DIY Smart Mirror

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DIY Smart Mirror

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Abstract. The Internet of Things concept has become increasingly popular when it comes to providing people with technology and tools that would make their lives simpler and ease their day-to-day routines. One such tool is a multipurpose mirror used both as a mirror and a device. There have been several successful attempts of building such a device, and some of them even turned into business opportunities. However, due to its selling prices and shipping policies regarding Bosnia and Herzegovina, it is almost impossible to acquire one. The main purpose of this paper is to show how the process of building a Smart Mirror from scratch showing basic information such as time, date, weather statistics, and recent news headlines. The displayed information is accessible at any point in time. The cost-effective analysis indicates significant cost savings for produced outcome compared to available off-the-shelf solutions.

Keywords: smart mirror, raspberry pi

1 Introduction

In the past few years, technology has become important and inevitable part of our daily routines. With technology progressing at rapid pace, people are also expected to be more productive and efficient in their daily activities. The use of smart phones, tablets, laptops and other similar devices has provided people with tools that help them stay productive and, more importantly, be time-efficient. However, as much as the use of such devices is time-efficient, it is also time-consuming as it has become yet another task on ones daily to-do list. In addition to this, time demands (deadlines) are most often the main cause of a person being under pressure. Therefore, good time management is the key to getting things done. This does not only apply to ones professional life, but to their private life as well.

One activity common to us all is getting ready to leave the house in the morning for school/work duties. It also consumes a good amount of time in the morning. Checking the phone constantly to see what time it is or what the weather is like for that day does not seem much time-consuming. But it is. Being focused on task at hand for a specific period of time is what good time management is.

In this paper, we present a multipurpose mirror that is meant to serve as both decoration and information source. With just one look at the mirror, one will have the basic information on what to wear based on weather forecast for

that day or how much time they have left if they want to arrive on time at planned destination.

The paper is organized in the following way, in section 2 we give a brief overview on what is currently available on the market as well as how it is being used in the research. Section 3 defines the concept of the smart mirror. The design and development are explained in more detail in sections 4 and 5. In section 6 we provide a cost-effectiveness analysis of available smart mirrors compared to our solution, while in section 7 we give conclusion and suggestions for the future work.

2 Related work

According to research, there are many different and interesting approaches to building a smart mirror. Some of the solutions are available on the market, while others are just prototypes or Do-It-Yourself (DIY) projects developed by enthusiasts for their own use.

The Cybertecture Mirror [1], developed by James Law, displays basic information such as date, time, and weather. It also allows social network integration, so the user has access to their social accounts even when in bathroom. The mirror can be controlled either by the remote controller or the mobile application. In addition to the mentioned features, the mirror also has embedded sensors that monitor persons health vitals such as weight, heart rate, or body fat. It is possible to watch videos or listen to music, as well as workout while following the exercise instructions displayed on the mirror. This device offers a wide variety of features which can be customized for every need. However, the price of the mirror does not make it quite affordable to everyone because the cost of customization goes from $3,600 to 7,700$ [1]. In 2012, at the Consumer Electronics Show held in Las Vegas [2], Samsung presented Smart Window a window that is also a device [3]. Although not a mirror, this device allows users to access applications such as weather or social apps all the while serving as a window. Serakus Smart Washbasin running on Android OS, displays various information, from news and weather forecast to how much water is being spent each day or how much a person weighs [4].

Another high-tech mirror on the list of currently available is Magic Memory Mirror, also known as Memomi [5]. This mirror is being used as a replacement for dressing rooms in shops that sell clothes. Customers are able to interact with the mirror through the mobile application. The mirror gives them a 360-degree view of their outfits as well as the possibility to modify their looks by changing the color or adding accessories to the outfit [6].

Aside from the above mentioned products, there are also smaller-scale projects that involved piecing components together to achieve the functionality of a smart mirror. These are mostly done as DIY projects and are used for individual purposes [7, 8].

Max Brauns bathroom mirror stands out from this group (DIY projects) [7]. This mirror does not offer as many features as those that are being sold, but it

does serve a purpose of a smart mirror as it displays basic information a person needs while in bathroom such as the weather, time and date, and news.

There are numerous other projects that involve building a custom-made smart mirror. One of the main reasons for this undertaking are the prices of available off-the-shelf products. With a bit of effort and imagination, the same result can be achieved and with much lower expenses. In section 6 we will provide a more detailed analysis of costs and performances of available smart mirrors compared to our built-from-scratch solution.

3 Concept

The idea behind our smart mirror is to display information such as time, date, weather, and list of tasks to be done on a mirror display. This is the basic information we need not only in the morning, but throughout the day as well. Making the most of the available time we have during the day is crucial when it comes to being efficient and productive, and this project is a great example of how technology can make our lives simpler and ease our day-to-day routines.

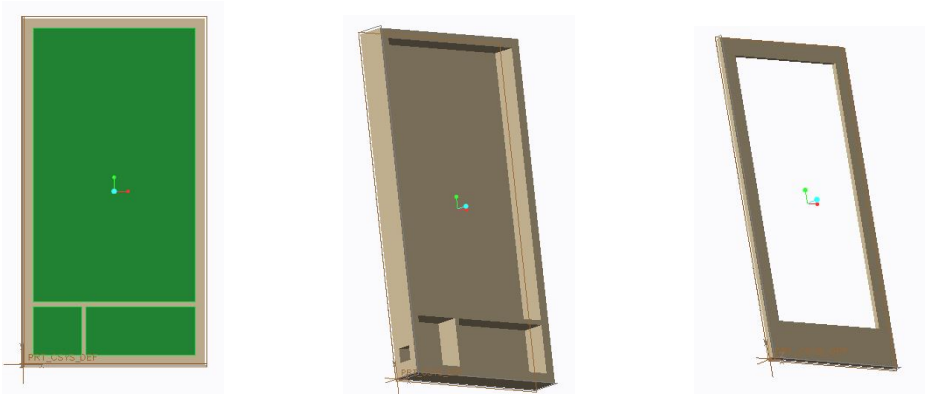
The concept of a smart mirror has been around for several years. The inspiration came from the Internet of Things (IoT) concept, which could be described as an effort to make everything smart. The goal behind this concept is to provide people with technology that would make their lives simpler and ease their daily routines. At its core, Internet of Things is about connecting devices over the Internet in a way that enables the communication between users and applications on such devices [9].

Following this concept, hardware components that are necessary for the mirror to be functional have been acquired. These include a Raspberry Pi controller board [10], monitor, and see through mirror [11]. In section 4 we give a detailed description of how these components are put together and tested out.

4 Design

The design of the device is done in two parts. The first part deals with designing the box that is used as a container for the monitor, controller board, and mirror. Both monitor and Raspberry Pi need to be placed inside the box and secured to avoid any possible damage to any of the components while moving the box around. Once these two components are fixed, the mirror will cover the front of the box. Any information that is to be displayed on the mirror will actually be displayed on the monitor. The characteristics of the mirror are such that the front side is reflective and acts as a mirror, while the back side is transparent, so anything that is displayed on the monitor can be seen on the mirror surface. Therefore, the mirror needs to be placed directly onto the monitor to ensure that all of the information is visible. In addition to this, the box will have openings for the controller board and monitor power cables. Furthermore, since Raspberry Pi has several USB ports that might be needed for keyboard or mouse for manual configuration of the device, the box has a side opening. To avoid any possible

movements of the monitor and controller board that could cause damage to these components, the box will have compartments for them to ensure they stay in place. We used Creo Parametric software [12] for modeling. Initial model of the box is shown in the figures below.



(a) Front view of the box

(b) 3D model of the box

(c) Front cover of the box

Fig. 1: Box model

Figure 1a illustrates the front view of the box. There are three compartments: one for the monitor, one for the controller board, and one for fixing the power cables.

A 3D model of the box is given in Figure 1b. In addition to the three compartments, one can also see an opening on one side of the box. This opening will allow access to the controller boards USB ports.

Figure 1c represents the front cover of the box. Once all components are placed inside, the box will be sealed with this cover and thus keeping everything inside of the box in one place.

The second part of the design is designing the application. Because the goal is to have a mirror that is displaying certain information, the design has to be such that the existing surface of the mirror, which covers the monitor, is used in the most efficient manner. The information that is to be displayed needs to be arranged in such manner that the display area of the monitor is efficiently utilized and that it does not stand in the way of ones reflection. Thus, careful planning of the design is an imperative. The best way to achieve this is to place these pieces of information in the corners of the display, leaving the mid part of the display surface empty, so that the persons reflection in the mirror is clearly visible. The final solution is given in the figure 2:

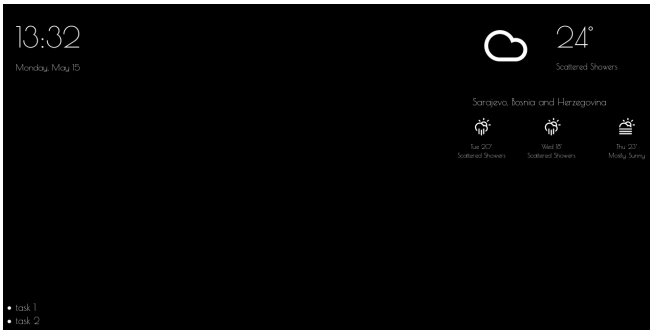


Fig. 2: Information displayed on the monitor

5 Development

Upon the completion of the design phase, the development phase begins. In this phase, the application that generates the specified information is developed. Prior to that, Raspberry Pi needs to be set up and configured so that it can run the application without problems. The set up includes a fresh install of a compatible operating system, which in this case is Raspbian. Once the operating system is installed, Raspberry Pi needs to be configured to automatically run the application on boot. This way, as soon as Raspberry Pi boots, the application is started in a full screen while hiding all other system components and features. These features can be accessed only when a keyboard is plugged in for debugging purposes. Once the configuration is done, the application is developed and installed. The application will be developed according to the design specifications. It will generate the specified information that include time, date, weather forecast, and list of tasks. The background of the application will be black and the font color will be white to ensure maximum reflection of the mirror. The initial solution for the application is to develop a website. For the development of the website, we will use Laravel framework [13]. The idea is to implement a sign-up/login feature, so that the user has their own account and is able to customize the mirror in the future. The user will enter their credentials during the first Raspberry Pi boot, and upon a successful login, they will be redirected to the page where the relevant information is stored. The Raspberry Pi is configured in such a way that, when it boots, it automatically launches the browser and loads a specified website. In the same manner the website that will display the information for this project will be launched. Aside from the sign-up/login feature, the website also allows a user to, once signed in, add or delete tasks they have set for themselves. These tasks are displayed on the page that is launched on Raspberry Pi. Adding and removing tasks is done over a smart phone, tablet, or laptop. Tasks are specific to users, so without being logged in it is impossible to add or remove any task. In addition to this, a request to the server is sent every thirty seconds to check if new tasks have been added or if some tasks have been removed so that the list can be updated accordingly.

6 Cost-effectiveness analysis

Products that already exist on the market and that are being sold are usually overpriced considering the fact that the same result can be achieved by investing some time and effort. In section 2, we discussed several different products and one of them, Cybertecture Mirror, was priced in thousands of US dollars, which limits it from mass-production. There are other products that cost less than Cybertecture Mirror. However, due to the lack of customization, the prices are still high. One example is Perseus Mirror [14] which costs $249, but the dimensions of the mirror are fixed, so the customers who wishes to own a larger mirror would not be satisfied with this one. Another smart mirror on the market is Smart Touch Vanity Mirror [15] sold by Evervue. This mirror is more expensive than the previous one and the prices range from $799 to more than $1,500, depending on the user customization. These prices do not include the costs of shipping to Bosnia and Herzegovina. All of the devices mentioned above are very similar in terms of applications running on them. They all show the same basic information and have similar features. However, this is a matter of software development and not hardware. So, from this perspective, it is by far cheaper to invest into the necessary hardware components and time and effort into developing the software. For example, the basic hardware components that are necessary for the smart mirror device to be functional include the controller board which costs $37 [10], the see-through acrylic mirror which costs around $27 [11], and the monitor, which can be found in computer stores that sell used computer equipment for under $50. The price of building the box for these components is under $20. Therefore, the overall price is around $134, which is a bit over half the price of the cheapest device mentioned above. This is in case all of the hardware components need to be purchased. The costs of building our device are lower as we already have the monitor, so the costs of our device will be around $84. This is shown in the table 1 below. All that is left is to invest time in developing the software that will generate the desired content.

Table 1: Cost-effectiveness analysis

MIRROR	PRICE ($)	ADVANTAGES/DISADVANTAGES
Perseus Mirror	249	Fixed mirror dimensions
Smart Touch Vanity Mirror	799 to 1,500	Customizable, but expensive
Smart Mirror	134	Customizable and low cost

7 Conclusions and future work

This project started as an attempt to contribute in bringing smart homes and devices to Bosnia and Herzegovina. Although the features this device offers are bare minimum of what it could offer, there is room for improvement and further development. At this time, the purpose of the displayed information on the mirror is to save the time spent in the mornings in search for such information. In the future, additional features will be added to the mirror, allowing it to be more customizable and user friendly. Users will be more in control in terms of selecting which type of information they wish to be presented with. They will also be able to interact with the mirror by using their smart phones. Smart Mirror is currently a hot topic. The purpose of this paper was to provide an overview of currently available solutions and detailed instructions on how to build your own. With enough time and effort, this project could turn into a great opportunity for further development and integration with other smart home components.

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