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Research Article

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Android Based Bluetooth Controlled MP3 Player

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Abstract The MP3 player has become a majora venue for listening to music on daily basis. Storage space requirement is drastically reduced by compressing raw audio with the MP3 standard. It made it possible for individuals to play audio from devices with limited storage capacities such as handphones, PDA's and flash-based MP3 players. The smallness in size of the MP3 file makes them be very conducive and adaptable for use in comparison to conventional audio CDs. This makes it feasible to purchase MP3 players that have the capacity to play MP3s from a CD having many music collections or from a hard disk comprising tens of hundreds of music collections. An additional benefit of their compactness in term of size is that they can be easily transferred from one device to another even from remote locations. In this study, an MP3 player was design and constructed. The proposed system was controlled by a smartphone via Bluetooth Modules within a certain range. The proposed system was confirmed to be working according to specifications.

Keywords MP3Player, Android, Bluetooth, Arduino Microcontroller, DFPlayer

1. Introduction

The MP3 player can be described as an introduction of technology within the society to provide excitement, comfort, well-being and reduce depression to its listeners [1]. There has been a significant increase in the MP3 player in recent years due to higher affordability and advancement in Smartphones and tablets which allows vast connectivity [2]. The research and implementation of MP3 player are getting more popular. Much of the research attention has been given in academia. Various wireless technologies that can support some form of remote data transfer, sensing, and control such as Bluetooth, Wi-Fi, RFID, and cellular networks have been utilized to embed various levels of intelligence in the society [3]. These studies have presented a Bluetooth based MP3 player using Android Smartphones without the Internet controllability.

As technology races forward and digital toys and gadgets flood the market, the MP3 player is the most widely used technology nowadays which made it possible to compress music files that take up a 12^{th} of the disk space compared to what normal audio files consume. Although portable music players have been around for a while their storage capacities are very limited. Adding a mass storage device will allow people to carry their own personal jukebox that would provide the soundtrack to their everyday lives [4]. An example of a related work for MP3 players that only controls using hard controls buttons is found in [3]. This study described the design and implementation of MP3 player that can be operated using manual controls buttons. The controlling of the MP3 player is done through wired controls system connected to the whole system (microcontroller) feature present in it. In the song selector mode, the user will be able to punch in a number, which represents the device number. The player will then start playing it. After playing the current song, it plays the next one after that and so on. User Interaction/Control User inputs are necessary for controlling the MP3 player. The inputs will consist of 14 pushbuttons and 1 knob. The knob will control the volume. There will be 0-9 numbers, play/select, skip/next, previous, and power push buttons [5].

Due to the active acquisition of large volume of information carried out in our daily life, it was observed that there have been problems and difficulty in controlling the MP3 player using control buttons and some other

features in the day to day activities and this has caused a lot of delay in carrying out task [6]. Some of the problems characterizing the current MP3 player include the fact that it does not use an external memory card. Also, it uses inbuilt memory with less capacity of 10mb (megabyte). Moreover, there is difficulty in pressing buttons to control the MP3 player for elderly and sick patients who might need to listen to music for relaxation and encouragement. The MP3 player control buttons are not durable and so can easily get spoilt. Furthermore, the current MP3 player consumes more electricity and does not have battery storage.

The intention of this study is to design and construct an MP3 Player which can be controlled to play music using Smartphone (Android Device) via the Bluetooth interface module. So that people will find it very easy to control the MP3 player without having any difficulties. To achieve our aim, we built an MP3 player that can be easily controlled through an Android smartphone. We designed an Android software code of a controller that communicates with the system through Bluetooth module to play, pause, next, reverse songs, and to increase or decrease volume. We also simulate the circuit designed using Proteus. In summary, our aim is to develop Arduino base MP3 player that is cost-effective and easy to use and is made use of the following components that has effective operation and usage.

This study is beneficial to the society because of the Android technology very popular and can be used to interact with the embedded system. It can be used to easily control the MP3 player via Smartphone without controlling through hard control buttons. It helps to eliminate the stress associated with having to press hard buttons to control the MP3 player. Also, it can aid learning as a student can listen to audio books and recorded lectures. The MP3 player has a facility which helps to block noise from our surrounding. Our proposed system can be operated using an Android mobile phone. The controlling of the MP3 player is done wirelessly through the Android smartphone (application) via the Bluetooth features. The MP3 player is interfaced with the ATMEGA328 Arduino microcontroller using some relay drivers which can drive the MP3 player to play, pause, forward, rewind, songs, and carry out some other operations.

2. Review of Related Work

Some work has been done in the area of designing MP3 player. Ballard [5], designed and construct an MP3 player that can only be controlled using hard control buttons. His work described the designing of MP3 player that can be operated using manual controls buttons. The controlling of the MP3 player is done through wired control buttons connected to the whole system (microcontroller) feature present in it. In the song selector mode, the user will be able to punch in a number, which represents the device number. The player will go directly to that MP3 and start playing it and then play the next one after that and so on. User Interaction/Control User inputs are necessary for controlling the MP3 player. The inputs will consist of 14 push buttons and 1 knob. The knob will control the volume. There will be 0-9 numbers, play/select, skip/next, previous, and power pushbuttons.

Wu *et al* [7], developed a high-end portable music player that supports MP3 file format. Music files are read from flash-based storage (SD Card), which can take only 128mb of size and decoded through a decoder chip and played through a high-end audio DAC. They used a programmable interface controller (PIC) microcontroller. The MP3 has no means of communication with any phone/device and the SD card module have the capability of taking less memory capacity of 128mb (megabyte). Luka *et al*. [8], designed a complete embedded system for MPEG Layer III (MP3) player using an FPGA board, The FPGA will read MP3 source files, decode them into a 16-bit Pulse Code Modulated (PCM) output, and play the audio files through an external speaker.

We observed from our study of the existing works in literature that most of the existing MP3 players used control buttons, have less capacity, uses PIC Microcontroller and infrared in achieving their communication. We now decide to use an embedded system Arduino ATMEGA 328 (microcontroller) [9, 10], Smartphone and a Bluetooth module as the communication link between the smartphone and the system. One reason for this is the desire to have a large storage capacity that can store as much music as possible on a limited amount of disk space. Knowing that MP3s are compressed music files that take up 12^{th} of the disk space compared to what normal audio files consume [11-13]. Adding a mass storage device will allow people to carry their own personal jukebox that would allow them to listen to any soundtrack whenever they want.

3. Materials and Methods

The methodology used in achieving our aim in this study is as shown in the system's block diagram in figure 1 below. The materials used include the power supply unit, the DFPlayer module unit [10], the amplifier module unit, the Speaker, the Bluetooth module unit, the control unit, the display unit, the switching unit and the analog buttons control unit.

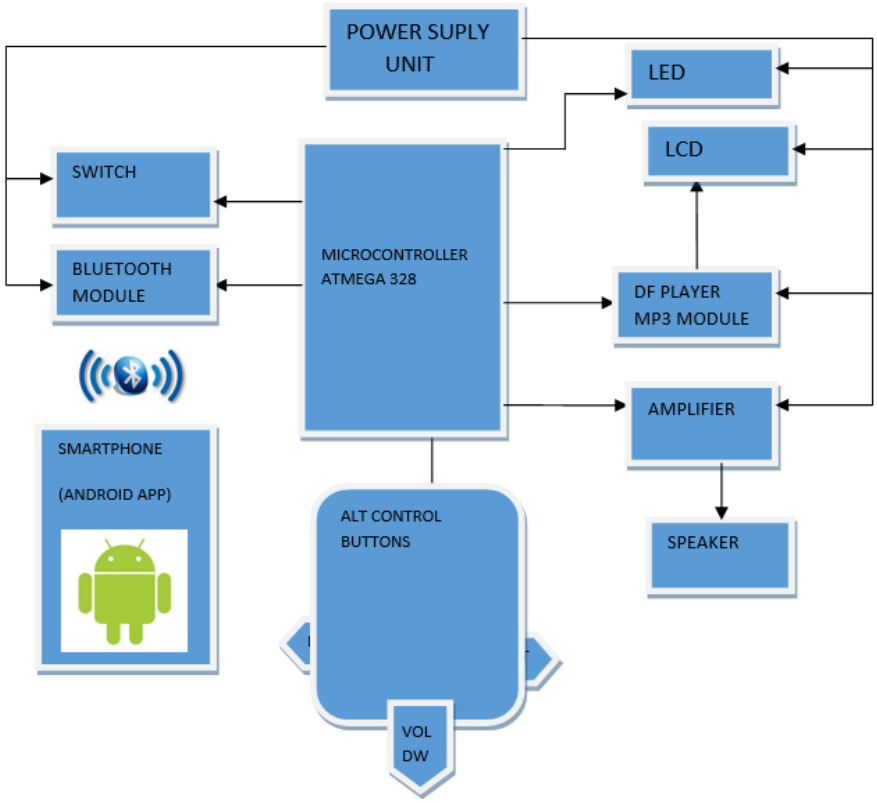

Figure 1: Block diagram

In this section, hardware components used for the study are discussed in details. The major component used here is the controlling device of the whole system which is Microcontroller Atmega328p, and others component such as Bluetooth module, LCD, transformer, speaker and DFPlayer (MP3 module) [10]. MP3 module is interfaced to the Microcontroller. A host Bluetooth device is capable of communicating with Bluetooth modules at the same time through one link. The DFPlayer (MP3 module) is used to insert the micro SD card (memory card) in accordance with the downloaded songs on it. Then using Android smartphone, the data received by the Bluetooth module from Android smartphone is fed as input to the controller which enables the device to play, pause, and change the music to the next track and listing the song through the speaker.

3.1. Design of the Study

The design of this system is depicted in the flowchart below. It shows all the MP3 player processes used in interfacing the components and devices:

The flowchart which is a pictorial representation of this study explains how the MP3 player works. When the MP3 player is power on, the system will display a welcome note and start initializing for loading the necessary information and stored songs after the memory card is inserted to the DFPlayer through the SD card interface. The control unit depends on the choice of the user, either through control push buttons or via smartphone android application. When choosing the operation to perform through a smartphone, the user will turn on his smartphone Bluetooth, search and pair the Bluetooth module for the MP3 player which the Bluetooth named as HC-05 then the user will be able to play, pause, next track, and previous track or increase and decrease volume. Below is the circuit diagram for the proposed MP3 player.

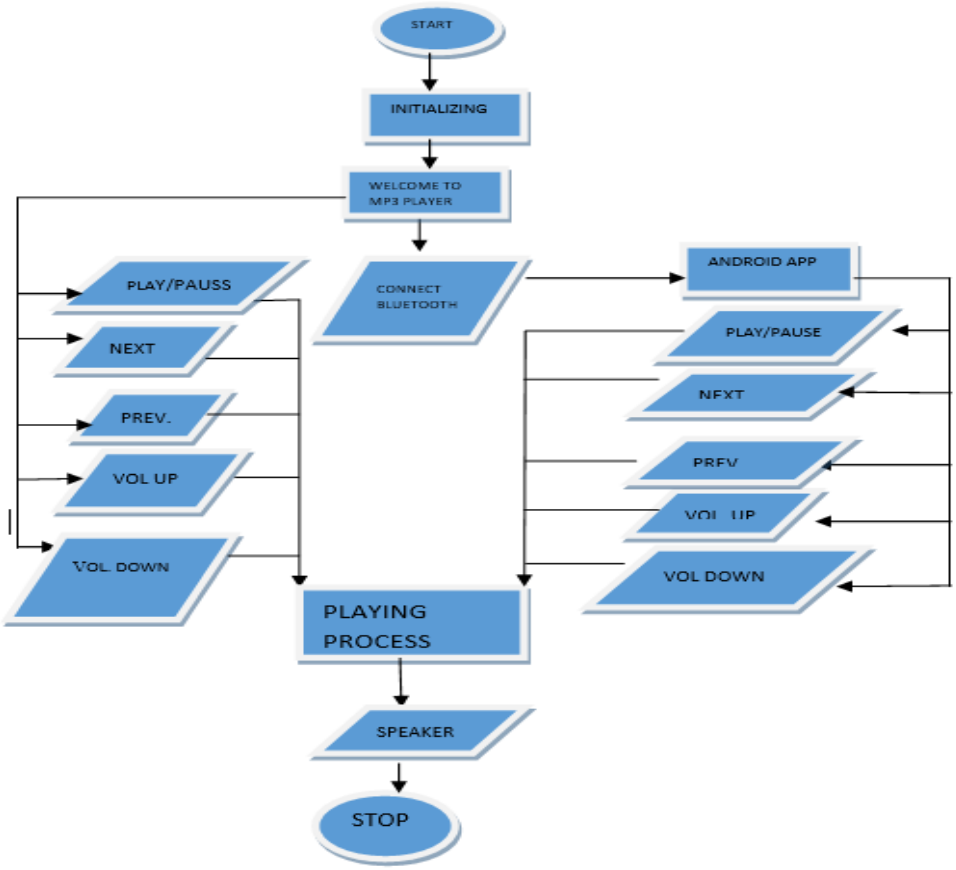

Figure 2: Flowcharts of how the MP3 player works

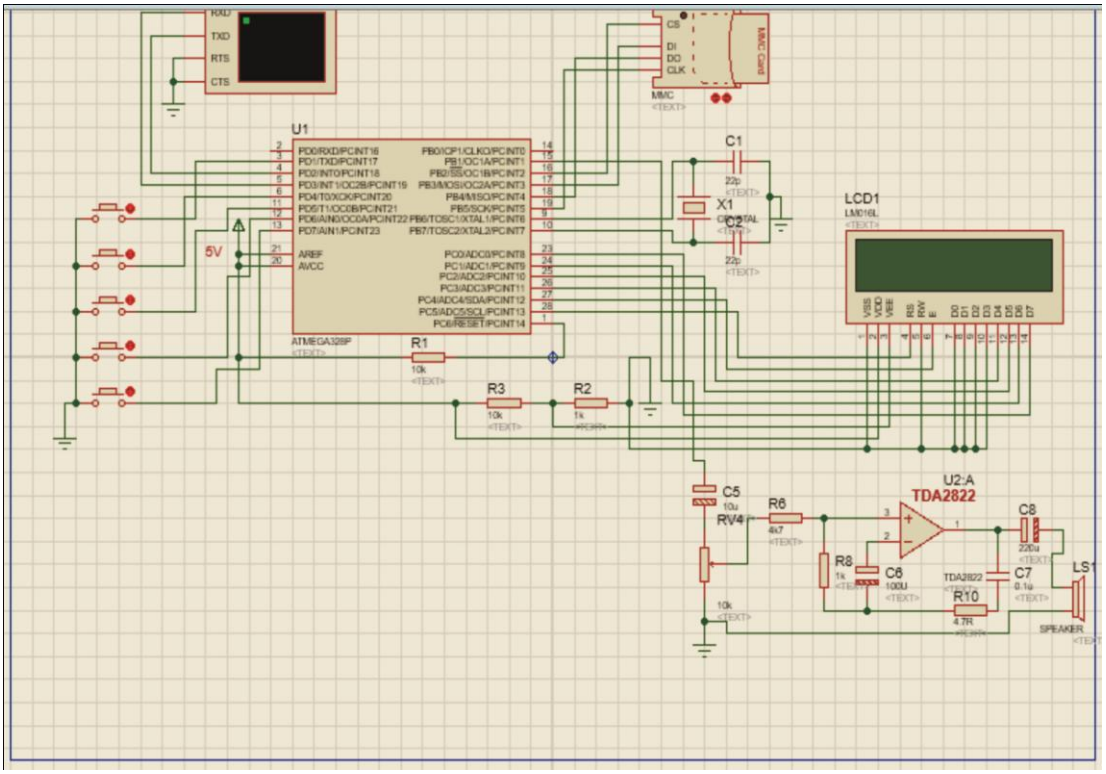

Figure 3: Circuit Diagram

3.2 Implementation of the Design

The design was implemented through software and hardware operations. The software is used for programming the Microcontrollers and simulation of the design.

3.2.1 The Hardware Section

Hardware is the physical devices and components used in the design. They include Arduino Board Microcontroller Atmega328p, Bluetooth HC-05 module, DFPlayer (MP3 module), LCD, the Amplifier and the power supply.

3.2.2 Software Section

This section provides information about the software used for designing the study and the android application used for controlling the study.

3.2.2.1 Programming language

The programming language used is Arduino which is a simplified version and compatible with both C and C++ programs. The Arduino provides the Arduino Integrated development environment (IDE), which is a cross-platform application written in Java programming language. Applications include Ardupilot, Arduinome, and Arduinophone.

3.2.2.2 Android-based Application (Arduino Bluetooth Controller)

The Arduino Bluetooth Controller is an application of the Android phone, downloadable on Google Play Store. It serves as the Controller module. It was used to reduce the complexity and size of the whole system. The user Play or Pause Buttons through the phone and Receive the input Signal the command given. The MP3 player begins to play the song' whenever the user press play from the application. The application runs on any android phone with an operating system based on the Linux Kernel [13, 14]. This was chosen due to the following features seen as advantages; Android 4.2 Operating System, 1GB Ram and 1.3GHz Quad-core processor.

3.2.2.3 Android Bluetooth receiver

This device interfaces the given commands to the controller. It is pre-configured as a slave Bluetooth device. Once it is paired with a master Bluetooth device such as a PC, and tablet, its operation becomes transparent to the user. No user code specific to the Bluetooth module is needed at all in the user microcontroller program.

3.2.2.4 Execution program

Here a summary of the command instructions written in the Arduino programming environment and intended response for the system is displaced.

Table 1: Summary of Execution Program

Command	Response of system4
“Left”	Change to Previous track
“Right”	Change to Next Track
“Up”	Vol. Up (Increase volume)
“Down”	Vol. Down (Decrease Volume)
“Pause	Pause the Track
“Play	Play the Track
“Stop”	System stops operating

4. Results, Test and Discussion

The first aspect of the construction was electrical circuit design which was assembled on a breadboard after it was set properly on the breadboard to see that it works fine in order to avoid mistake or mismatch. Later on, it was transferred to a Vero board. The Vero board was split into sections which include power supply unit, transmitter/receiver unit (for the Bluetooth module), audio interface unit (MP3 module) and microcontroller unit section. Before the components were soldered on the Vero board, the strip lines of the Vero board were cleaned with a razor blade to remove any grease, oxidation, oil, and dirt. The capacitors, crystal capacitors, resistors, and diodes, as well as connecting terminals, were carefully connected using soldering iron and soldering flux on the Vero board to avoid damaging the integrated circuit (IC) sockets that were used.

On the process of soldering the components on the Vero board, attention and care were taken to minimize component damage due to excessive heat from soldering iron. Also, adequate attention was taken to avoid short-

circuit between adjacent copper strips on the Vero board during soldering. In order to avoid possible short circuits, discontinuity of the copper strips was created when necessary; this is done by cutting the copper strips where necessary.

4.1. Testing

The testing was done on each and every components/ section that make up the circuit to ensure proper and satisfactory operation of the MP3 player with the MP3 module. The hardware units of the system were tested to ensure that they were in good working condition. Then, each and every unit was interfaced and implemented individually with the microcontroller board and driven with the software according to the necessity of the application. The testing of the application was not done at once after it was completed. Rather each unit of the application was tested individually. The second unit was not tested until the first unit gave the expected result and until it was confirmed to be working according to specifications.

After it has been confirmed that all of the units were working correctly, the units were connected together and then the whole system was developed and tested. It was easy to figure out the bugs in the system as the behaviour of each unit was known while testing it. After the hardware units were tested, the communication of the Android Bluetooth application with the Bluetooth module was also tested.

4.1.1. Testing of the MP3 Module (DFPlayer)

The ascertain that the MP3 module is working correctly, it was tested by connecting the circuit on a breadboard.A micro SD card (2gb) with 100 songs downloaded on it was inserted to the MP3 Module. A speaker was connected to the MP3 module pin 4 and 6. When the system is powered ON, the player is initialized, and it starts playing the first track of song from the memory card. The simulation of a working MP3 player is depicted in the figure below.

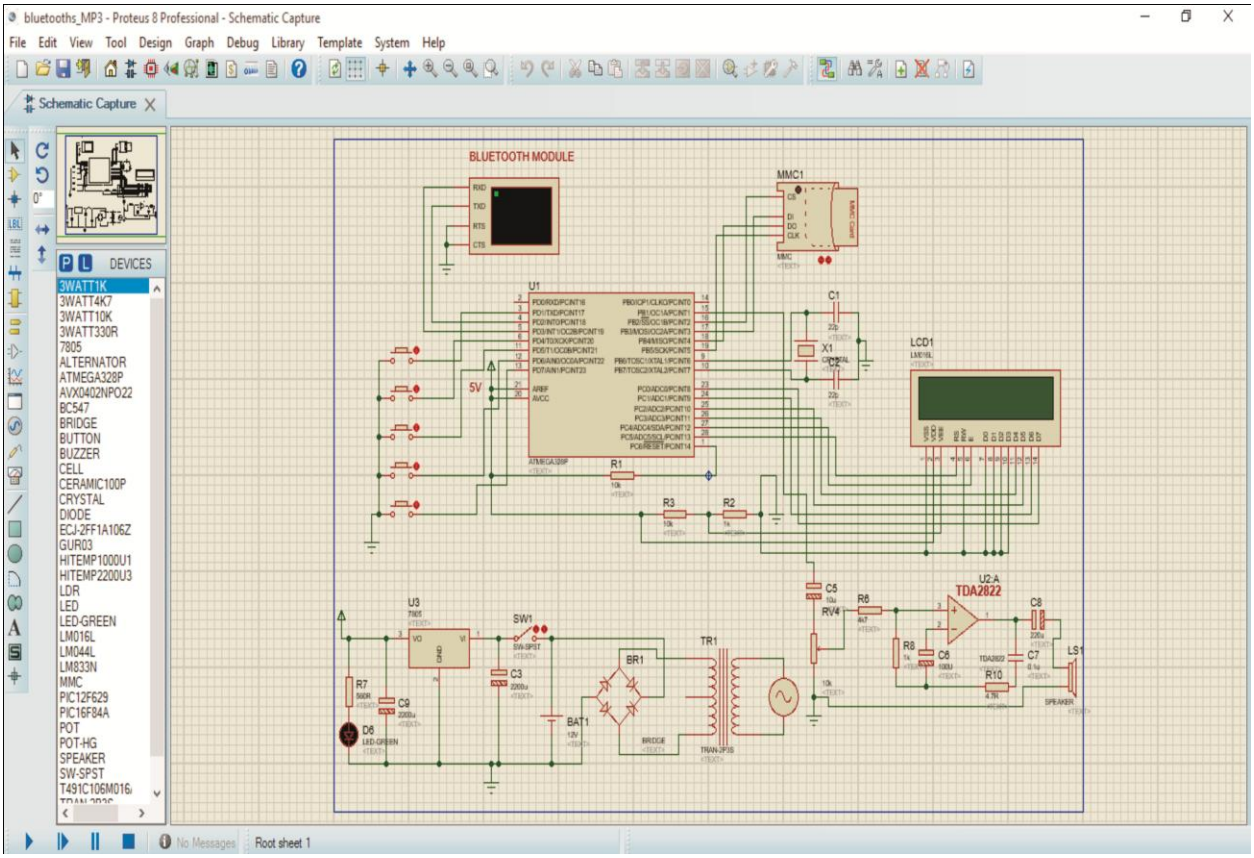

Figure 4: The Simulation of a Working MP3 Player

4.1.2 Testing of the Bluetooth Module

The Bluetooth module was tested by connecting the circuit on a breadboard. After the system was powered ON at the same time with Bluetooth module, the Bluetooth module with its pair name known as HC-06 and visibility was set to automatic visible waiting for a device to pair.

4.1.3 Testing Arduino Bluetooth Control Application

To carry out this testing, the Arduino Bluetooth application was installed on the Android smartphone. When the application started, it will begin to search for visible Bluetooth device and then paired. After it is paired, the communication between the Arduino Bluetooth module and Android application is ready for transmission. Now its process of controlling the ArduinoMP3 player via an Android smartphone, while the control soft keys are as follows:

- Arrow up= increase volume
- Arrow down = decrease volume
- Arrow front= next track
- Arrow back= previous track
- Middle soft button= play/pause

4.2 Discussion Of Results

The MP3 Shield/module has seven buttons and a UART interface, that is to say, the user has two ways to control the module flexibly. The UART interface is connected to the Arduino hardware UART by default. Since most Arduino boards have only one UART interface, this module's UART interface can be redefined to Arduino D7 (TX) and D8 (RX) through the jumpers on board. With Soft Serial lib, Arduino could also send data to this module. The microcontroller unit responds to the instructions sent by the Android Smartphone according to the necessity of the application as well as playing the song, moving the song to the next and previous track, and increasing and decreasing volume. Table 2 below represents the results for voltage measurement and power consumption.

Table 2: Current-voltage measurement and power consumption

Component	Design Value	Standard Value	Measurement
Resistor	10k Ω	10k Ω	9.8k Ω
Atmega328	+5v	+5v	+4.98k Ω
MP3 module	3.3v	3.3v	2.98 k Ω
Amplifier	1.77A	1.77A	1.75A
Battery	12v	12v	8.95k Ω

Where the Battery runtime, W= (V x Amp)/1000

Power consumption in Watts= Amp x Volt

Watts = 9x12=108watts/hr

Battery Should discharge up to 80% of its capacity, 80% of 108watts/hr

=80/100x108

=86watts/hr

The table below shows the result for the duration required for the battery to be fully charged when the MP3 player is ON and When is OFF.

Table 3: Battery duration for the full charge

When the MP3 player is working	It takes up to 4hrs
When the MP3 player is switched off	It takes up to 2hrs 30min

The below table shows the result for the duration when the MP3 player is working depending on the level of the volume

Table 4: Result of Test for battery duration when

Volume Level	Duration
Volume at a high level	Approximately 4hrs
Volume at a medium level	Approximately 5hrs 30min
Volume at a low level	Approximately 8hrs

The result of our test shows that the Bluetooth range of the MP3 player is around 10m.When Bluetooth connection is far from the precise range, the connection will be disconnected. The constructed MP3 player is in figure 5 below.

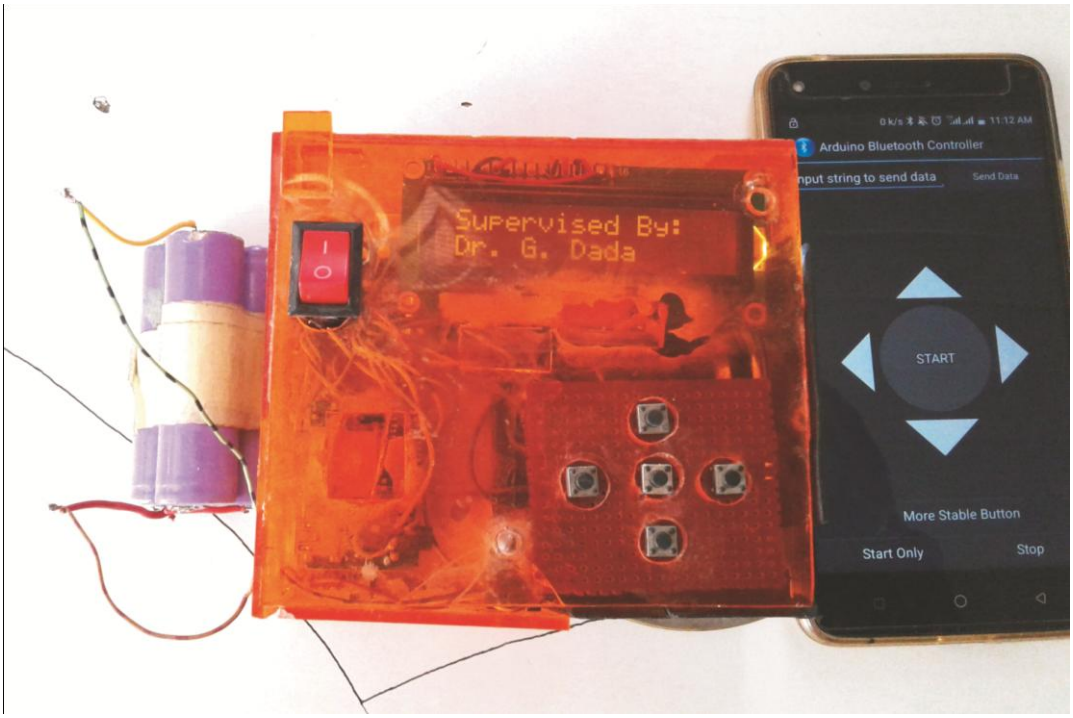

Figure 5: MP3 Player after Construction

5. Conclusion

In this study, an MP3 player device was designed and constructed using relatively cheap components. The different units were tested and confirmed to be working properly. The product of this research is an MP3 player that proffers solution to the challenges associated with the existingMP3 players. Some of the drawbacks of the existing MP3 players is that they require the user to upload the MP3 data from a computer to the player before the player could be used. Our proposed MP3 player can play the MP3s that are stored on the external storage device using Android Bluetooth. This is a noticeable benefit due to their small size. We conclude by stating that the final outcome of this study that was produced was a fully functional Android Bluetooth controlled MP3 player. It has the capacity to play MP3 files. The quality of the sound that is produced is good and no external noise interfered with the sound produced by the MP3 player. In general, the player is user-friendly and very entertaining to use.

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