POLYTEHNIC UNIVERSITY OF TIMISOARA
FACULTY OF ELECTRONICS, TELECOMMUNICATIONS AND INFORMATION TEHNOLOGY
TST ENGLISH SERIES

DEVELOPMENT PROJECT

Smart Mirror

Students: Goman Alexandru-Bogdan, Pop Raul-Adrian,
Rebegea Victor, Crăciun Stavrula-Adina

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INTRODUCTION. A LITTLE BACKSTORY

The silver-glassed mirrors most of us are familiar with today got their start more than 200 years ago in Germany. While they still serve a useful purpose when reflecting your image back to you, some fashion and beauty leaders figured that if you added smart technology to mirrors, they could elevate the customer experience. This vision is now a reality thanks to the significant advances that have been made in artificial intelligence, augmented reality, and gesture recognition technology. These mirrors can adjust your image, including the clothes you wear to your hairstyle, hair color, and makeup to create a very realistic augmented reflection.

Smart mirrors feature three components: a two-way mirror, digital display and computer. Unlike standard mirrors, smart mirrors need light to pass through from behind the glass to view the display. That's why you need a two-way mirror, like you'd find in a police station.

Behind the glass there's a built-in digital display (a monitor screen or tablet) powered by an internal computer. The computer connects to your home's wireless network or your phone via Bluetooth, allowing it to display real-time information from the Internet.

Project Description and our Objective

The subject of our project is the fascinating and innovative concept of the "Smart Mirror." Imagine a mirror that not only reflects your physical appearance but also provides a dynamic and interactive interface, seamlessly merging technology with everyday life. This cutting-edge device serves as a gateway to a world of convenience, information, and personalization right in the comfort of your own reflection.

Our Smart Mirror combines the functionality of a traditional mirror with advanced technologies such as touchscreen interaction, different applications for day-to-day use and internet connectivity. By leveraging these capabilities, it opens up a realm of possibilities that goes far beyond the limits of a traditional mirror.

Rather than being a mere reflection, our Smart Mirror acts as a versatile personal assistant, providing a range of features and services. From displaying real-time weather updates and calendar events to delivering news headlines and personalized messages on the display, this intelligent mirror transforms an ordinary routine into an extraordinary experience.

Figure 1. Image showcases our Smart Mirror in action

Exploring the Benefits of Our Project

Personal Information Management:

- The Smart Mirror aims to streamline and simplify the management of personal information by displaying real-time updates, such as weather forecasts, calendar events, news headlines, personalized messages, listening to music. By consolidating and presenting this information in an intuitive manner, the mirror enhances convenience, productivity, and decision-making processes.

Weather Module:

- The weather module delivers current weather data and forecasts in real time directly to the Smart Mirror display. By integrating weather data from reliable sources, users can conveniently access weather information without the need for separate devices or applications. This module aims to improve user preparation, planning and decision-making by providing instant and easily accessible weather information.

News Module:

- The news module brings curated news headlines and updates to the Smart Mirror interface. It enables users to stay informed and up-to-date with the latest news from various sources. This module fosters an informed and engaged user base by conveniently delivering news content through the mirror's interface.

Personalized Messages Module:

- Allows users to receive customized messages or reminders on the Smart Mirror display. Users can set reminders, receive notifications or display motivational quotes or personal notes. This module improves personal organization, productivity, and emotional well-being by serving as a central hub for important messages or self-motivating notes.

Spotify Module:

- Integrates the popular music streaming service directly into the Smart Mirror. Users can access their music libraries and playlists or discover new music recommendations without the need for additional devices. The Spotify module extends the functionality of the mirror by enabling seamless music playback, creating an immersive environment and personalizing users' daily routines.

The touchscreen interaction feature:

- Allows users to interact directly with the mirror's user interface through taps, swipes, and gestures on the touchscreen display. This intuitive and tactile interaction method provides users with an easy and responsive experience when accessing various modules and functionalities.

Project Design: A Step-by-Step Guide

Step 1. From idea to reality:

- Every project begins with its fundamental element, the idea. We've made the decision to make our Smart Mirror a reality, so we've spent many hours researching what it should look like, what it should be able to do based on our desires, and what materials it should be constructed of.

Step 2. Research and sketch of our vision

- We must be certain of every element of our project, from the inside out to make it a reality. A successful project requires thorough research, thus we gave careful consideration to every area of it, from software integration to hardware implementation.

  Our software of choice is MagicMirror2, an open-source and free program that allows us to create a sophisticated Smart Mirror with whatever module we desire.

  Magic mirror and Raspberry PI go hand in hand, therefore it was the ideal time to merge the two key elements of our mirror.

  Research meant also finding what else we can combine in order to put our vision into reality, so we were in need of more materials.

Denumire	Valoare (RON)
Folie cu efect de oglinda (emag)	75.00
Sticla (geamgiu)	53.00
Sampon de bebe (auchan)	10.00
Spray curatat geamuri (auchan)	8.00
Sticluta pulverizat solutie (auchan)	6.00
Taietor sticla (hornbach)	20.00
IR Frame + WS2801 LED Strip (amazon)	1254.00
Taiat sticla	10
Rama lemn	100
Profil led	67
Baiț lemn	39

TOTAL	/ Person
1642.00	410.5
Budget	**2000.00**
Usage (%) of allocated budget	
82.1	%

Figure 2. Bill of Materials

We had to start from scratch since we needed to get the resources needed to physically execute the Smart Mirror for our concept to become more than just a notion on paper. We created an Excel spreadsheet so we could keep track of all the necessary parts and their prices for better organization.

Step 4. Establishing the foundation for implementation

- Before we could start the project's actual implementation, we had to polish several areas after all the supplies had arrived.

  We purchased an 80 cm TV, and in order to properly fit the glass on the TV screen, we had to cut it to the appropriate size.

Figure 3. 80cm TV

For there to be no empty space between it, the frame for our TV needs to be in perfect alignment with its margins. Making the measurements and making sure nothing was left behind took some time.

Figure 4. Mirror frame made of wood

Additionally, we had to trim some of the foil we used because it was considerably larger than we needed.

Figure 5. Foil measurement and cutting

From idea to reality: Implementation phase

It was time for us to begin putting the Smart Mirror into practice now that we had every one of the required parts.

First design state:

- Entails detaching the TV frame from the display and handling the cables and TV parts with care to avoid damaging any vital parts.

Figure 6. Carefully managing the display

Figure 7.Succescfully dispatching the display from it's case

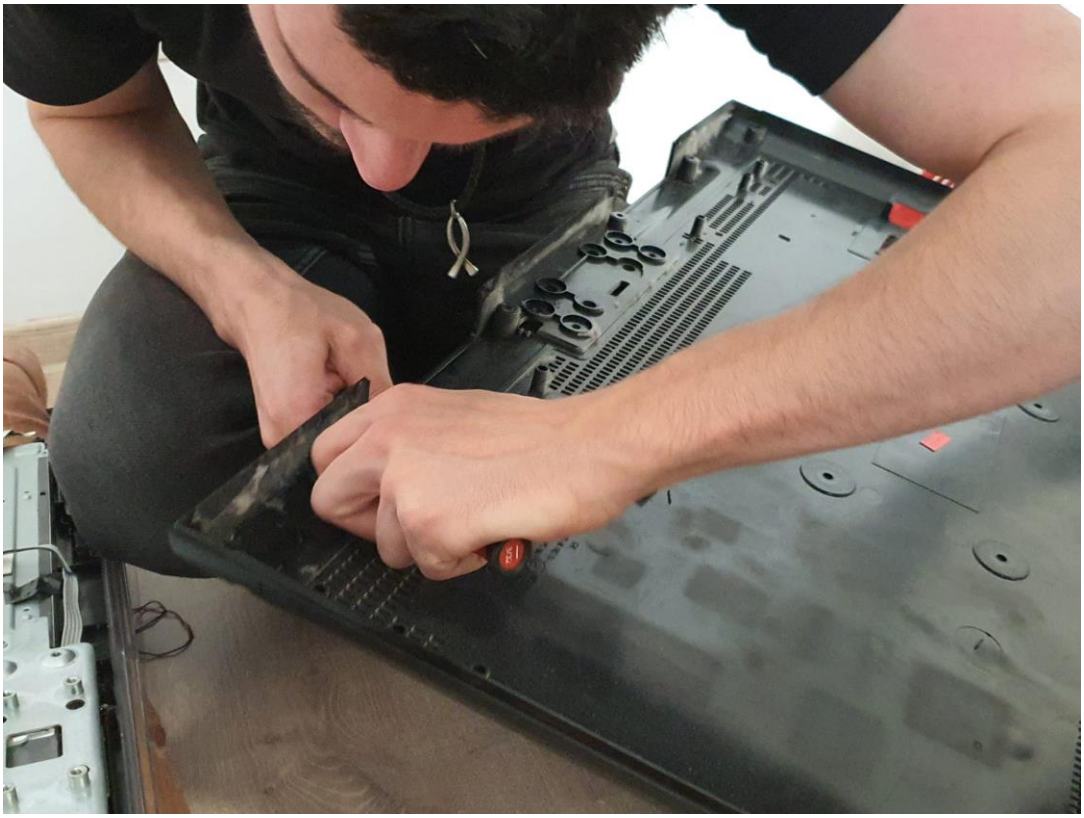

Figure 8. Final adjustment in order to get off all components from the frame

Second design state:

- We were prepared to focus on cutting the two components after measuring the foil and the glass and packing the display with everything it needed.
  Since you require a steady hand and a set of equipment to complete the task, regulating the diameters of the glass and foil was a difficult operation. We had to be extremely careful because it is a delicate product and any handling error may cause the glass to break.
  It was crucial to cut the foil correctly, using the proper size and amount of blades. Also the importance of placing the foil correctly on the glass was the main problem that could decide if our project would become mirror or not.

Figure 9. Cutting of the foil

Third design state:

- We required some essential elements in order to breathe life into our mirror.

The Buck converter and power supply are the central units of our mirror. A buck converter, also known as a step-down converter, is a DC-DC converter that transforms the high voltage level of the power supply to a lower voltage level so that the board can operate safely. The Raspberry PI is powered up at 5V, thus in order to achieve this, we utilized a buck converter.

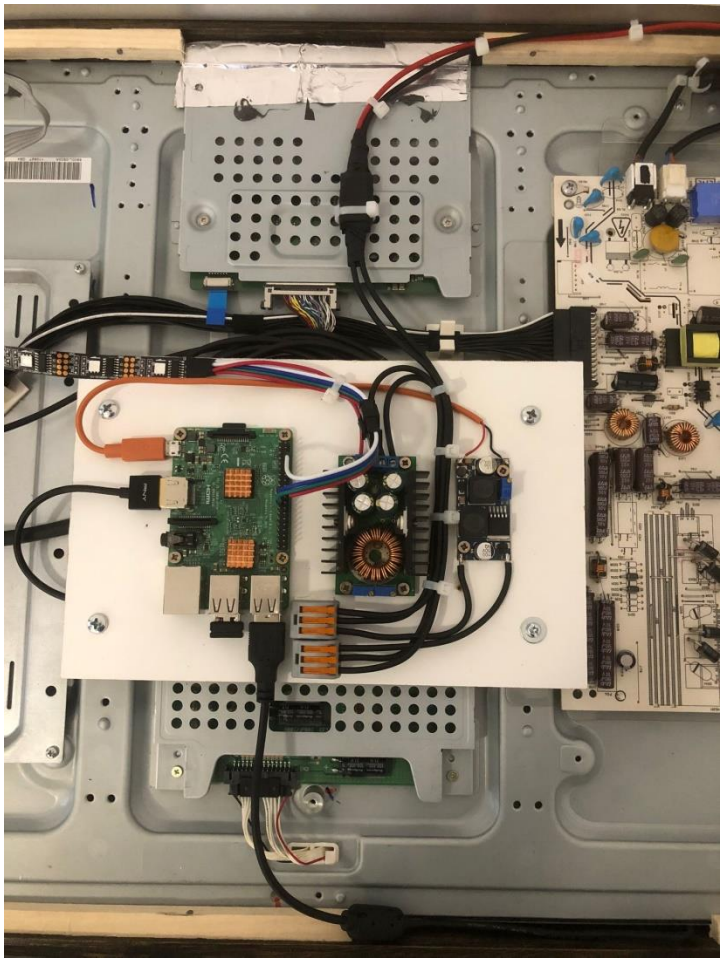

Figure 10. Buck Converter connected to the Raspberry PI

Figure 11. Showcase of the PS and the Buck connected to the Raspberry PI

Forth design state:

- The process of setting up the program is what made Smart Mirror a reality in our minds. We wanted to add a lot of practical modules to support users on a daily basis, which made the program integration process difficult.

  Because Magic Mirror2 is powered by a few Linux commands, it requires considerable expertise to operate things properly.

We configured the following modules on the Raspberry PI after installing the software:

Spotify Module

For the Spotify module to be implemented and sync every album and song with the Smart Mirror, a user account connection was required.

A Smart Mirror's Spotify module is a feature that enables users to access and manage their Spotify music streaming account from the mirror's user interface. The user's audio experience is improved, and it offers a practical and smooth solution for them to listen to their favourite music while using the mirror.

It often appears as a separate part on the Smart Mirror's user interface, giving controls for playback and navigation as well as pertinent information about the song that is presently playing. It can be put in a prominent spot on the mirror's surface so that the user can easily see and reach it.

The Spotify module on a Smart Mirror offers the following main features and advantages:

Playback of Spotify music: From the mirror, users can play, pause, skip tracks, and change the volume of their Spotify audio. With only a few touches or voice commands, users can start playing their favourite playlists, albums, or songs without having to pick up another device.

music Information: The module shows pertinent details about the music that is presently being played, including the track title, artist name, album art, and occasionally even the lyrics. Users don't have to stop what they're doing to look in the mirror to check what tune is playing.

According on the user's listening tastes , the Spotify module can offer personalized music recommendations. It may make recommendations for playlists, albums, or musicians in line with the user's musical preferences, enabling them to discover new songs or revisit old favourites.

Playlist management: From the mirror, users can access and control their Spotify playlists. Within the mirror's interface, they can easily arrange their music collection, make new playlists, add or remove tracks, and more.

Integration with Smart Home Systems: The Spotify module can be connected to various voice assistants and smart home systems. Users may easily integrate their Smart Mirror into their broader smart home ecosystem by using voice commands to control the playback of their music.

The Spotify module on a Smart Mirror guarantees easy device synchronization with other devices. Users can begin playing music on their computer or smartphone, and with just a quick tap or voice command on the mirror, they can seamlessly transfer the song to the mirror

Real-Time Events Module

A Smart Mirror's real-time events module is a feature that offers users the most recent news and details on events taking place all over the world. It offers a practical approach to stay up to date and engaged with important events, current affairs, and breaking news in real-time.

On the Smart Mirror's interface, the real-time events module often appears as a separate part that shows a hand-picked selection of news stories or headlines. It can be placed at a visible spot on the surface of the mirror, allowing users to quickly access and glance at the most recent updates.

Here are some important features and advantages of a Smart Mirror's real-time events module for news:

News Aggregation: To give users a diverse and thorough perspective of current events, the module gathers news from a variety of trustworthy sources, including news websites, RSS feeds, and news APIs. This guarantees that readers get a well-rounded viewpoint on various subjects and breaking news headlines.

Headlines and Summaries: The module presents news article headlines or summaries, enabling users to rapidly skim and understand the essence of each piece. This makes it possible for consumers to keep informed even when they are pressed for time.

Customizable choices: Within the module, users frequently have the option to alter their news choices. They can choose certain news categories, such as politics, sports, technology, or entertainment, to ensure that the information provided is relevant to their interests.

Support for photos and other multimedia: In addition to news articles, the real-time events module may also include images, videos, or other multimedia components. Users may find a more captivating and immersive news browsing experience thanks to this graphic improvement.

Breaking News Alerts: The module can send out breaking news alerts or notifications in addition to presenting news items to make sure users are swiftly notified about important events or developments. To attract the user's attention, these notifications might be sent in a standout visual fashion or with the use of audio cues.

Users can interact with the real-time events module to access complete news stories from the sources they have chosen. They may read the entire narrative or look into more details by clicking on links or using integrated features, making for a seamless experience.

Personalized Messages Module

Everyone's wellbeing is vital because it not only affects how they feel during the day but also greatly aids in maintaining their mental health. We all offer and receive compliments, and it's extremely simple to do so.

A timer controls the flow of messages displayed on the screen, and the module of personalized messages on display offers the option of various messages that may be specified by the user.

Users can improvise their messages to assist themselves get through difficult times or simply to make themselves happy.

Weather Module

A Smart Mirror's weather module is often made to give the user access to current weather information. In order to gather and present meteorological data on the mirror's interface, it makes use of a variety of technologies and APIs. The operation of a weather module on a Smart Mirror is described in the following technical terms:

Data gathering: Reliable sources of weather information must be used by the weather module. Typically, it makes use of APIs (Application Programming Interfaces) offered by national meteorological organizations, OpenWeatherMap, and other weather services. The Smart Mirror can get meteorological data like forecasts for temperature, humidity, wind speed, and precipitation through these APIs.

The software of The Smart Mirror interfaces with the selected weather API. In order to complete this integration, an HTTP or HTTPS connection must be made to the API. The mirror contacts the API with queries that identify the area for which weather information is required.

Location Ascertainment: The Smart Mirror may be able to determine its location using GPS or IP geolocation. This makes it possible for the mirror to locate the user on its own. As an alternative, the user can manually enter their location on the interface of the mirror.

Data Retrieval: After locating the place, the mirror makes a request to the weather API with the necessary details, such as the coordinates or name of the site. The meteorological data returned by the API is structured, such as JSON (JavaScript Object Notation) or XML (extensible Markup Language).

Data Parsing: The Smart Mirror's software analyses the weather data it has received to extract pertinent details including the current temperature, humidity, wind speed, and weather (such as whether it is sunny, cloudy, or raining). The software then arranges this data in a manner that may be seen on the interface of the mirror.

User interface: The weather data is displayed on the mirror's display by the program. This can entail creating a weather module that is both aesthetically pleasing and simple to understand. The module might feature icons, graphs, or textual representations of the weather data.

Real-Time Updates: The Smart Mirror periodically updates the weather data by repeating processes 3 through 6 at predetermined intervals to guarantee current weather information. The mirror can now show the most recent weather data thanks to this.

Financial Stock Market Module

Since some people are interested in the financial sector, we developed the Stock Market Module where users can view the most recent news about businesses and corporations in general.

In order to decide how to invest and when it is the ideal time to do so, they can examine how the stocks react in real-time.

There is no cost to access this material, and no extra connection is necessary.

Real-Time Display Module

A Smart Mirror's time showing module is a feature that shows the time and date in an aesthetically pleasing and legible fashion. Users can use it as a quick and easy way to check the time while utilizing the mirror for a variety of activities, such as getting ready in the morning or getting ready for an event.

The time-displaying module normally takes the form of a digital clock that is visible on the surface of the mirror. Depending on the design of the mirror and the user's preferences, it can be placed in a corner or any other defined location of the mirror. The Smart Mirror's interface can be seamlessly integrated with the clock by altering the clock's design to fit the Smart Mirror's general aesthetic.

A Smart Mirror's time showing module frequently has extra functionalities in addition to only showing the time to improve its performance. These qualities could consist of:

The module has the ability to display the date and the day of the week in addition to the time. Users that need to remember appointments, due dates, or other time-sensitive tasks can benefit from this information.

Options for Time Format: Smart Mirrors typically give users the option to switch between 12-hour and 24-hour time formats in accordance with their preferences or cultural standards.

Time zone Support: A few Smart Mirrors allow users to view the time in various time zones, allowing them to view local time in various countries or towns throughout the world. This function is advantageous for travellers or individuals with international contacts

Adaptability: The time showing module can frequently be adapted to the user's preferred visual aesthetic. Users can customize their experience with Smart Mirror by choosing options to alter the font, colour, size, or even the general appearance of the clock.

Infrared Frame Module

We all love to interact with our gadgets and it is a part of our day-to-day life. Here is where touchscreen module comes in.

This feature would not be possible without the Infrared frame:

In a Smart Mirror, touchless interaction and gesture detection are the main purposes of an IR frame. A variety of infrared sensors are often built into the frame and carefully positioned behind the mirror's reflective surface. The infrared light that these sensors release and pick up is invisible to the human eye but is detectable by the sensors.

The IR sensors included into the Smart Mirror's frame are able to recognize people when they walk up to or stand in front of it. The sensors detect modifications in the infrared light pattern brought on by a person's movement or body heat. The software of the Smart Mirror then processes this data and makes the appropriate adjustments.

A Smart Mirror can enable numerous touchless interactions by using the IR frame. For instance, it can recognize hand motions like swiping, tapping, or waving, enabling users to operate the mirror's interface without contacting the surface directly. When a user approaches the mirror, the IR frame can be used for proximity detection, launching particular actions or displaying pertinent information.

The Smart Mirror may be used in a more natural and user-friendly way thanks to the IR frame's ability to detect movements and proximity. It provides a seamless and hygienic mode of engagement by doing away with the necessity for physical buttons or touchscreens. Additionally, it creates opportunities for extra features based on the user's presence or motions, such as facial recognition, adaptive lighting, or tailored content.

Figure 12. IR Frame

Additionally, we made the decision to add something more impressive to the rear of our mirror when the project was still in the execution stage.

We purchased a led strip, which we had to slightly cut to fit the diameter of the mirror because we wanted everything to be more vivid.

The LED strip can be configured to light up in whatever color the user chooses, including a series of hues that are set by a timer and alternate between them.

We had to carefully unwrap the packaging that was containing the adhesive in order to attach the strip to the rear of the frame, and getting the placement just right was a little bit of a difficulty.

It is incredibly aesthetically appealing to observe because the LED’s are really strong and provide an absolutely fantastic light show.

Figure 13. LED's in action during night time

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Testing: What You Need to Know

It was time to check to see if everything was functioning as intended once all the parts had been put together. Even though we tested our product during the installation process, we still wanted to make sure that everything was functioning as we had intended.

First testing phase:

- The cables from the TV that were attached to the Raspberry PI board were first tested to ensure that the connections were secure.

After removing the TV from its case, we had to examine some of the electrical parts on its PCBA to make sure nothing was damaged that would impair its functionality. To do this, we tested the jumpers and other components using a Multimeter.

Second testing phase:

- We didn't have to test as many things during the hardware phase as we did during the software implementation phase. As a result, it didn't take as long because we were able to handle everything and ran into no issues.

However, because MagicMirror2 is a program that runs on the Raspberry PI, installing modules required programming and Linux expertise, making it difficult to debug and write the code. This was necessary to make everything work as it should.

The glass had to be foiled so in order not to make mistakes, because this was a one time trial, we tested some parameters before we actually cut the foil.

Following up is the testing of the Infrared frame that was necessary for the touchscreen interaction; therefore, before attaching it to the TV display, we placed it on it to check that the user's interaction with the display functions flawlessly and that there are no delays or other issues that would make the experience less enjoyable.

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Conclusions

- For the Display part a two-way mirror is used as the display surface, with a screen and a backlight positioned behind it.
- A small computer, such as a Raspberry Pi, is used to run the software which contains diverse modules for different purposes and control the display.
- For the Touchscreen a touchscreen overlay is applied to the mirror, more precise, the IR Frame, allowing users to interact with the display.
- A variety of sensors can be used to enhance the mirror's functionality, such as motion sensors to activate the display, temperature and humidity sensors to display weather information, and light sensors to adjust the backlight and we will also place a band of LED’s.
- Personalized information: The mirror can display personalized information, such as the user's calendar, to-do list, and news and social media feeds or personalized messages.

This project required a lot of time to complete, as well as hours of meetings and discussions, but in the end, it not only taught us how to work as a team and communicate more effectively, it also showed us how dependent we are on one another to complete a project of this level.

It also helped us get ready for our senior year of college, as well as our upcoming bachelor's exam and presentation. To organize and teach us how to do things correctly, the documentation-making and practical work processes worked flawlessly.

Meet the Team

- This project was made possible by four friends who share a passion for engineering, electronics, and programming and who are always willing to learn new things.

Bibliography