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Cloud Communication Based Smart Home Automation with integrated IoT

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Abstract:

In based on the positive and medium answers of the user the ecosystem smart control with the appliance of a cognitive agent.The simplification process for enable automation and scripts through the reflected conversational descriptions succeed according to the user opinion with small errors or desynchronizations that can be internet issues also. Furthermore,Cloud Communication Based the participants would introduce the ecosystem to their friends and also the most answer that they would adapt for personal use to their house.The system proved that is convenient in the most of cases and impressive considering the conversational way request with descriptive features with integrated IoT.The participants according to the interaction with the Dashboards including Pandora found interesting and useful the idea of creating dedicated big coloured icons and subtitles for supporting people with special needs.

Key Words:cognitive agent, integratedIoT, Cloud Communication, icons, automation, scripts

1. Introduction

The smart ecosystems are increasing rapidly by empowering the energy efficiency in smart facilities and comfort. Smart facilities are consisting smart devices, devices that characterized as smart from their ability of communicating with each other via communication protocols. The KNX protocol is one of the most popular protocols in the word for residential usage, although it is not the only communication standard that exists in the technological world[1]. The communication protocols are providing the interoperability between the smart devices that are part of smart buildings. The intelligent buildings are following rules and standards for the communication and the information exchange between the smart devices. The open protocols can be wired or wireless according to the smart device type that will support. The KNX protocol is one of the most popular protocols in large networks because of the tree topology that characteriseit.There are many other popular protocols like MQTT, AMQP, for the interconnection of the smart devices that are providing different characteristics, advantages and disadvantages.The communication protocols that are standardize the smart devices are applied also to the industry with other form of industrial protocols like the Modbus TCP.The smart devices are interacting with each other by exchanging data through the cloud. The smart devices that can be part of the cloud interconnectivity can be any type of smart devices like sensors, actuators, servers and mechanical devices.Health care services, residential applications and cities can be instantly supported through the internet of things technology.Home automation is one of the most related usage resources of the internet of things technology, end user and administrators are facing issues that are based on the interoperability limitations that is based on the high degree of technology fragmentation issues[2].

The home automation system (HAS) is a group of smart devices that are providing automating tasks according to condition, triggers and actions. In the last ten years automation market increased rapidly and smart home applications increased for supporting the customer demands in more user-friendly environments interfaces, dashboards, voice assistants using smart speakers like Amazon echo and Google assistant.The adaptation of these devices from people is providing improvements in operability according to control and entertainment in parallel for being more pleasant to the user. Although the development has been more complex, and the fragmentation is pointed by the gap of interoperability across proprietary technologies.This gap is based on the device standardization protocols and technical specification that are leading to incompatibility.The research that is mentioned in the related work was pointing to automatically control appliances through the voice or text-based control.The application that builds is offering also remote control[3]. Although the application was designed to support simple user commands for control specific devices.

Figure 1: Related Work Arduino Board Connected to Dialog flow for Custom Voice Assistant

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2. Smart Home automation

The ecosystem that was built for evaluate the experimental purpose consists of smart devices that are providing services to the most dedicated facilities. The smart devices that are picked for examine features, operability and functionality in any popular section of the smart facilities are smart devices that are providing system program accepting features.More specifically the smart devices that are collected are manufactured from Hager and their main technical characteristics can provide to the system the programmable behaviour that is needed for creating a complex specialized automation behavioural system[4].

Figure 2: Redqueen Ecosystem Cloud Service Connection Diagram

The devices can accept adjustments and configuration in systemic level for supporting the installation in any way. The lights control is succeeded with the appliance of dedicated relay power output actuators that are mounted on a din rail[5]. Modular devices are comfortable according to the installation because they have the ability to be installed in to electrical enclosures that are designed to adapt this type of products.

2.1 Smart Thermostat

The thermostat that is picked for the experiment and the ecosystem support is 80440100 that is manufactured from Hager Berker and provides many functional objects that valuable for automation and control that is based in two-point control and PID control for the HVAC systems. The smart thermostats are providing energy consumptionfeatures by involve the learning curves procedure technique for accurate room temperature according to the user mode and also having the ability to control and drive heating cooling controllers.

Figure 3: Berker KNX Smart Thermostat 80440100

The heating cooling systems controller for HVAC control is one of the most significant members of an installation. The HVAC controllers can divide the facility to different temperature zones that controlling according to the system configuration that is applied from the system administrator. The heating cooling controller that is picked to support the experimental procedure is TYM646T that is manufactured from Hager and provides control to pumps that cold or hot water circulates[6]. This type of controller supports the "two-point control" and "PID" control. The "PID" control is for the adjustments in pumps according to the percentage that is needed to provide for heating and cooling accuracy.

The "two points" control is the control of a unit by single sophisticated "On/Off" according to the controller and the thermostat that are collaborating together by taking in advance also the information from the weather station sensors for predict the best way to control the building temperature.

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2.2 Smart Metering

The method that can reveal the energy consumption that applied through the smart control of lights, heating cooling systems, HVAC, shutter control and many others is the appliance of a smart metering equipment that is part of the system for calculating the energy through time by estimating the different types of the cost tariffs in parallel. The smart metering device that is picked for the experimental procedure for point also to energy data points control is the TE332 that is manufactured by Hager and provides measurements for history graphs through cost and energy consumption. TE332 is very accurate and has the ability to measure one or three phase systems according to the most important electrical measurements[7].

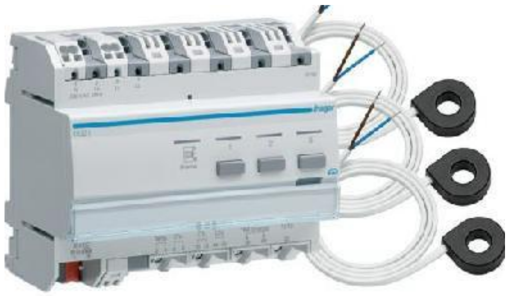

Figure 4: TE332 KNX Smart Metering Device - Through Current Transformers

Number	Name	Object Function	Description	Group Address	Length	C	R	W	T	U	Data Type	Priority
0	Current tariff	Emission	current tarif emition	4/5/3	1 byte	C	R	-	T	U	8-bit unsigned value	Low
9	Input 1 metering	Power	Power measurements	1/3/10, 1/3/149	4 bytes	C	R	-	T	U	power (W)	Low
10	Input 1 metering	Total energy	TE332 Metering input 1 total energy	1/3/150	5 bytes	C	R	-	T	U		Low
11	Input 1 metering	Dynamic mode activati...	Dynamic mode activation 1	1/3/16, 1/3/151	1 bit	C	R	W	-	U	start/stop	Low
12	Partial meter reset...	Control	Partial meter reset 1	1/3/17, 1/3/152	1 bit	C	R	W	-	U	1-bit	Low
13	Input 1 metering	Partial energy	Partial energy 1	1/3/11, 1/3/153	5 bytes	C	R	-	T	U		Low
15	Input 2 metering	Power	TE332 Metering input 2 power	1/3/154	4 bytes	C	R	-	T	U	power (W)	Low
16	Input 2 metering	Total energy	TE332 Metering input 2 total energy	1/3/155	5 bytes	C	R	-	T	U		Low
17	Input 2 metering	Dynamic mode activati	TE332 Metering input 2 dynamic mode ac	1/3/156	1 bit	C	R	W	-	U	start/stop	Low
18	Partial meter reset...	Control	TE332 Metering partial meter reset input...	1/3/157	1 bit	C	R	W	-	U	1-bit	Low
19	Input 2 metering	Partial energy	TE332 Metering input 2 metering partial e...	1/3/158	5 bytes	C	R	-	T	U		Low
21	Input 3 metering	Power	TE332 Metering input 3 power	1/3/159	4 bytes	C	R	-	T	U	power (W)	Low
22	Input 3 metering	Total energy	TE332 Metering input 3 total energy	1/3/160	5 bytes	C	R	-	T	U		Low
23	Input 3 metering	Dynamic mode activati...	TE332 Metering input 3 dynamic mode ac...	1/3/161	1 bit	C	R	W	-	U	start/stop	Low
24	Partial meter reset...	Control	TE332 Metering input 3 partial meter rese...	1/3/162	1 bit	C	R	W	-	U	1-bit	Low
25	Input 3 metering	Partial energy	TE332 Metering input 3 partial energy	1/3/163	5 bytes	C	R	-	T	U		Low
32	Addition metering	Current tariff	additional mettering curent tarif	4/5/9	1 byte	C	R	W	-	U	8-bit unsigned value	Low
33	Addition metering	Power	aditional mettering power	4/5/4	4 bytes	C	R	-	T	U	power (W)	Low
34	Addition metering	Total energy	aditional mettering total energy	4/5/5	5 bytes	C	R	-	T	U		Low
35	Addition metering	Dynamic mode activati...			1 bit	C	R	W	-	U	start/stop	Low
36	Partial meter reset...	Control			1 bit	C	R	W	-	U	1-bit	Low
37	Addition metering	Partial energy	aditional mettering partial energy	4/5/8	5 bytes	C	R	-	T	U		Low
44	Temperature	Emission	TE332 Metering temperature emission	1/3/169	2 bytes	C	R	-	T	U	temperature (°C)	Low
61	Input 1 metering	Voltage	Voltage 1 measurement	1/3/14, 1/3/172	4 bytes	C	R	-	T	U	electric potential (V)	Low
62	Input 1 metering	Strength of current	Strength of current 1 measurement	1/3/15, 1/3/173	4 bytes	C	R	-	T	U	electric current (A)	Low
69	Input 2 metering	Voltage	TE332 Metering input 2 metering voltage	1/3/174	4 bytes	C	R	-	T	U	electric potential (V)	Low
70	Input 2 metering	Strength of current	TE332 Metering input 2 strength of current	1/3/175	4 bytes	C	R		T	U	electric current (A)	Low
77	Input 3 metering	Voltage	TE332 Metering input 3 voltage	1/3/176	4 bytes	C	R	-	T	U	electric potential (V)	Low
78	Input 3 metering	Strength of current	TE332 Metering input 3 strength of current	1/3/177	4 bytes	C	R	-	T	U	electric current (A)	Low
93	Addition metering	Voltage	aditional mettering voltage	4/5/6	4 bytes	C	R	-	T	U	electric potential (V)	Low
94	Addition metering	Strength of current	additional mettering strength of current	4/5/7	4 bytes	C	R	-	T	U	electric current (A)	Low

Figure 5: TE332 KNX Smart Metering Functional Objects ETS Program

The TE332 smart metering device is providing the measurement of the voltage per phase, the current, the Power, the total energy, the partial energy the current tariffs and many other features for further experimentation for the energy consumption cost reduce.

2.3 Motion Detection

The benefits that smart devices are providing are pointing to keep in good, comfort and economic things in balance with or without the human to be present in the facility[8].The system changes form and different technical characteristics are triggered that are based on the sense of a human presence or not. There are a lot of ways for the system to search if human presence exists in the facility, the most common is the motion sensors that are providing useful information about the history of motion senses, luminosity and light luminosity control by collaborating with other devices also. The picked motion sensors that are picked among others for the experimental process of the ecosystem are three, TCC510S, TCC530E and the TCC520E that are manufacture from Hager and are providing many features about the room control automation and handle based on the presence, the motion sense, the luminance and the dimming value that the room has to be reach.

Figure 6: TCC5X0E KNX Motion Detector

2.4 Room KNX Smart Controllers Multi-Sensor

The information for controlling a smart system in multimodal way demands as many sensors are possible to participate to the solution, Humidity, temperature, CO2 andOxygen are also important measurements for humans[9]. In danger zone multiple times there would be saved people if a CO2 sensor was existed. The experiment supports CO2 measurements with the appliance of the Room Controller 75441326 that is manufactured by Hager Berker and provides to the experiment CO2, humidity measurements and room control that is based to the room and outsidetemperature.

Figure 7: Berker KNX 75441326 Controller-Sensors

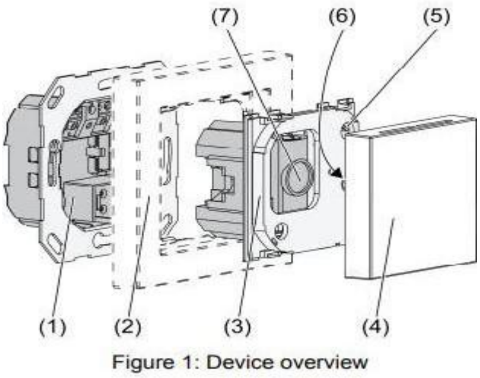

Figure 8:Berker KNX 75441326 Room Room ControllerMulti-Sensor Assembly

Number	Name	Object Function	Description	Group Address	Length	C	R	W	T	U	Data Type
0	B.Channel 1	Switching object 11	KNX CO2 sensor B channel 1 switching obj...	1/3/114	1 bit	C	-	W	T	-	
2	B.Channel 1	Switching object 12	KNX CO2 sensor B channel 1 switching obj...	1/3/115	1 bit	C	-	W	T	-	
4	B.Disable channel 1	Disabling switching obj..	KNX CO2 sensor B channel 1 disabling obj...	1/3/116	1 bit	C	-	W	-	-	
23	R.Output	Actual temperature	KNX CO2 sensor R Output Actual tempera...	1/3/117	2 bytes	C	R	-	T	-	
25	R.Input	Basic setpoint	KNX CO2 sensor R Input Basic setpoint	1/3/118	2 bytes	C	-	W	-	-	
23	R.Input	Operating mode switch...	KNX CO2 sensor R Input Operating mode...	1/3/119	1 byte	C	-	W	T	-	
32	R.Input	Operating mode forced...	KNX CO2 sensor R Input Operating mode...	1/3/120	1 byte	C		W	T		
33	R.Input	Presence object			1 bit	C	-	W	-	-	
34	R.Input	Window status	KNX CO2 sensor R Input Window status	1/3/122	1 bit	C	-	W	-	-	
35	R.Output	Heating/cooling switch	KNX CO2 sensor R Output Heating coolin	1/3/123	1 bit	C	-	-	T	-	
35	R.Output	KNX status operating...	KNX CO2 sensor R Output KNX status ope...	1/3/124	1 byte	C	-	-	T	-	
42	R.Output	Cmd. value for heating			1 bit	C	-	-	T	-	
44	R.Output	Cmd. value for cooling			1 bit	C	-	-	T	-	
50	R.Output	Setpoint temperature	KNX CO2 sensor R Output setpoint tempe...	1/3/127	2 bytes	C	R	-	T	-	
52	R.Output	Current setpoint shift	KNX CO2 sensor R Output Current setpoi...	1/3/128	1 byte	C	R	-	T	-	
53	R.Input	Setpoint shift specificati...	KNX CO2 sensor setpoint shift specification	1/3/129	1 byte	C	-	W	-	-	
55	R.Output	KNX status	KNX CO2 sensor R Output KNX status	1/3/130	2 bytes	C	-	-	T	-	
55	R.Output	KNX status forced oper....	KNX CO2 sensor R Output KNX status forc...	1/3/131	1 byte	C	-	-	T	-	
59	R.Output	Actual temp. not adjust...	KNX CO2 sensor R Output Actual temp n...	1/3/132	2 bytes	C	R	-	T	-	
80	S.Temperature	Measured value	KNX CO2 sensor S temperature Measured...	1/3/133	2 bytes	C	R	-	T	-	
81	S.Humidity	Measured value	KNX CO2 sensor S humidity Measured val...	1/3/134	2 bytes	C	R	-	T	-	
82	S.CO2	Measured value	CO2 Concentration value	2/3/24, 1/3/135	2 bytes	C	R	-	T	-	
83	S.Dew point	Temperature	KNX CO2 sensor S Dew point Temperature	1/3/136	2 bytes	C	R	-	T	-	
85	S.CO2	Limiting value 1			1 bit	C	R	-	T	-	
89	S.CO2	Limiting value 2			1 bit	C	R	-	T	-	

Figure 9: Berker KNX 75441326 Room Controller Multi-Sensors Functional Objects ETS Program

2.5 KNX Smart ButtonFolds

The smart installations are consisted of many control spots inside and outside the building for the user to trigger automation, scripts, events, scenes and single control. The smart button folds are placed on or inside the wall for providing to the user the ability of easy access, although the potential of the control that can be succeed with smart button folds installation are limited. The smart button fold significance according to the usage and control is valuable to occur, the WST314 WST316 four and six buttons smart KNX button folds are part of the experiment for testing purposes through the ecosystem collaboration components[10].

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Figure 10: WST31X SYSTO KNX Smart Button Folds

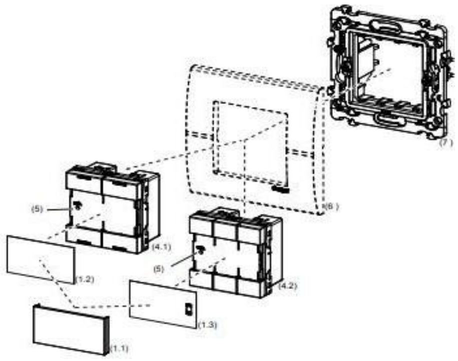

Figure 11: WST31X SYSTO KNX Smart Button Folds Assemply

3. Applications

3.1 n Home Simulation Panel

The smart facilities are consisting many smart devices that are intercommunicating with each other through a communication protocol. The communication between the smart devices through the local network protocol and the internet protocol is critical to occur[11]. According to our knowledge until now the appliance of many gateway servers that are co-existing in the same system and are communicating with the same or with different communication protocols doesn't have applied before.

Figure 13: Bathroom Shutters and Lights Simulation

Figure12: Main Internal Rooms Simulation Panel

According to the testing procedure the need of the ecosystem to reach the limits the appliance of many different gateway server occurred by involving hardware and virtual servers in the same network[12].

The gateway servers are interconnected that are interconnected in the same network are tow real server with hardware and five virtual that are existing on cloud platforms and also locally. This dissertation is pointing to simplify the control according to the automation, scripts, events and information cognitive filtering. The ecosystem check for interoperability, operability, remote control potentials and security check is interesting to occur. Different kind of servers that are communicating via KNX or MQTT protocol occurred and connected to the same network to succeed the interaction, the entities reflection in many places at the same time and smart devices collaboration through different gateways was successfully tested with positive results. The smart system components are interacting together and the data information is transferred everywhere with low latency. The experiment preparation for the user interaction with a real ecosystem for testing was led to install the equipment to three main panel that are caring the equipment for bring real installation similarities and technical difficulties. The procedure for building the three separated panel units was occurred by following the electrical installation national rules in parallel with KNX community certification and ETS softwarelicenceLite. Three panel were created, made from wood materials and holders with rollers for transferring purposes. The panels cabling was installed in the back of any panel for safety reasons and only the modular smart KNX devices are visible at the front of the panel. The main panel is simulating a real house with the installation of pictures that are describing the house different areasforsimulation. The living room, the bathroom, the kitchen, the outside place and the pool are simulating on the main panel board. The main panel consist many different kinds of light component for examine the control behaviour, the commands latency execution and accuracy. The devicespower supply is being applied with the installation of many types of voltage 230V, 12V DC, 12- 24V AC, 30V DC.

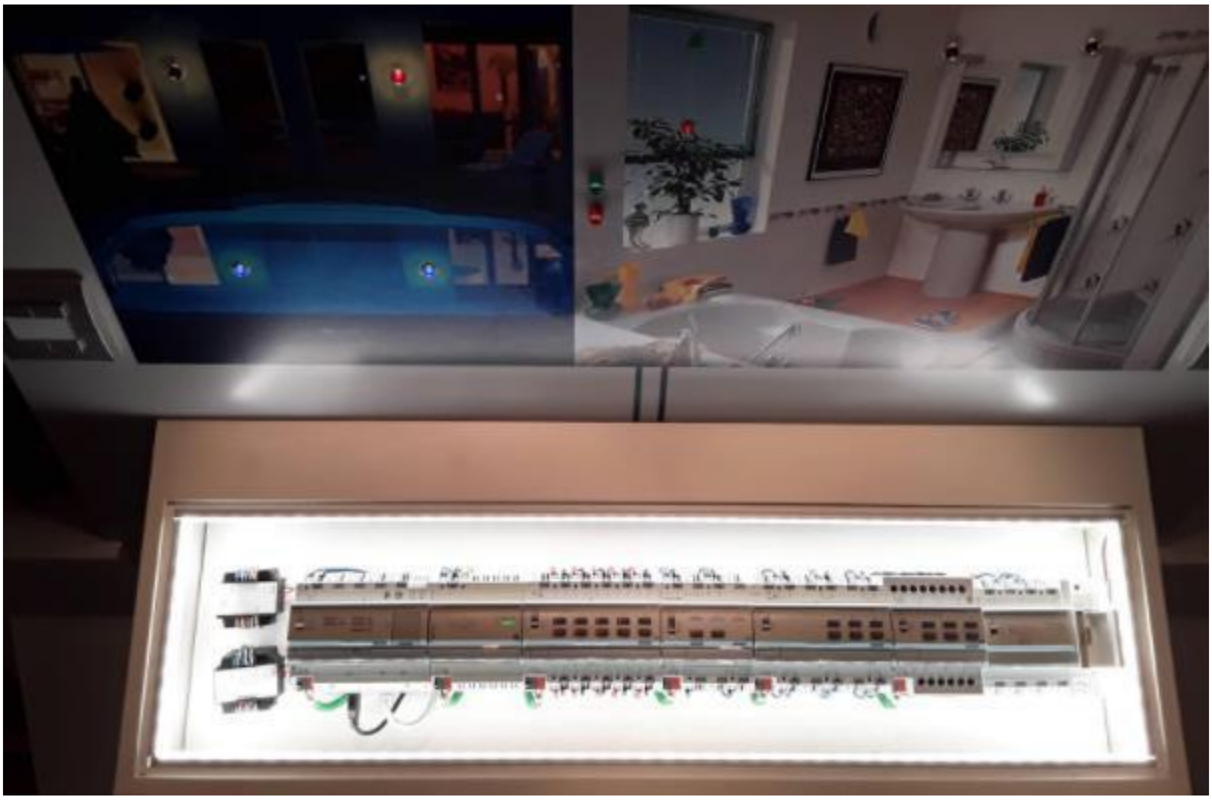

Figure 14: Hager Modular Devices Din Rail - Hidden Led Tape Light

The components are mounted on a din rail for stability and the cables are going on the back for connections through cables din rail connectors[13]. In the same panel a pattern was created for provide experiments with light fibers. The light fiber react according to automation triggering as status feedback of different types of commands triggering that are involving lights and status LEDs. The control from the user side is succeeded with two types of wall mounted control. The first type of controlling the panel lights achieved with the installation and usage of binary contacts that are connected through cables with the TXA306 binary contacts modular smart device. The second way of controlling the main panel different devices is via the four- and six-fold smart buttons that are mounted on the panel front side. The cable that connects the KNX network is BUS topology with every cable end connected at BUS dedicated terminals for better connection results.

Figure 15 Smart Ecosystem Creation - Automating Lights in Party Mode for Random Colours, Brightness and Light Temperature inside Various Limits

Three Smart KNX Motion detectors are installed at the front side of the panels for providing the different room's motion detection and luminosity control via the Domovea and Home assistant servers[14]. The motion detectors are mounted on the panel but can be moved until ten meters away for experimental simulation purposes.

3.2 Wellness RoomPanel

The wellness room is created with wood materials, holders with rollers for flexible movements and transfer. The three-panel board are separated units that are connected with each other with dedicated socket connectors for easy connection. The wellness room panel board consists some of the most significant part for testing automation, scripts, events and scenes that are created in any server independently[15].The real shutter is the point of interest of the automation that are taking in advance the weather station that is also installed in the same panel and has the flexibility to move until 10meters distance for being installed outside the house for wind speed measurements, temperature, humidity, sun position, sun elevation and azimuth, rain indication based on the real time GPS coordinates that supports. The panel is equipped also with a simulation room that is mounted on the panel for testing temperature, humidity and CO2, basically information points for automation that is following increase or decrease value of the involved data points.

Figure 16 WellnessRoomEquipment

Figure 17: Wellness Room Simulation – RealShutter

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3.3 DataPanel

The data panel is created for adapting all the third-party devices, voice assistants, router, KNX IP routers, Hue Phillips Bridge, Raspberry Pi 4b+ and components that are highly involved with the internet, sound, vision, media, IP lines and networks, WIFI and Bluetooth[16]. The data panel is equipped also with not smart television and stereo sound systems in purpose for supporting legacy devices by making them smart with the appliance of third-party modules that are also collaborating with the ecosystem that was built for examine compatibility issues, collaboration and operability between the devices that are involved and having different kind of data and firmware and are parts of the same smart network.

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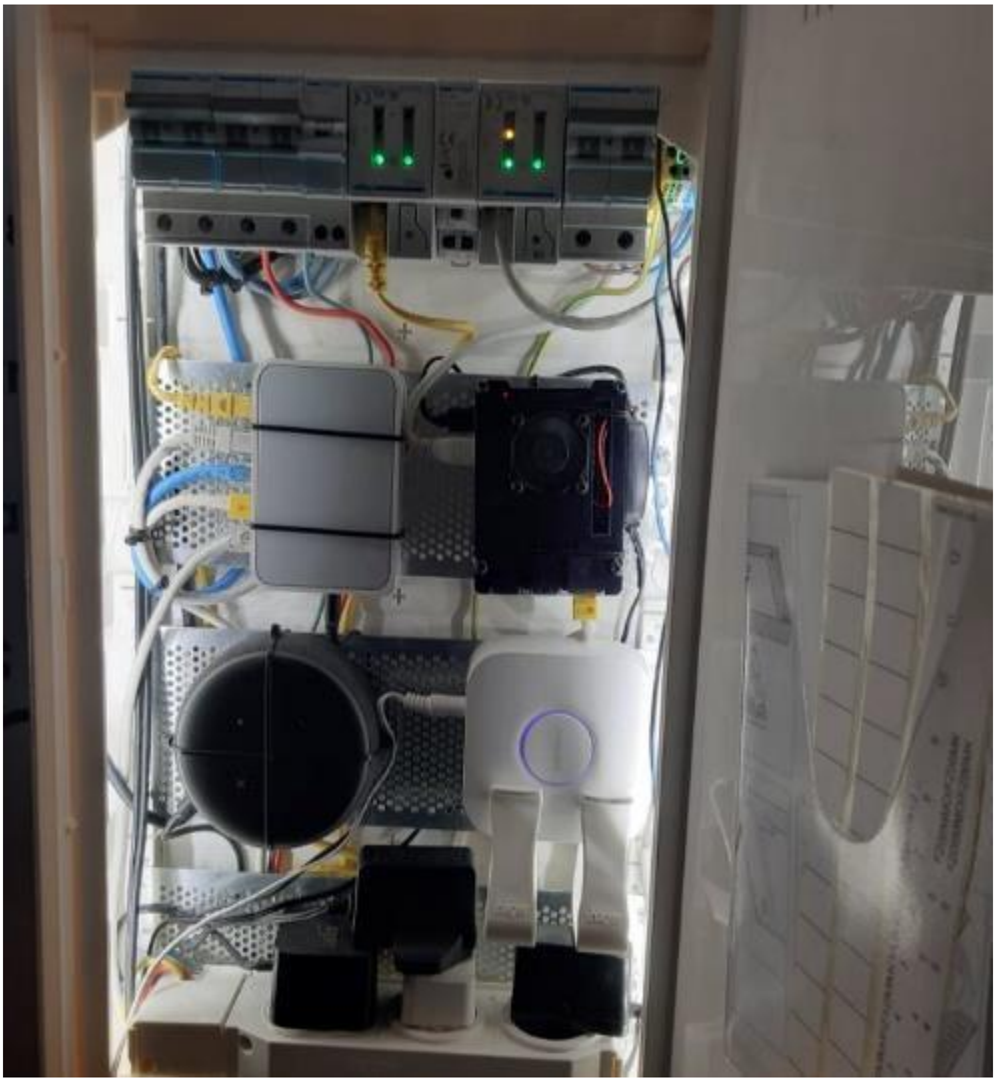

Figure 18: Computer Room Multimedia Panel

4. Conclusions

The knowledge that achieved among all the combined smart devices to a complex ecosystem, cloud services, voice assistants and natural language processing agents was a really great experience and significant according to the participants evaluation answers results. Though the experimental procedure that was applied the parallel communication and interaction through two computers applied and worked fluently.The parallel interaction was applied for examine if the ecosystem or the cognitiv voice assistant would have increased latency to the answers but everything worked normal.The natural language processing agent that applied via the Dialogflow essentials to the experimental method via Pandora voice assistant isn't completed yet according to the training phrases, intents and learning process and needs more training for reaching the level of supporting everything with technical approach of things.

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