
VIRTUAL PIANO USING RASPBERRY PI

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ABSTRACT

The project aims to develop a portable virtual piano using Raspberry Pi and touch sensors. By leveraging Raspberry Pi's processing power and touch sensor technology, users can simulate the experience of playing a traditional piano without the need for a physical keyboard. The Raspberry Pi serves as the central processing unit, processing sensor data and generating corresponding piano notes. Touch sensors detect user input, allowing interaction with the virtual piano. The virtual piano offers advantages such as portability and sound customization. Users can carry the Raspberry Pi board and touch sensors, enabling them to play music anywhere. They can also experiment with different instrument voices and sound effects, enhancing creativity in music production and performance. The project allows for easy integration with other digital music software and systems, opening up possibilities for collaboration and access to various music production tools. A graphical user interface (GUI) provides visual feedback, making the virtual piano intuitive to use. In conclusion, the virtual piano project utilizing Raspberry Pi and touch sensors offers a portable and interactive musical experience, providing flexibility and creativity in music production and performance.

I. INTRODUCTION

The piano, often hailed as the "king of instruments," is a majestic and versatile musical instrument that has captivated musicians and audiences alike for centuries. With its rich history, expressive range, and timeless beauty, the piano holds a prominent place in the world of music.

Invented in the early 18th century by Bartolomeo Cristofori, an Italian harpsichord maker, the piano has undergone various modifications and advancements over the years. Its name, derived from the Italian word "pianoforte," meaning "soft-loud," reflects the instrument's ability to produce both delicate, nuanced tones and powerful, resonant sounds.

At its core, the piano is a keyboard instrument with a distinctive arrangement of black and white keys. The keys are connected to a complex mechanism that activates hammers, striking strings inside the instrument, producing sound. The player's touch and technique, combined with the piano's unique mechanical design, allow for an incredible range of dynamics and expression.

One of the piano's most captivating qualities is its versatility. It is equally at home in classical music, where it has been a cornerstone for composers like Mozart, Beethoven, and Chopin, as well as in various other genres such as jazz, pop, rock, and contemporary music. The piano's ability to accompany singers, orchestras, and ensembles, or stand alone as a solo instrument, has made it an indispensable part of the musical landscape.

Beyond its musical significance, the piano is also a stunning work of art. Crafted with meticulous attention to detail, pianos come in various styles and designs, from grand pianos with their majestic presence to upright pianos suitable for more compact spaces. The craftsmanship and beauty of a piano can enhance the ambiance of any room, turning it into a focal point and a symbol of refined taste.

Learning to play the piano is a journey of exploration and self-expression. It requires discipline, practice, and a keen ear for music. Aspiring pianists can unravel the vast repertoire of compositions, from timeless classics to modern compositions, and create their own melodies, harmonies, and emotions.

Whether as a professional musician, an enthusiastic amateur, or an appreciative listener, the piano has the power to transport us to new emotional landscapes and connect us to the profound depths of human creativity. Its unmatched versatility, expressive potential, and timeless elegance ensure that the piano will continue to inspire and captivate generations to come.

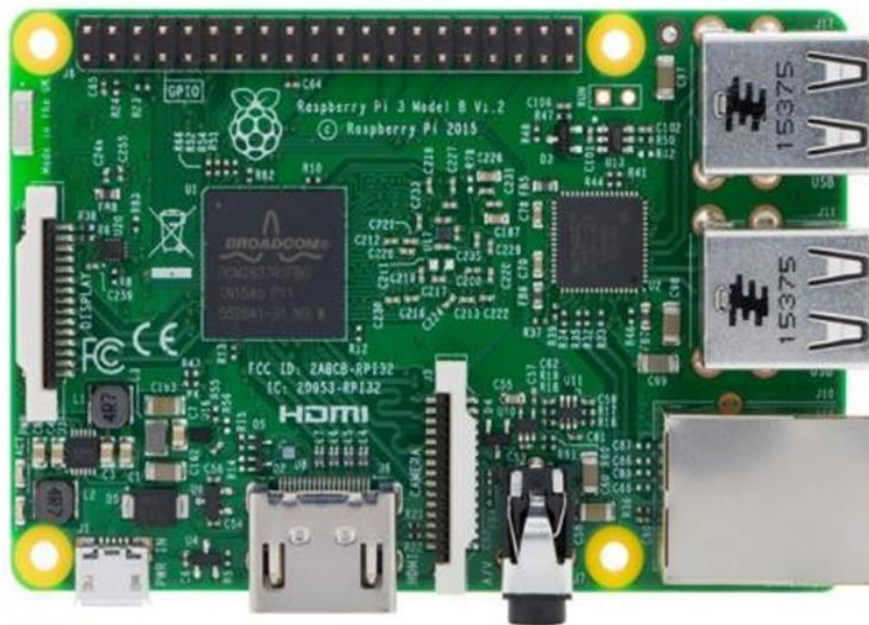
II. HARDWARE

RASPBERRY PI

A Raspberry Pi 3 board contains BCM2837 controller which supports ARM11 processing unit. This is the Broadcom chip used in the Raspberry Pi 3, and in later models of the Raspberry Pi 2. The underlying architecture of the BCM2837 is identical to the BCM2836. The only significant difference is the replacement of the ARMv7 quad core cluster with a quad-core ARM Cortex A53 (ARMv8) cluster. The ARM cores run at 1.2GHz, making the device about 50% faster than the Raspberry Pi 2. The VideocoreIV runs at 400Mhz.

The Raspberry Pi 3 Model B builds upon the features of its predecessors with a new, faster processor on board to increase its speed. It also features WiFi and Bluetooth Low Energy capabilities to enhance the functionality and the ability to power more powerful devices over the USB ports [20].

- Quad Core 1.2GHz Broadcom BCM2837 64bit CPU
- 1GB RAM
- BCM43143 WiFi and Bluetooth Low Energy (BLE) on board
- 40-pin Extended GPIO
- 4x USB 2 ports
- 4 Pole stereo output and composite video port
- Full size HDMI
- CSI camera port for connecting a Raspberry Pi camera
- DSI display port for connecting a Raspberry Pi touchscreen display
- Micro SD port for loading your operating system and storing data



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TOUCH SENSORS

1 Channel Capacitive Touch Sensor Module uses the touch-sensing IC TTP223 to sense the touch input thus making it easy to add capacitive touch input to your project. The touching detection IC is designed for replacing traditional direct button key with diverse pad size. The module has single touch pad. Power the module with 2 ~ 5.5V DC and the touch pad is all active to sense the input.

Single Channel Capacitive Touch Sensor Module is easy to interface. It can be used along with a microcontroller or an Arduino or even without one. When a capacitive load (such as a human hand) is in close proximity to the sense-pad, the sensor detects the change in capacitance and activates the switch. Custom sense-pads can be made from nearly any conductive material and these sensors can detect touch through thin layers of non-conductive materials such as glass, plastic, fabric or even wood.

In the normal state, the module output is low, low power consumption; when a finger touches the corresponding position, the module output high, if not touched for 12 seconds, switch to low-power mode.

Jog type: the initial state is low, high touch, do not touch is low (similar touch of a button feature)

Module can be installed in such as surface plastic, glass or non-metallic materials

In addition to the thin paper (non-metallic) covering the surface of the module, as long as the correct location of the touch, you can make hidden in the walls, desktops and other parts of buttons.



- Touch sensors work similar to a switch. When they are subjected to touch, pressure or force they get activated and act as a closed switch. When the pressure or contact is removed they act as an open switch.
- Capacitive touch sensor contains two parallel conductors with an insulator between them. These conductors' plates act as a capacitor with a capacitance value C_0 .
- When these conductor plates come in contact with our fingers, our finger acts as a conductive object. Due to this, there will be an uncertain increase in the capacitance.
- A capacitance measuring circuit continuously measures the capacitance C_0 of the sensor. When this circuit detects a change in capacitance it generates a signal.

The resistive touch sensors calculate the pressure applied on the surface to sense the touch. These sensors contain two conductive films coated with indium tin oxide, which is a good conductor of electricity, separated by a very small distance.

- Across the surface of the films, a constant voltage is applied. When pressure is applied to the top film, it touches the bottom film. This generates a voltage drop which is detected by a controller circuit and signal is generated thereby detecting the touch.

SPEAKER

Before discussing the specific components of audio-related circuits and electronics, let's first take a crash course on the basic concepts of sound.

Sound is simply a type of energy vibrating through a medium (such as air or water); this energy, within a specific range of frequencies, is interpreted by the human ear as sound.

Sound is made up of three basic elements:

However, the human ear is more sensitive to (i.e. able to discern at lowest intensity) frequencies ranging between 2,000 and 5,000 Hz (see Hearing Range - Wikipedia). Recall that Hertz (Hz) is a unit defined as cycles per second.

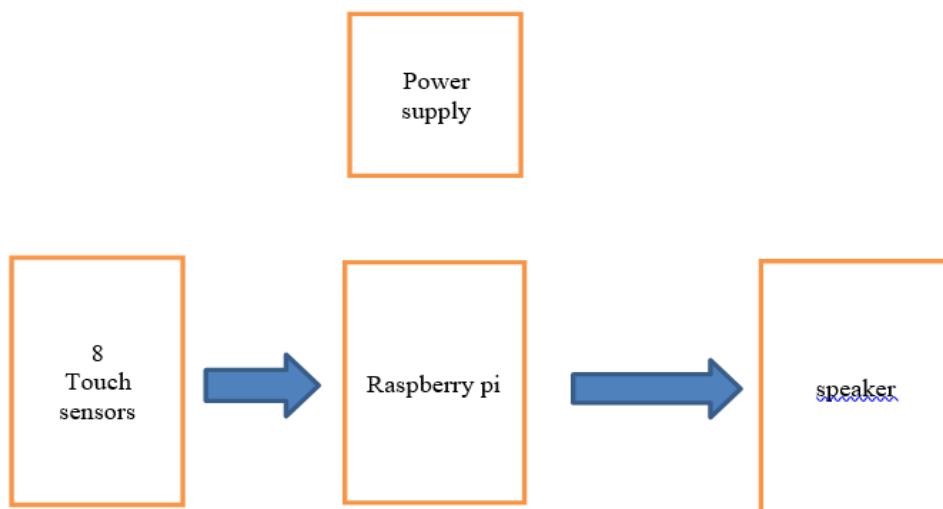
A sound's intensity corresponds to the amount of energy associated with that sound. The decibel (dB) is used for measuring the sound's energy in a way that is relevant to how humans perceive loudness.

In the context of audio, the decibel is defined as follows: $dB = 10 \log_{10} (I/I_0)$

where

- I = the measured intensity (W/m)
- $I_0 = 10^{-12} \text{ W/m}^2$, which represents the lowest sound intensity detectable by the human ear

III. BLOCK DIAGRAM



IV. RESULT



V. CONCLUSION

In conclusion, the Virtual Piano project utilizing touch sensors and Raspberry Pi represents a remarkable fusion of technology and music. Through the combination of hardware and software, this project offers an interactive and immersive experience, enabling users to play a virtual piano-like instrument by simply touching sensors connected to a Raspberry Pi.

By leveraging the power of Python programming, the project transforms touch inputs into musical notes, creating a dynamic and customizable virtual piano environment. The calibration of touch sensors ensures accurate detection, while the mapping of notes to each sensor allows for intuitive and expressive playing.

The Virtual Piano project opens up a world of possibilities for musicians, enthusiasts, and learners. It provides an accessible and portable platform to explore the art of piano playing, experiment with melodies and chords, and delve into the realms of composition and improvisation.

Furthermore, the project showcases the versatility and capabilities of Raspberry Pi as a microcomputer, enabling real-time sound generation and output. By connecting speakers or audio devices, users can enjoy the sounds of their virtual piano compositions and performances.

The Virtual Piano project not only serves as a creative outlet but also encourages learning and skill development. It offers a hands-on approach to understanding the fundamentals of music and the intricacies of playing the piano, making it an invaluable educational tool for aspiring musicians and students.

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