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Research Original Article

Design of Midi Drum Controller Using Piezoelectric and Arduino-Based TCRT5000 Sensor to Facilitate Sound Engineer Performance in the Music Industry

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Abstract

This study discusses the Midi Drum Controller using the Arduino Mega which has many analog pins making it suitable for producing complete drum pads as well as piezoelectricity which is used to detect vibrations when the drum pad is beaten, as well as the Tcrt5000 sensor which is used to control the hi-hat so that it can move. from the sound of an open hi-hat to a closed hi-hat. The results of this study indicate that piezoelectricity can detect vibrations and dynamics of strong and weak drum beats and send the game to midi-based virtual drum applications. The Tcrt5000 sensor used can also work well, judging by the sound it produces and the data sent when the Tcrt5000 sensor is on and off.

Keywords: Midi Controller, Drum Electric, Piezoelectric, TCRT5000

Introduction

The drum is one of the basic instruments for making a song. Drums can be digitized using a Midi Controller to make it easier to make music, by utilizing a microcontroller. Midi Controller is a solution to make it easier to draw notes & rhythms in a song (Fasha, 2021). So far, musicians have always been constrained to have a musical instrument, especially in terms of costs. An example is an electric drum, when viewed from the various types of high-tech electric drums, are the same as the previous electric drums, it's just that the newest electric drums are equipped with an internet connection for plugin updates and have a clear sound quality (Pratama, 2015). This producer strategy releases the same product but in different packaging (Kartika et al., 2022). By adding a few programs to the product software to monopolize the market (Sibarani & Kartika, 2022). The results are almost the same if we compare the electric drums from well-known manufacturers with DAW (Digital Audio Workstation) software. It's just that there is a slight difference in sound sharpness, but this is understandable because DAW software is freeware.

In this study, the authors conducted research on the application of piezoelectricity as a midi drum controller and the tcrt5000 sensor as a hi-hat controller based arduino mega.

Basic Theory

1. Piezoelectric

   A piezoelectric or piezo sensor is an electronic component that can convert mechanical energy into electrical energy (Yun et al., 2023) (Muradi & Kartika, 2023), called the piezoelectric effect (Su et al., 2021). Piezoelectric will produce an electric voltage if pressure or mechanical strength is generated in both fields (S. W. Nasution & Kartika, 2022). The piezoelectric effect was first discovered in 1880 in France by two physicists Pierre Curie and Jacques Curie. The word piezo itself comes from Greek which means pressure (Mowaviq et al., 2018).

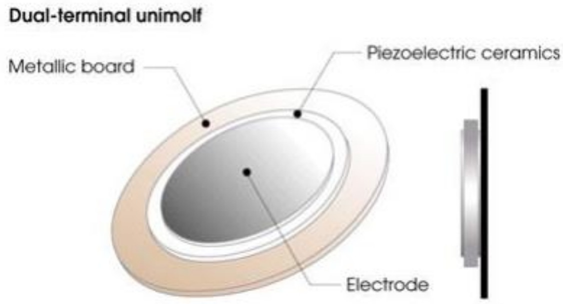

Figure 1. Piezoelectric

2. Arduino Mega 2560
   Arduino Mega2560 is a microcontroller board based on ATmega2560 (ATmega2560 datasheet) (Parmar et al., 2017). Arduino Mega 2560 is equipped with 54 digital input/output pins, of which 15 pins can be used as PWM outputs, 16 pins as analog inputs, and 4 pins as hardware serial ports (UART) (Mina & Kartika, 2023), as well as a 16 MHz crystal oscillator, USB connection, power jack. ICSP headers, and the reset button needed to support the microcontroller (Pan et al., 2018). To power up the Arduino Mega2560, simply connect it to a computer via a USB cable or supply power from an AC-DC adapter or battery. Arduino Mega2560 is compatible with most shields designed for Arduino Duemilanove or Arduino Diecimila. This microcontroller board is the latest version which replaces the previous Arduino Mega version (Majid, 2016), (E. S. Nasution et al., 2018), (Hasibuan et al., 2021), (Nrartha et al., 2022).

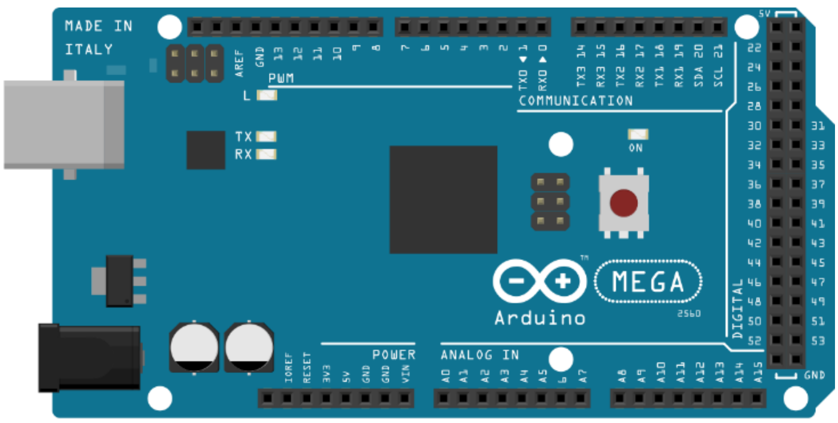

Figure 2. Arduino Mega 2560

3. TCRT5000
   The TCRT5000 sensor is a type of sensor that reflects infrared light and functions to transmit and receive signals (Mnati et al., 2021). The tcrt5000 sensor is usually used as an object detector by reflecting light which is then received by the diode on the sensor (Pitriyanti et al., 2022). Infrared light cannot be detected by the human eye, so a phototransistor is needed to capture it (Zikri et al., 2018).

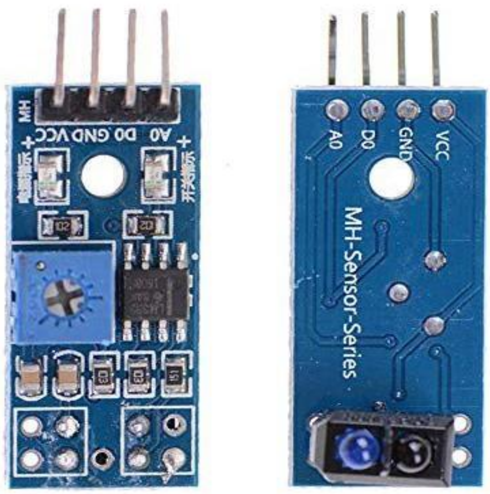

Figure 3. TCRT5000 Sensor

4. Micro SD Card Adapter Module
   The SD Card Module (MicroSD Card Adapter) (Jaw et al., 2010) is a module for reading and writing data on micro memory cards using the SPI interface (Nabawi, 2019). This module is suitable for applications that require database storage such as attendance systems, queues, data logging, parking systems, and so on (Pindrayana et al., 2018).

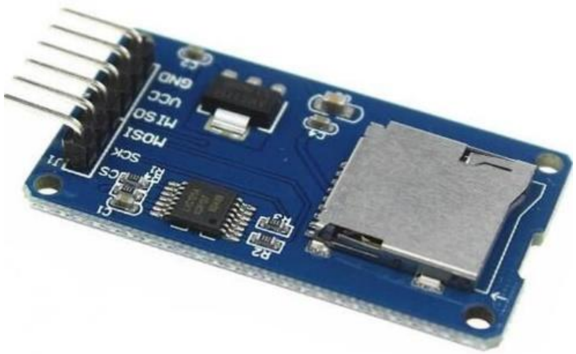

Figure 4. Micro SD Card Adapter Module

5. Loop Midi
   Loop Midi is an application that creates virtual midi ports on Windows XP to Windows 10 32bit/64bit operating systems (Huber, 2007). This program functions to connect midi software by creating a midi loopback port. This application created by Tobias Erichsen uses a virtual midi driver (Gimeno León, 2020) that was also created by him. Midi Loops are available free of charge for personal, non-commercial use (Utama et al., 2018).

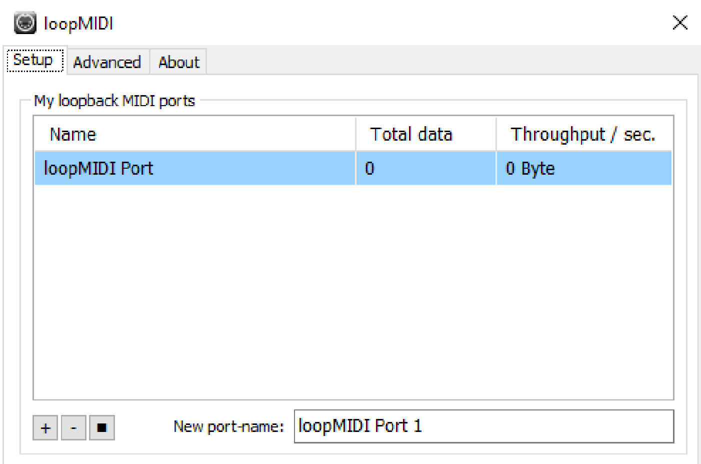

Figure 5. Interface Loop Midi

Research Method

From the flow chart above, it can be described as follows.

a) The study of literature involves the crucial step of conducting a comprehensive review of existing literature that pertains to the issues under discussion. This literature review serves the purpose of instilling confidence in the feasibility of conducting the proposed research and simultaneously serves as a means to minimize potential errors that may arise during the research process.
b) The identification and analysis of needs play a crucial role in this research, specifically in the process of identifying and analyzing the needs associated with the problems that have been discussed. This step is essential in order to ensure the successful execution of the research and its ability to effectively address the identified issues.
c) System planning involves the effective management of the design process for the obtained problems, which encompasses three distinct components: mechanical design, electronic design, and program design. By carefully and appropriately handling these three aspects, the overall system can be efficiently developed to address the identified problems.
d) Testing techniques and data collection involve the implementation of tests on the realized designs, to ensure the system's smooth operation. These tests are conducted to evaluate the functionality and performance of the system, collecting valuable data to assess its effectiveness and address any potential issues that may arise.
e) Functional testing refers to evaluating the various components employed to ascertain their proper functioning. This type of testing involves the examination of sensors, Arduino Mega, Piezoelectric, and TCRT5000 Sensor to ensure that each component is operating according to its intended functionality.

f) Performance testing involves conducting tests on the overall system design. If the obtained performance does not meet the design requirements, necessary corrections, and improvements are made

g) Result and Discussion, conduct a review and analysis of test data so as to find new ideas to draw conclusions.

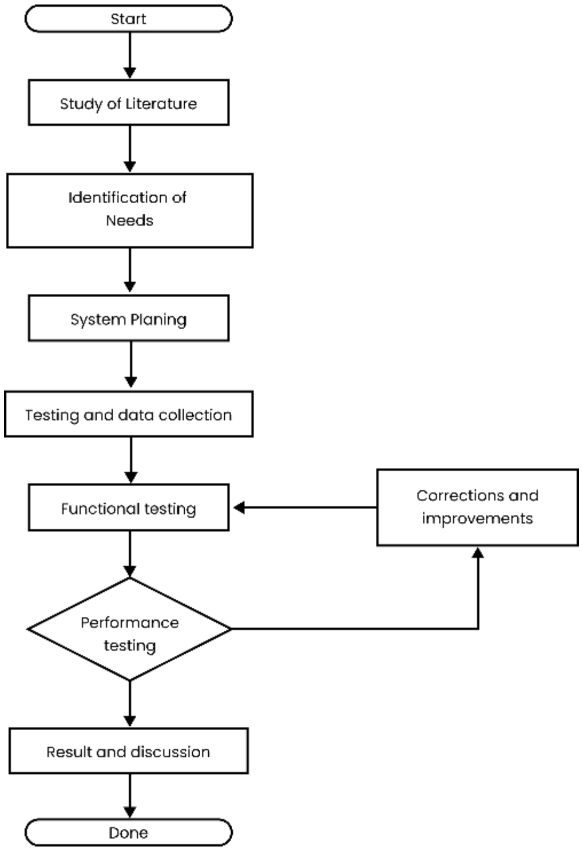

Figure 6. Flowchart research

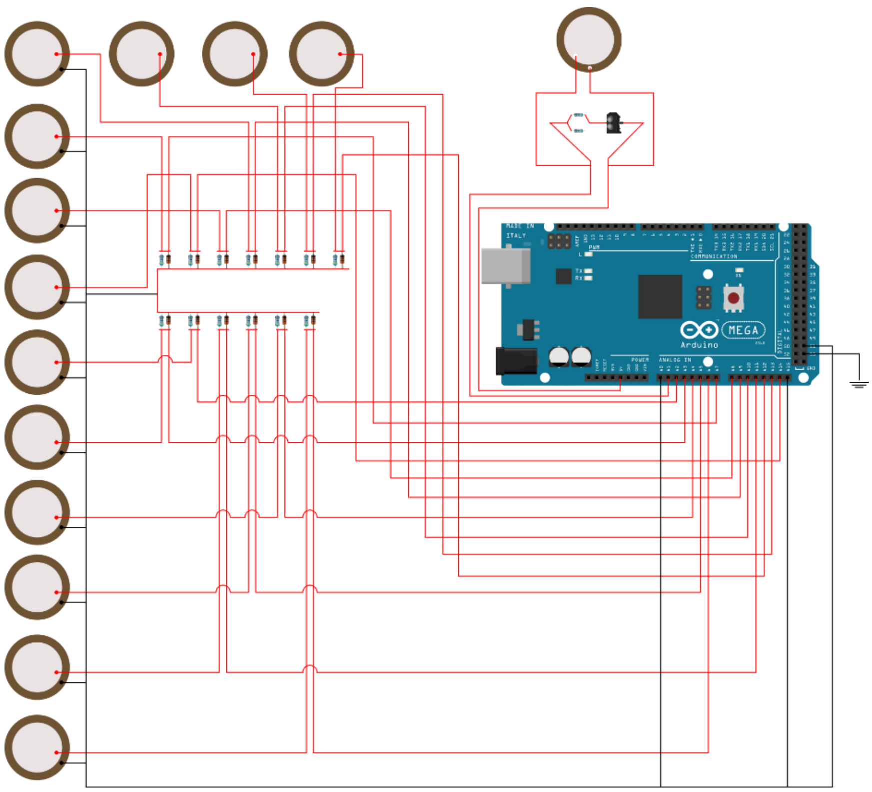

Figure 7. Midi drum controller circuit

Results and Discussion

From this research, a prototype of an electric midi drum was produced. The results in this test are carried out by beating each drum pad and monitoring whether the hexa data sent from the electric drum matches the data on the VST MIDI Drum being controlled. The process of monitoring the hex value is carried out using Pocket Midi application to find out the hex value produced when the drum pad is beating.

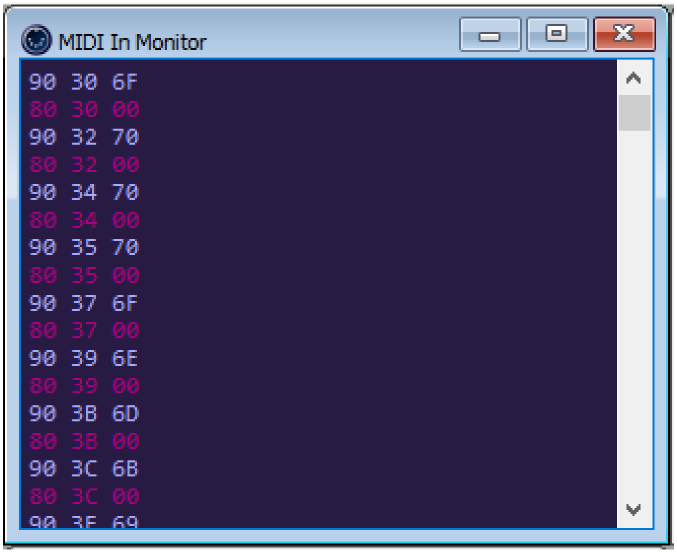

Figure 8. Monitoring Results of Hex Values Using the Pocket Midi Application

The Midi Pocket application shows every hexadecimal value received from each beat on each pad. Next, it will be checked whether the value entered is in accordance with the value in the VSTi Addictive Drum.

Table 1. Piezoelectric Testing as a Midi Controller

Pad Drum	Note	Data Sent (Hex)	Data On Addictive Drum (Hex)	Information
Kick	C1	90 24 6C 90 24 78	90 24 6C	Sensors Working
Snare	D1	90 26 6C 90 26 1D	90 26 6C	Sensors Working
Rim	E1	90 25 69 90 25 5C	90 25 69	Sensors Working
Tom 1	D2	90 32 6F 90 32 22	90 32 6F	Sensors Working
Tom 2	B1	90 2F 5F 90 2F 3F	90 2F 5F	Sensors Working
Tom 3	G1	90 2B 6E 90 2B 1A	90 2B 6E	Sensors Working
Tom 4	F1	90 29 62 90 29 2C	90 29 62	Sensors Working
Crash 1	C#2	90 31 6B 90 31 0D	90 31 6B	Sensors Working
Crash 2	A2	90 39 51 90 39 04	90 39 51	Sensors Working
Crash 3	G2	90 37 5E 90 37 01	90 37 5E	Sensors Working
Ride Bell	F2	90 35 18	90 35 5E	Sensors Working
Ride	D#2	90 33 75 90 33 4D	90 33 75	Sensors Working
Kick	C1	90 24 6C 90 24 78	90 24 6C	Sensors Working
Snare	D1	90 26 6C 90 26 1D	90 26 6C	Sensors Working
Rim	E1	90 25 69 90 25 5C	90 25 69	Sensors Working

Tom 1	D2	90 32 6F 90 32 22	90 32 6F	Sensors Working
Tom 2	B1	90 2F 5F 90 2F 3F	90 2F 5F	Sensors Working
Tom 3	G1	90 2B 6E 90 2B 1A	90 2B 6E	Sensors Working
Tom 4	F1	90 29 62 90 29 2C	90 29 62	Sensors Working
Crash 1	C#2	90 31 6B 90 31 0D	90 31 6B	Sensors Working
Crash 2	A2	90 39 51 90 39 04	90 39 51	Sensors Working
Crash 3	G2	90 37 5E 90 37 01	90 37 5E	Sensors Working
Ride Bell	F2	90 35 18	90 35 5E	Sensors Working
Ride	D#2	90 33 75 90 33 4D	90 33 75	Sensors Working

The test results show that there is a change in the data sent from the pad to the drum, but the initial data sent is no different from the data in the VSTi Addictive Drum. Changes to the data sent can still be tolerated considering that the 2 bytes of data sent still have the same value.

Conclusions

Based on the results and discussion of the system that has been made, several conclusions are obtained, namely: The results of the Velocity test show that the size of the sound has dynamics that affect the strength of the sound as seen at the changing velocity depending on the size of the sound. The results of reading midi data prove that each pad in the series functions and outputs hexadecimal data which is then translated into MIDI through the configuration of the Addictive Drum. When the drum pad sensor is beaten, the piezoelectric sends two hexadecimal data to be forwarded to the VSTi Addictive Drum with a length of 3 bytes each, the second hexadecimal value has a difference of 3 bytes with the hexadecimal value in the VSTi Addictive Drum, but the pad is in Addictive drum still works because the difference in value only occurs in the 3rd byte and the second value who received. The sound emitted by Addictive Drum corresponds to the drum pad that has been configured in the Arduino IDE when it is played

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