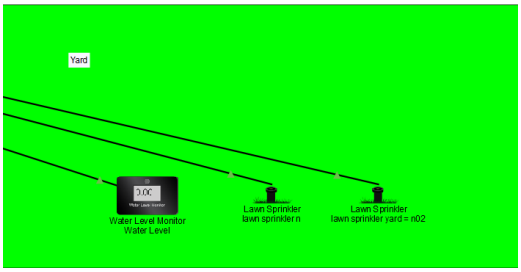

Figure 8: IoT Architecture of Yard.

Figure 9: Conditions for activate devices in yard.

4 CONCLUSIONS

Through this research, we have been able to develop an effective model for the design, integration and implementation of IoT technology alongside the Packet Tracer visual simulation tool. The visual simulation can provide an overview of how the device works and set conditions according to the organisation's needs. The built design can be the basis for real implementation, especially in relation to the need for IoT tools to support the realisation of a smart campus at xyz university.

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