2022 Smart Information Systems and Technologies (SIST)
28-30 April, 2022, Nur-Sultan, Kazakhstan

Integration of a Video Surveillance System Into a Smart Home Using the Home Assistant Platform

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2022 International Conference on Smart Information Systems and Technologies (SIST) | 978-1-6654-6790-2/22/$31.00 ©2022 IEEE | DOI: 10.1109/SIST54437.2022.9945718

***Abstract*—Home automation and video surveillance systems are constantly undergoing changes due to advances in electronics and communications. Starting with telephone-controlled home appliances and a simple camera-based system, home automation and video surveillance have now entered the IoT (Internet of Things) and IoE (Internet of Everything) era, where every device integrated smart are connected to worldwide network and controlled abroad. Home automation makes life easier by providing control of all home appliances at one point, which is basically by a smartphone. The need for surveillance is rapidly increasing in domestic and commercial applications due to its low cost and ease of deployment. To ensure the security of video surveillance of personal homes and small businesses, people resort to third-party organizations with expensive equipment. In turn, the solution for providing a video surveillance security system based on a Raspberry Pi single-board computer using HomeAssistant software is more profitable and easier to implement. The choice fell on the HomeAssistant software, since HomeAssistant is an open source application and does not require additional costs.**

This article analyzes how home automation and video surveillance systems have been modified and implemented. For the review, the Home Assistant smart home platform was implemented with the introduction of a video surveillance system.

Keywords—smart home; control system; control panel; Home Assistant; Raspberry Pi; Intelligent Control Systems; IoT

I. INTRODUCTION

In recent years, the concept of the Internet of Things has undergone a severe gradual development and is at the present time being used in different fields as smart building, telemedicine, smart homes, industrial environments, etc [1]. The connected network can create a number of problems in the application development process [2]. The Internet of Things is not the only one technology, but it is a general notion in which recently developed things are brought together, interconnected and turned on, and this opens up several business occasions [3]. According to [4], the world of the Internet of Things is constantly raising - from two billion objects in 2006 to a projected 200 billion by 2022. It means that there are about twenty-six smart devices for every person on Earth.

BMS (Intelligent Building Management Systems) are of great significance part of the Internet of Things paradigm, which directs at a target to manage and analyze by monitoring the mechanical and electrical devices of a smart building. Connecting devices and equipment's in a smart building to the global internet allows users to control and manage it remotely. From simple devices that may be managed to turn on and turn off with a tablet, smartphone, notebook, or voice command, to complicated thermostats that control room temperature, access control, or air conditioner turning on and off, smart BMS interpretations have begun to be popular in these years [5]. Smart buildings and smart homes direct at a target to combine and integrate smart home automation. Smart building and home automation are an excellent solution which provide a range of benefits including comfort, security, energy savings, long term money savings, convenience and peace of mind. Access control and security system.

II. HOME ASSISTANT ACCESS AND SECURITY CONTROL SYSTEM

For access control and security purposes, this article provides modified simple and flexible solution called

Home Assistant that can be used to control devices in smart home or building. Home Assistant aims to offer a standard that allows to manage, provision and communicate with a variety of devices. Home Assistant is an Open Source programmable project, in the development of which every researcher can take a part. This platform does not stand still and develops exponentially every day, expanding its functionality with various dockers, plugins and devices.

Home Assistant does not try to reinvent the wheel, but uses existing and widely used technologies for the new extension. Classic Ethernet or a local Wi-Fi network is usually sufficient for a working Home Assistant setup. Most Home Assistant devices are based on Raspberry Pi boards, which is economical, small and easy to operate. Updating device firmware is an important task that is often neglected when dealing with a large fleet of devices. Home Assistant makes this easier by allowing to update the firmware in the usual way for different types/models of devices. The idea behind Home Assistant is to control programmable systems that have a TCP/IP stack with simple HTTP requests. These systems can be, for example, single-board computers or microcontrollers with TCP/IP support.

The Raspberry Pi is an open source programmable hardware technology that combines a programming language and an IDE (Integrated Development Environment) [6]. The Raspberry Pi is an exciting technological development, much cheaper than any desktop computer or mobile device. Most of the software and projects run on the Raspberry Pi are open source programmable and supported by online communities of users who are always excited about new projects. Raspberry Pi software part is developed in Python, as this programming language is considered one of the simplest using the fewest lines compared to similar programming languages. This proposed work project used a Raspberry Pi 4 single board computer, which is energy efficient unlike its parent older computer counterparts. The Raspberry Single Board Home Assistant setup can perform several roles as host device and as a hub for the Home Assistant software when other modules such as relays and other sensors are connected to it as shown in Figure 1.

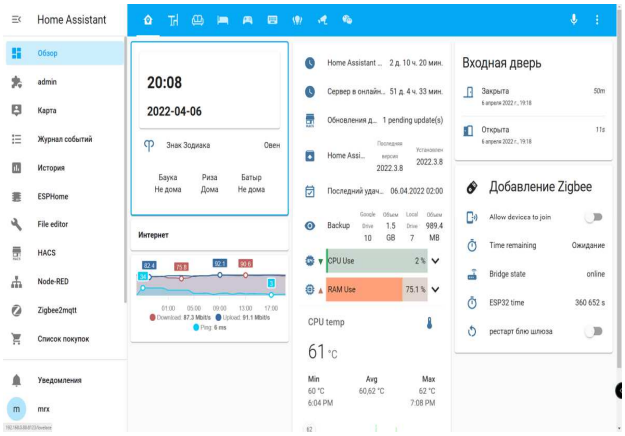

Figure 1. Home Assistant platform control panel

The proposed modified automation system can be monitored and controlled very easily using developed mobile app and its associated ecosystem. It provides a user-friendly user interface called UI that comes as a Progressive Web Application (PWA). The Home Assistant software is multi-platform and can be run on iOS/ Android/ Windows/ Mac OS/ Linux and more. The Home Assistant app is bundled with the HomeAssistantServer package [7]. This allows users to receive the latest software update when the server is updated. The update process is automatic because it is a web application. Home Assistant is an open source programmable web application and is constantly being improved by caring researchers and developers. The main purpose of this web application is automation, as well as one of the ways to connect smart modules into one shell. Once installed, the Home Assistant app will be found in the device's app list and can be uninstalled anytime the user wants as in Figure 2.

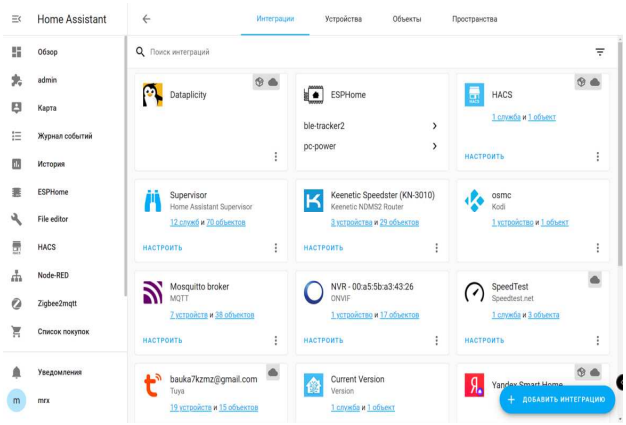

Figure 2. Example of using Home Assistant platform integrations

The first time the user is prompted to login, it should be used as an administrator with a blank password, but it is highly recommended to set the correct passwords on the application's settings page for obvious security reasons. Home Assistant has a lovelace module for creating tabs and information cards that display connected devices. They can be edited, resized, and scripted.

III. Integration of a Video Surveillance System Using the MotionEye Web Interface

Not so long ago, having a home video surveillance system for security reasons was considered extravagance. Previously, they were only installed on government buildings and commercial sectors using expensive equipment. Nowadays, CCTV (Closed Circuit Television) cameras have become a common affordable security device that any user can afford. These cameras carry many benefits as a video babysitter and prevent and reduce vandalism and theft. In most cases, when burglars spot cameras, they are more likely to give up on the break-in attempt. Moreover, in the event of a burglary, the cameras will record the incident and help the authorities catch the perpetrator. The presence of affordable video surveillance on a smartphone allows to monitor user property, children and pets remotely from anywhere in the world, with the possibility of accessing the Internet.

The main differences between different type DVRs (Digital Video Recorder) are the type of cameras and the cables they use. One type of DVR is used with IP cameras over a wireless network or using Ethernet cables, while another DVR records analog cameras using coaxial cables or Ethernet cables using baluns. NVR (Network Video Recorder) Video Surveillance Complex records high-definition video and is easy to use and integrate [8]. In addition to the main wired video surveillance cameras, it is possible to integrate with network IP cameras that can be placed anywhere where there is a wireless or wired network to the World Wide Web.

MotionEye is a web interface from where a user, having access to his account and a browser, can control his video cameras. In order to install and use MotionEye as a remote interface, its needed to turn a single-board computer into a video surveillance system by installing the MotionEyeOS operating system. The operating system is built on the basis of BuildRoot, using motion in the server part, and MotionEye for external access. Several cameras can be connected to the device at the same time. A hub is a device that combines other MotionEye devices and allows them to be accessed remotely. An IP camera is a stand-alone device that operates and transmits a signal over a network IP protocol. Thanks to the MotionEye software, the user has access to a convenient multi-platform interface, to which, in addition to IP cameras, most USB cameras and modules for Raspberry Pi cameras can be attached. In addition, it is possible to receive notification by e-mail, upload videos to the Google Disk/Yandex Disk or Dropbox cloud space. Although the Raspberry Pi single board computer is an excellent solution for a MotionEye video surveillance system, it has a number of performance limitations. It is especially noticeable when working and integrating more than 5-7 cameras at the same time, which record video in good resolution with a high frame rate as shown in Figure 3. An excellent analogue of the Raspberry Pi is the ODROID single-board computer, which runs on Android and Linux operating systems [9]. ODROID allows optimizing the performance by having access to more cameras.

The script architecture in MotionEye can be different. The simplest scenario is to connect one device with one camera, which will allow the user to easily integrate them. However, users need to visit the address of each device separately, that is, open one browser tab per device. In addition, it is required to configure separate ports for each device so that there is access via the Internet.

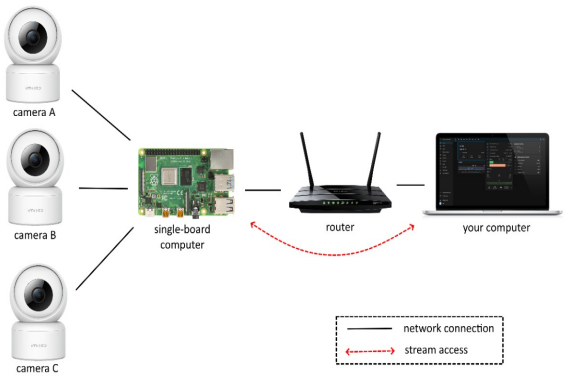

Figure 3. Scenario Architecture Using Multiple Surveillance Cameras

The user can turn his Raspberry PI into a simple yet fast network camera using the "Fast Network Camera" option in the "Expert Settings" section. However, the setting is only available using the Camera Serial Interface (CSI) module. The MotionEyeOS operating system typically does not use the full processing power of a single board computer's GPU (Graphics Processing Unit). Video processing including encoding is performed by the onboard CPU (Central Processing Unit).

When using the MotionEyeOS fast camera setup option, it refers to a separate StreamEye backend. StreamEye typically captures JPEG frames using the Raspberry Pi's single-board GPU and converts it to MJPEG (Motion JPEG) format via HTTP. Using an IP camera allows to achieve higher resolution and frame rate, the parameters of which can be configured by the user through an accessible interface. In this case, the browser consumes significantly less CPU when using the same frame rate settings, thanks to a pure MJPEG broadcast stream, rather than triggering each update via JavaScript. The goal of StreamEye is to simplify and improve the broadcast of an MJPEG streamer. This stream service is written in C# language and consumes lower costs. The picamera device that provides the camera module interface uses the raspimjpeg.ru script, which is written in Python. The minimum requirements for deploying and failsafe operation of a video surveillance system include a Raspberry Pi or ODROID single board computer, an IP camera, a sufficiently powerful power supply that can ensure continuous operation of the single board and its associated devices, a memory storage device compatible with single board computer, and built-in or external network adapter.

IV. Connecting to the MotionEye System

Local cameras are camera devices, usually USB cameras or custom board cameras, that are connected to the MotionEye system. Cameras that operate on a network protocol initially have video transmission in MJPEG format [10-12].

The login process is very simple and requires a username and password, as shown in Figure 4.

Figure 4. Login process on MotionEye

Adding local cameras or network cameras can be done as shown in Figure 5.

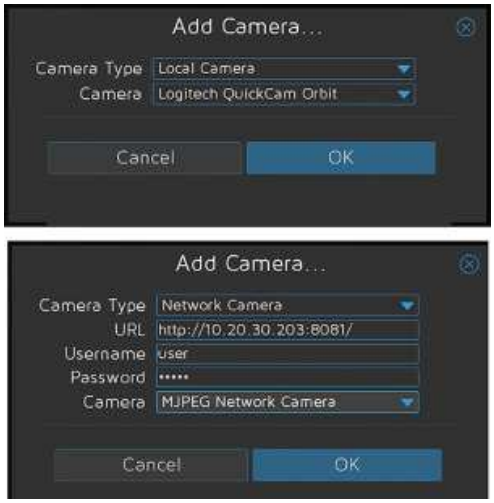

Figure 5. Adding network cameras

To use the camera in Home Assistant, its needed to add the camera and streaming integrations using a script as below in Figure 6.

```
stream:
camera:
  - platform: mjpeg
    name: My Fancy Camera
    still_image_url: "http://URLFROMMOTIONEYE/picture/1/current/"
    mjpeg_url: "http://URLFROMMOTIONEYE:8081/mjpeg"
```

Figure 6. Configuration.yaml script

Making sure the port matches the one set in MotionEye and add mjpeg to actually get the mjpeg stream.

Once the camera and stream are set up correctly, its needed to add an image object card to Home Assistant as below, in Figure 7.

```
- type: picture-entity
  entity: camera.my_fancy_camera
  camera_view: live
```

Figure 7. Ui.lovelace.yaml script

Restarting the Home Assistant it should be seen the camera stream in Fig. 8.

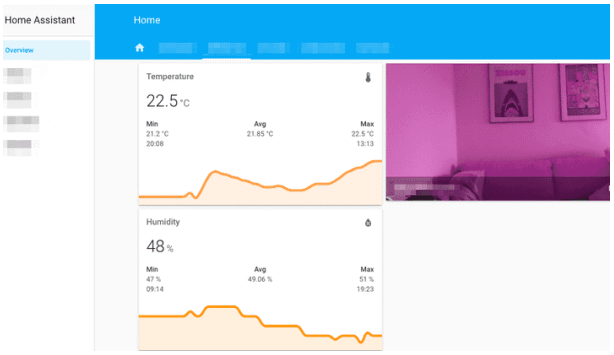

Figure 8. Home Assistant Dashboard Adding Widget with Surveillance Camera Stream

V. CONCLUSION

Technology plays an important role in people's lives. With the advent of the era of digitalization and the digitization of all objects, more and more people are trying to make their lives easier with new technologies, including the security of a personal home. Module designers and manufacturers make it easy to implement a low-cost security system for their homes and commercial premises.

In this proposed work project, a couple of modified solutions for providing a video surveillance security system based on Raspberry Pi single-board computers and ESP8266 microcontrollers were provided. The proposed options are cost-effective, intuitive to use and small in size. The integration of the proposed systems does not require high costs and is easy to set up, which is an advantage over similar solutions.

To ensure the security of video surveillance of personal homes and small businesses, people resort to third-party organizations with expensive equipment. In turn, the solution for providing a video surveillance security system based on a Raspberry Pi single-board computer using HomeAssistant software is more profitable and easier to implement.

The choice fell on the HomeAssistant software, since HomeAssistant is an open source application and does not require additional costs.

The main goal is to make HomeAssistant a prototype of a smart home with different functionalities, a system that could be constantly developed, improved and extended to other functionalities. The main task of improving the security system is to use the Home Assistant software as a solution for building smart homes further.

ACKNOWLEDGMENT

The authors wish to thank everyone who made every effort to improve the content of this research paper. This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. BR10965311 "Development of the intelligent information and telecommunication systems for municipal infrastructure: transport, environment, energy and data analytics in the concept of Smart City"). N.Z. acknowledges the Scholarship Programme of IsDB (2021-588606).

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