

Advanced Home Monitoring Systems Technical Analysis

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New Challenges for Engineers

Throughout the history of humanity, engineering has led the major advance in home monitoring systems for the advancements of civilization. The past has seen some great miracles in science and technologies, from electrical engineers who lightened up our world to aerospace engineers who connected the peoples of the world through travel by reducing the weeks of the journey to an hour flight. As humanity grew, it was nurtured and improved with all the sophisticated tools of agriculture, textile technology and inventions that changed the way humans interacted and communicated with each other. Inventions, such as Engines, mechanical clocks, and digital devices changed the entire civilization irreversibly.

The modern era of industrialization has brought the influence of engineering to all divisions of life, as automation and control systems have replaced human labour with innumerable tasks completion, improved health by improving the sanitation system, created ease in mining by inventing the steam engine, and supplied power to the industries. In the recently ended century, engineering recorded the brightest achievements. Computers and the Internet are important inventions of the century which completely changed the daily lives of humans.

As this progress gave birth to dreams for the future, the next century has implications about challenges that are worse than the previous one. With the exponential growth in the world's population, the needs and desires of people also increased. So addressing the problem of continuous progress of civilization along with the possible life quality enhancement became more urgent and critical. Industrialization brought many diseases along with the advancements, so the general public is demanding more efficient, quick, cheap and easy treatment options. Scientists are feeling pressure to create protective and preventive methods to alleviate the violence, epidemic diseases, and natural disasters. Meanwhile, the public wishes for the new products and processes which create entertainment for them and increase the joy of life.

Humanity has always been concerned about issues like health, safety, sustainability, and liability along with the enjoyment of life and it wants engineering to answer these issues. Engineers are always in search of ways to cater for these problems by applying their knowledge and research. Engineers are solely responsible for forging a better future by applying wit, critical thinking, reason, scientific methodologies, and imagination.

The most important challenges are the ones which are time-critical and need to be met at the earliest

to ensure a sustainable future. The earth has limited resources and these resources are close to depletion with this rate of population growth. At the moment humans are using energy resources more vigorously than ever. The famous warnings emphasize the need to develop new energy sources while preventing or reducing environmental degradation. Nuclear energy seems promising, but we also have some reservations about it. Fusion and fission power generation must be regulated as they also contain serious health issues. We should also consider the economic and environmental feasibility of nuclear power while planning the complete reliance on nuclear energy. Computers and the Internet have become the two basic needs of the 21st century, and people are living without them. Social life and virtual reality are becoming more important than real life. We generate thousands of gigabytes of data daily, and companies are selling millions of communication devices worldwide. Privacy and information security pose new challenges for computers and storage problems, network problems, and hacking. Data engineers, network experts, and computer architects must deal with all these problems. The provided examples are just the tip of the iceberg of challenges which 21st-century engineers and computer scientists are supposed to cater to in the coming decades. Engineers will face some hard times while answering problems like sustainability, climate change and greenhouse gasses, physical and psychological impacts of technology, data security, and unemployment due to automation.

Abstract

In today's world with the rise in the crime rate, home surveillance has become very critical. Especially in the case of the elderly or children, we want to keep an eye on them so as to be aware of their situation. Home monitoring is also very important in the case of theft or break-in scenarios, as surveillance can provide us with moment-by-moment activity and can help us recognize the face of criminals or home invaders. Home surveillance systems are really important in the crime solution, so law enforcement agencies are recommending everyone have the system installed in areas where there is a crime probability. So, the home monitoring system has become a necessity. A typical home monitoring system consists of an array of cameras, a controlling device called a DVR with recording capability, and a display screen mostly an LED or a TV monitor. DVR is the central device with which we connect all the cameras, DVR gets the video stream from the cameras and then decodes it and stores it in the hard drive. This DVR can display the real-time stream as well as the backtime on the display device. In recent times, with the advancements in the field of control and automation, the bulky DVR has been replaced with smart microcontrolling devices like PIC, Arduino, and Raspberry Pi. The devices have more functions and high flexibility as well as more efficiency. In this survey paper, we have researched and reviewed some smart home monitoring systems using Raspberry Pi. These Raspberry Pi-based monitoring systems have replaced the old Radio Frequency Identification-based monitoring systems which were very expensive compared to the Raspberry Pi. In the paper, we have described the use of low-cost and highly efficient Raspberry Pi, as a standalone platform for image processing, a very cost-effective single onboard computer (OBC). This monitoring system has the capability of capturing high-resolution data from the IP cameras and then sending it to the mobile

application via a 3G network so that we can see the real-time video at any place.

Introduction

Home intrusion has become a real headache in recent times due to the development in technology; thieves have developed new ways of entering your home, no matter how reliable your door security system is. So in this case, if you have installed a system of security cameras then you will be able to monitor your home and property at any time. Most companies and landowners are taking advantage of these surveillance systems to keep an eye on the property in case of illegal intrusion and terrorist activity. Security cameras have evolved with time; now, they are more advanced, cheap, simple to use, and have high resolution.

Utilization of Monitoring

These monitoring systems come with many benefits depending upon their place and purpose of use. There used to be times when the practice of surveillance techniques was only limited to the shopping malls and gold markets due to the high price and complex working, but nowadays we can observe CCTV (Closed Circuit Television) cameras at every place from schools to playgrounds. This plague of monitoring networks has made surveillance more reliable, and as a result, we have enhanced our feeling of being safe, and we are witnessing a great decrease in crime.

In the past capturing a video and sending it through a wired or wireless medium used to be a lengthy process and there used to be a huge delay in the processes which made real-time surveillance almost unmanageable. But with the invention of microcontrollers like Raspberry Pi, the processing time has reduced to microseconds which made possible the real-time observation of scenarios. This factor has helped the organization and home user act on the situation accordingly because they know what is happening in real-time.

The Need for Smart Monitoring Systems

We are leading a busy life; we have very little to no time to sit and monitor and keep the record every time. Every family member is supposed to pay for the expenses of the home, so everybody has to work and monitoring everything in this scenario seems impossible. We are moving from hard work to smart work, and a smart solution to this problem is a smart monitoring system which you can carry around everywhere you go. So a smart home monitoring system with Bluetooth, WIFI, or 3G, connectivity can enable you to monitor your house, elderly and kids anytime anywhere.

Literature Survey

We have surveyed three different research papers and journal articles to establish a conclusion on the matter at hand; we will discuss them individually. First of all, we have a conference paper on the topic of “Network video capture and short message service alarm system design based on embedded Linux” in which the designer used the S3C2440 microprocessor as a central processing unit in the video acquisition system (Zhou & Tan, 2010). The designer based this system on the Linux operating system, and they used the V4L (video for Linux) API for real-time video capture. This system came with many advantages ease of installation, good stability of video frames and overall an intelligent system, but there were some disadvantages too like it was a very costly system, and it needed continuous presence of a GSM network for its proper functionality. It uses GSM technology to communicate with the host. Here is the flowchart of the video for the Linux video-capturing protocol.

Figure 1: V4L Video Capture Protocol

This flow diagram shows the complete video-capturing process of the Linux operating system. In the initialization process, the V4L checks the buffer information, and then it acquires the video frame then it checks whether the capturing process ended or not, and at the end, it closes the current capturing process and deletes the data from the buffer so as to make room for next acquisition. This system had the capability of managing anti-theft intelligence, smart home and premises surveillance, smart medical treatment, and intelligent transportation.

Second, we have a journal article, “Implementation of Embedded Video Retrieve System Based on ARM9 Processor”. This article elaborates on the basic principle of the OV511 camera to USB Bridge in the Linux operating system. The video format used in the paper is the MPEG-4 video technology. The microcontroller used in the process is again S3C3440, which is a built-in chip in the ARM9 processor. They used the Video4Linux, Application Programming Interface (API), to process the captured video. Here is the graphical representation of the proposed system’s video capturing and transmission process. They linked the cameras with the ARM processors collected the data stream from the cameras and then transmitted it to the personal computer with V4L API.

Figure 2: Video Capturing process using ARM9 Processor

This video capturing and transmission system was very efficient in how they designed it. It realized the live streaming and real-time transmission of the captured video. This system had a stable performance and was not very costly, too, but it needed some improvements in image processing as image quality enhancement. Overall, it was a great achievement in the area of real-time video surveillance and monitoring (Jyothi, Rao, & K.Hanuja, 1970).

Next, we have a video surveillance system based on the 3rd generation wireless mobile telecommunication technology. Wang Liwei, Yan Shi and Xu Yiqiu proposed a monitoring system named “A wireless video surveillance system based on the 3G network”. In the system propped a

video control server database is used to automatically capture and store the selected frames of the captured video stream. This system could transmit the captured video on the wired Ethernet network and transmit the data on the wireless 3G data network to a remote server. IEEE 802.11 is used as a media access control to implement wireless communication in the frequency band of 900 MegaHertz. Below is the proposed structure of data capturing and transmission in the system (Liwei, Shi, & Yiqiu, 2010).

Figure 3: Data Streaming Structure

The main advantages of this 3G video surveillance system are the high speed and excellent quality data capturing and transmission, but this proposed system did not cater for the malfunctions associated with the 3G network.

Conclusion

Everybody wants to be in a trusted and secure world, and constant monitoring and surveillance is the need of time. In this survey paper, we tried to cover some of the research and development in the field of video acquisition and surveillance. These systems have evolved with the evolution of control systems and microcontrollers. This paper covered the main structure of three proposed monitoring systems along with their advantages and disadvantages. The future is bringing the wireless world, so we are hoping for some fast, cheap, high-definition, and reliable monitoring systems.

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