

# **IOT AND GREEN ENERGY BASED WIRELESS PACE MAKER CHARGER DEVELOPMENT WITH EMERGENCY CUT-OFF SYSTEM**

Submitted in partial fulfillment of the requirements for the award of

Master of Technology degree in Medical Instrumentation

by

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**DEPARTMENT OF BIOMEDICAL ENGINEERING**

**SCHOOL OF BIO AND CHEMICAL ENGINEERING**

## **SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC**

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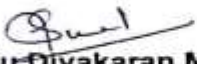
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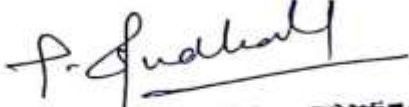
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## DEPARTMENT OF BIOMEDICAL ENGINEERING

### BONAFIDE CERTIFICATE

This is to certify that this Project report is the bonafide work of **Adith Raghunath**(Reg. No. **41440001**) who carried out the project entitled "**IOT And Green Energy Based Wireless Pace Maker Charger Development With Emergency Cut-Off System**" under our supervision from **November 2022 to April 2023**.

  
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## DECLARATION

I, **Adith Raghunath** (Reg. No. **41440001**) hereby declare that the Project report entitled **"IOT And Green Energy Based Wireless Pace Maker Charger Development with Emergency Cut-Off System"** done by me under the guidance of **Ms. Sindu Divakaran, ME.,(Ph.D.,)** Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

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## **ABSTRACT**

The transcutaneous power transfer for the Pacemaker of the heart can be done by the principle of mutual induction. The primary coil and secondary coil present in this transformer should be positioned in such a way to enable the transfer of power from the transmitter section to the receiver section wirelessly. The mutual induction process will take place when we keep both the coils parallel. The receiver coil should be positioned inside of the body and the transmitter coil should be positioned outside of the body. The voltage regulator will provide or regulate the required output voltage. The Internet of things technology is used here to observe the charging level of the battery. The inductive power transfer method eliminates the risk of infection caused due to surgery along with that other parameters as Solar Panels are used as a renewable source to charge the batteries and is also added if abnormalities are detected, we immediately cut off the charging unit.

**Keywords:** Pace Maker, Wireless Charger, Internet of Things, Solar Panel , Renewable Energy.

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## LIST OF ABBREVIATIONS

|       |                                                |
|-------|------------------------------------------------|
| AVB   | Atrioventricular block                         |
| ATP   | Atrial triggered pacemaker                     |
| ADC   | Antibradycardia                                |
| BT    | Bluetooth                                      |
| CC    | Cloud Connectivity                             |
| DP    | Demand Pacing                                  |
| DCD   | Dual-chamber device                            |
| EMW   | Electromagnetic wave                           |
| IOT   | Internet of things                             |
| ICWPT | Inductive coupling wireless power transmission |
| MF    | Magnetic field                                 |
| NR    | Non-radiative                                  |

|      |                                         |
|------|-----------------------------------------|
| PCM  | Pacemaker                               |
| RF   | Radio Frequency                         |
| RS   | Renewable source                        |
| RE   | Renewable energy                        |
| SHZ  | Synchronization                         |
| SND  | Sinus node disease                      |
| SSS  | Sick sinus syndrome                     |
| SM   | Serial monitor                          |
| TP   | Transcutaneous Power                    |
| WF   | Wi-Fi                                   |
| WC   | Wireless charger                        |
| WPCN | Wireless powered communication networks |
| WPT  | Wireless power transfer                 |

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## CHAPTER-1

### INTRODUCTION

The basic function of the pacemaker is to pace the heart in the absence of intrinsic impulses and to recognize intrinsic cardiac electrical activity if present and restrain pacing consequently. Systems such as implantable cardiac pacemaker have benefited millions of people. These devices are usually used to treat patient who suffers from a disease called arrhythmia. They can be implanted temporarily to treat a slow heartbeat after a heart attack, surgery or medication overdose. Or they can be implanted permanently to correct a slow or irregular heartbeat or, in some people, to help treat heart failure. However, there is a constraint for power supply L. Xie, et.al.,(2013). The current implantable pacemaker is powered with lithium iodine battery, which can last from 5 to 10 years or more – on the average about seven years. Once, the battery is fully drained, patient must be advised to replace the pacemaker with a new unit, which is carried out by a surgery. To overcome this limitation, this paper proposes a Inductive coupling wireless power transmission (ICWPT) method, IC-WPT works on principle of mutual induction, where an electromotive force is produced due to varying magnetic field in an electrical conductor. The IC-WPT technique with rechargeable lithium-iodine battery can solve our problems of power supply. And it also avoids the risk related to surgery and post-surgery infection. Wireless charging also known as wireless power transfer, is the technology that enables a power source to transmit electromagnetic energy to an electrical load across an air gap, without interconnecting cords S. Ulukus, et.al.,(2020). This technology is attracting a wide range of applications, from low-power toothbrush to high-power electric vehicles because of its convenience and better user experience. Nowadays, wireless charging is rapidly evolving from theories toward standard features on commercial products, especially mobile phones and portable smart devices. In 2014, many leading smartphone manufacturers, such as Samsung, Apple and Huawei, began to release new-generation devices featured with built-in wireless charging capability. IMS Research envisioned that wireless charging would be a 4.5 billion market by 2016.

- Firstly, it improves user-friendliness as the hassle from connecting cables is removed. Different brands and different models of devices can also use the same charger.
- Secondly, it renders the design and fabrication of much smaller devices without the attachment of batteries.
- Thirdly, it provides better product durability (e.g., water- proof and dustproof) for contact-free devices.
- Fourthly, it enhances flexibility, especially for the devices for which replacing their batteries or connecting cables for charging is costly, hazardous, or infeasible (e.g., body-implanted sensors).
- Fifthly, wireless charging can provide power requested by charging devices in an on-demand fashion and thus are more flexible and energy-efficient.

Nevertheless, normally wireless charging incurs higher implementation cost compared to wired charging. First, a wireless charger needs to be installed as a replacement of traditional charging cord Laavanya rachakonda (2019). Second, a mobile device requires im-plantation of a wireless power receiver. Moreover, as wireless chargers often produce more heat than that of wired chargers, additional cost on crafting material may be incurred.

The development of wireless charging technologies is advancing toward two major directions, i.e., radiative wireless charging (or radio frequency (RF) based wireless charging) and non-radiative wireless charging (or coupling-based wireless charging). Radiative wireless charging adopts electro- magnetic waves, typically RF waves or microwaves, as a medium to deliver energy in a form of radiation. The energy is transferred based on the electric field of an electromagnetic wave, which is radiative. Due to the safety issues raised by RF exposure, radiative wireless charging usually operates in a low power region. For example, omni-directional RF radiation is only suitable for sensor node applications with up to 10mW power consumption. Alternatively, non- radiative wireless charging is based on the coupling of the magnetic-field between two coils within the distance of the coils' dimension for energy transmission. As the magnetic- field of an electromagnetic wave attenuates much faster than the electric field, the power transfer distance is largely limited S. Sudevalayam,et.al,(2011).

The emerging wireless charging systems with regard to the fundamental technologies Ravi Jon, et.al(2019), international standards as well as applications in wireless issues in RF- powered wireless networks with the focus on the receiver-side (i.e., energy harvester) designs. This survey differs from in the following aspects: this survey i) covers various major wireless charging techniques, namely, inductive coupling, magnetic resonance coupling and RF/microwave radiation, from fundamental principles to their applications, ii) reviews the existing international standards, commercialization and implementations, and iii) emphasizes on the transmitter-side (i.e., wireless charger) strategy designs for different types of network applications. Another recent survey in provides an overview of self-sustaining wireless communications with different energy harvesting techniques, from the perspective of information theory, signal processing and wireless networking Pau redon (2021). Unlike this survey focuses on the wireless charging strategies in communication networks with wireless energy harvesting capability, also referred to as wireless powered communication networks (WPCNs).

Inside a pace maker it consists of a pulse generator, which has a battery and a tiny computer circuit, and 1 or more wires known as pacing leads, which attach to your heart. The pulse generator emits electrical impulses through the wires to your heart Aamir Arsalan and Syed Muhammad (2022). The rate at which the electrical impulses are sent out is called the pacing rate. Basic Function Modern pacemakers usually have multiple functions. The most basic form monitors the heart's native electrical rhythm. When the pacemaker wire or "lead" does not detect heart electrical activity in the chamber – atrium or ventricle – within a normal beat-to-beat time period – most commonly one second – it will stimulate either the atrium or the ventricle with a short low voltage pulse. If it does sense electrical activity, it will hold off stimulating. This sensing and stimulating activity continues on a beat by beat basis and is called "demand pacing" S. Ulukus,3(2015). In the case of a dual-chamber device, when the upper chambers have a spontaneous or stimulated activation, the device starts a countdown to ensure that in an acceptable – and programmable – interval, there is an activation of the ventricle, otherwise again an impulse will be delivered

**Table 1.1: The revised NASPE/BPEG generic code for antibradycardia pacing**

| Chamber(s)     | Chamber(s)     | Response to sensing | Sensed Response to sensing | Rate modulation |
|----------------|----------------|---------------------|----------------------------|-----------------|
| O = None       | O = None       | O = None            | O = None                   | O = None        |
| A = Atrium     | A = Atrium     | T = Triggered       | R = Rate modulation        | A = Atrium      |
| V = Ventricle  | V = Ventricle  | I = Inhibited       |                            | V = Ventricle   |
| D = Dual (A+V) | D = Dual (A+V) | D = Dual (T+I)      |                            | D = Dual (A+V)  |

From this the basic ventricular "on demand" pacing mode is VVI or with automatic rate adjustment for exercise VVIR – this mode is suitable when no synchronization with the atrial beat is required, as in atrial fibrillation. The equivalent atrial pacing mode is AAI or AAIR which is the mode of choice when atrioventricular conduction is intact but the sinoatrial node of the natural pacemaker is unreliable – sinus node disease (SND) or sick sinus syndrome. Where the problem is atrioventricular block (AVB) the pacemaker is required to detect (sense) the atrial beat and after a normal delay (0.1–0.2 seconds) trigger a ventricular beat, unless it has already happened – this is VDD mode and can be achieved with a single pacing lead with electrodes in the right atrium (to sense) and ventricle (to sense and pace).

These modes AAIR and VDD are unusual in the US but widely used in Latin America and Europe xiao zhang (2021). The DDDR mode is most commonly used as it covers all the options though the pacemakers require separate atrial and ventricular leads and are more complex, requiring careful programming of their functions for optimal results.

Automatic pacemakers are designed to be over-ridden by the heart's natural rate at any moment that it gets back to a non-pathologic normal sinus rhythm and can reinitiate influencing the electric activity in the heart when the pathologic event happens again. A "ventricular -demand pacemaker" produces a narrow vertical spike on the ECG, just before a wide QRS. The spike of an "atrial -demand pacemaker" appears just before the P wave. Comparably, a Triggered

Pacemaker is activated immediately after an electrical activity is commenced in the heart tissue by itself. A "ventricular triggered pacemaker" produces the impulse just after a pulse is created in the ventricular tissue and it appears as a simultaneous spike with QRS. An "atrial triggered pacemaker" is the mode in which an impulse is produced immediately after an electrical event in the atrium. It appears as a discharge following the p wave but prior to the QRS which is commonly widened.

## CHAPTER-2

### LITERATURE SURVEY

Aamir Arsalan and Syed Muhammad (2022) wearable sensor-based methods commonly use data from electroencephalography, electrocardiogram, galvanic skin response, electromyography, electrodermal activity, heart rate, heart rate variability, and photoplethysmography both individually and in multimodal fusion strategies. Whereas, methods based on non-wearable sensors include strategies such as analyzing pupil dilation and speech, smartphone data, eye movement, body posture, and thermal imaging.

Min wu and Hong cao (2019) integrated two modalities of sensors, i.e., HRV sensors And accelerometers, to monitor the perceived stress levels in daily life. We first extracted features from the sensory data and then applied 4 existing machine learning methods for stress inference.

Laavanya rachakond and Prabha sundaravadi vel (2018) electronics Implementation of this approach uses temperature, humidity and accelerometer sensors. The detected stress value is then classified to three levels: low, normal and high. The ease of accessing the data off-line is provided by an IoMT cloud implementation.

Talha Iqbal and pau redon (2021) In this paper, several frequently used key indicators of stress, such as heart rate, respiratory rate, skin conductance, RR interval, heart rate variability in the electrocardiogram, and muscle activation measured by electromyography, are evaluated based on a detailed statistical analysis of the data gathered from an already existing, publicly available WESAD (Wearable Stress and Affect Detection) dataset.

Ning jin a and xiao zhang (2021) The life quality of sportsmen is improved by detecting huge potential known to be stress for preventing and managing the diseases. a real-time detection framework is proposed for analysing the level of stress for a particular sports person. The proposed framework consists of a hybrid

classification technique named Multi- Output Regression (MOR) with Deep Convolutional Neural Networks (DCNN) to analyse and identify various stress levels and its relationship with data of HRV.

Laavanya rachakonda (2019) it monitors stress levels in a person through human body temperature, rate of motion and sweat during physical activity

Dhruv r and seshadria (2019) This review discusses the application of wearable sensors to monitor human performance assessment to track and monitor physiological parameters, such as heart rate, distance, sleep and Stress.

Keerthana (2020) This paper urges a Multi-level function Framework planted on vest of the soldiers. This framework envelops several information in a single knob, comprising physiology, emotions, fatigue, environment and locations.

W.B.P.N.Hearth (2021) to identify the mental stress of patients through their skin conductivity. Galvanic Skin Response sensor for the bed ridden elderly and identify the relationship between body temperature, heart rate and GSR of them.

Erick vavrinsky viera (2021) The results will be obtained from several physiological variables including electrodermal activity, heart rate and respiration, body temperature, blood pressure and others. Trends towards the production of new telemedicine equipment.

M.muthesswari (2015) This paper presents a method to charge the cardiac pacemaker over a wireless link by magnetic induction. Antenna is used here as a primary and secondary coil which works based on the inductive coupling principle. Through this technology we can reduce the wires or we eliminate the complications and infections caused by the wires. The aim of the system is to transfer the power efficiently to the battery of the pacemaker and automatically charge when battery charge is low. We studied the inductive coupling and coupling coefficient of the primary and secondary coil and we studied the electrical characteristics of the antenna with equivalent circuit.

Quan Xiong<sup>1</sup> (2015) To overcome the limitation of energy supply for artificial cardiac pacemaker, this paper investigated a wireless charging device based on the magnetic coupling resonant wireless transfer (MCR-WPT) technique. We designed the bilayer coupled coils for energy transmission, which had twice power factor than monolayer coils. The frequency is 200 kHz when the MCR-WPT system was in resonance. Furthermore, we put the titanium alloy case behind the receiver coil to simulate the environment of artificial cardiac pacemaker.

Abinaya (2021) The vast majority of the modernized implantable devices and Biosensors are set inside a patient's body. To overcome this constraint, in this paper we have designed a rechargeable battery with wireless power transfer technique. The transdermal power transfer for the Pacemaker which is placed inside the heart should be possible by the concept of mutual inductance. The receiver loop ought to be situated inside the body and the transmitter coil ought to be situated outside of the body. The voltage controller will give or manage the necessary yield (output) voltage. The experiments were conducted on wireless charging through pork tissues reveal that from a 3.919-mw power source, 3.072-mw power can be received at 300kHz, reaching a high wireless power transfer efficiency of 78.4%, showing that the charging is very fast.

Xian (2021) The utility model discloses a wireless charger of a cardiac pacemaker, which comprises a hardware part, an external power transmitting part and an internal power receiving part. The external power transmitting part mainly comprises a direct current power supply, a full-bridge inversion module, a transmitting coil, an MCU, a sampling module, a Bluetooth chip and the like. The direct-current power supply and the transmitting coil are connected through the full-bridge inversion module, the MCU is connected to a gate pole of the MOSFET of the full-bridge inversion module through pins, and the MOSFET is controlled to invert direct-current voltage. The sampling module is connected with the MCU through the ADC, and the sampling information is transmitted to the main control chip. The Bluetooth chip and the MCU are connected through the UART.

Houda Bougrine (2017) In order to surpass the energy supply limit and its drawbacks, the idea of wireless charging for artificial cardiac pacemaker is discussed. Since there are many ways of delivering power wirelessly with various

advantages and disadvantages, only one will be considered because it is best suited for medium frequency devices that need quick and efficient charging, while being completely harmless to humans. The wireless power transfer (WPT) technique investigated in this paper is the inductive coupling. This technique is based on coupling two main coils (inductors); one that transmits power generated in a first circuit, and another that receives it and delivers it to the pacemaker through a second circuit. Throughout this paper, the aim is to find the optimum way to charge the pacemaker wirelessly and at the same time minimize its size by reducing the battery design criteria.

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The transdermal power transfer for the Pacemaker which is placed inside the heart should be possible by the concept of mutual inductance. The receiver loop ought to be situated inside the body and the transmitter coil ought to be situated outside of the body. The voltage controller will give or manage the necessary yield (output) voltage. The experiments were conducted on wireless charging through pork tissues reveal that from a 3.919-mw power source, 3.072-mw power can be received at 300kHz, reaching a high wireless power transfer efficiency of 78.4%, showing that the charging is very fast. The vast majority of the modernized implantable devices and Bio-sensors are set inside a patient's body. To overcome this constraint, in this paper we have designed a rechargeable battery with wireless power transfer technique. The transdermal power transfer for the Pacemaker which is placed inside the heart should be possible by the concept of mutual inductance. The receiver loop ought to be situated inside the body and the transmitter coil ought to be situated outside of the body. The voltage controller will give or manage the necessary yield (output) voltage.

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Patel BR (2018) Many of the modern bio-sensors and bio-implants are placed inside a patient's body. Hence a question arises for the supply of device which is placed for a long term basis. To overcome the limitation of artificial cardiac pacemaker in terms of source replacement after expiry, this paper present a method to eradicate the surgical technique in order to place a rechargeable source for artificial cardiac pacemaker. For this, a transmitter, which is outside patient's body, and receiver which is inside circuit of pacemaker, is used to deliver power to artificial cardiac pacemaker based on principle of magnetic induction.

Dinging wing (2022) Wireless charging devices for implantable cardiac pacemakers have not been clinically applied. For actual applications, safety assessments of a wireless charging system must be conducted. For systems with a certain power, frequency is one of the important factors that directly affect safety. This paper aims to study the safety evaluation method and optimal operation frequency of a cardiac pacemaker wireless charging system. The wireless power transfer (WPT) model considering the coils' AC resistance is established, which is more in line with the actual situation. The analytical solution to the current in coupling coils is derived, which reveals the effect of the frequency. The currents used in electromagnetic and thermal simulations are calculated or measured for different charging prototypes. A safety evaluation method that comprehensively considers specific absorption rate (SAR), electric field, efficiency, temperature rise and electromagnetic interference (EMI) is proposed. In particular, the temperature rise is an innovative perspective as it has rarely been studied in previous literatures.

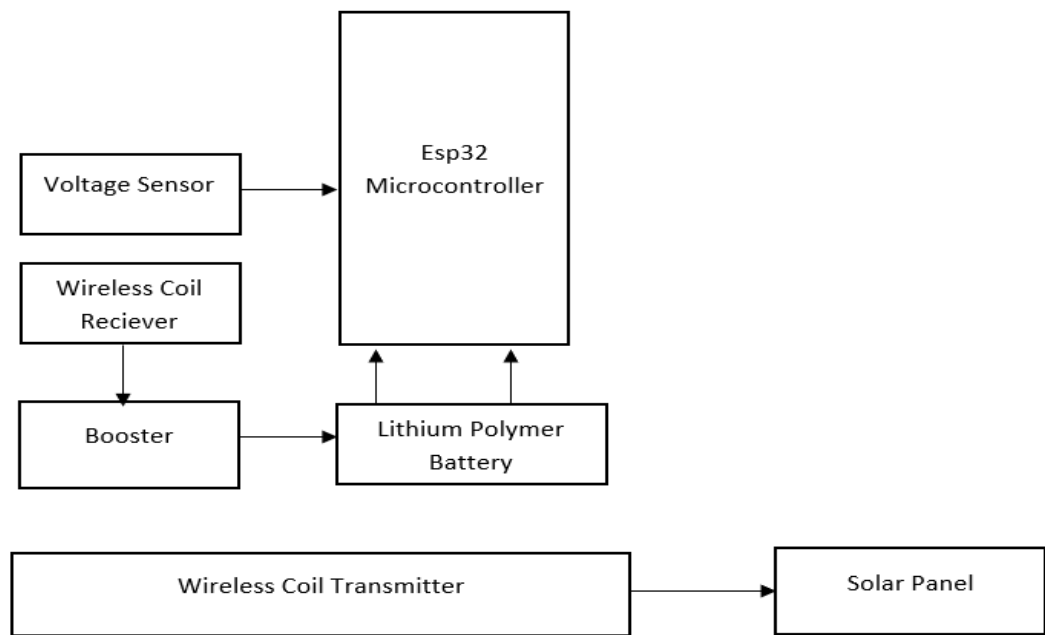
## CHAPTER-3

### AIM AND SCOPE

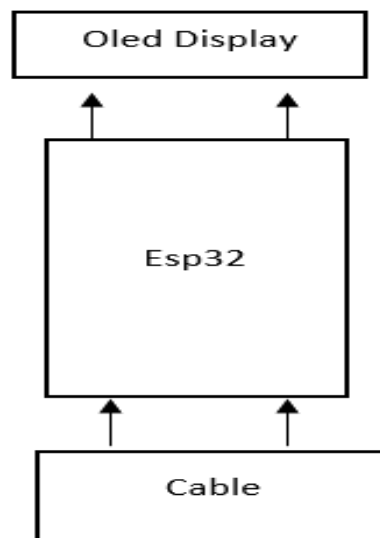
Aim of the present work is to develop the Transmitter circuit is to transform the received voltage into high-frequency alternating current. After the high-frequency current is generated by the transmitter circuit it is fed to the transmitting coil in the very circuit. As the high-frequency alternating current is relinquished through the coil, it induces the magnetic field in the coil and the coil now operates as an electromagnet in accordance with the 2 and Law of Electromagnetic Induction. Now, as the magnetic field in one coil changes, and if the other coil is placed in the sufficiently close distance, the emf will be inducted into the neighbouring coil. The alternating current induces alternating flux in the transmitting coil which induces an alternating magnetic flux in the core. As the core extends through secondary so some magnetic flux is linked with secondary also. Now, again the same reversed phenomenon will take place, the induced magnetic field in the receiver coil will generate the alternating current into the receiver circuit in accordance with the faradays Law of induction. Hence the energy is transmitted from the transmitter circuit to the Receiving circuit through induction or coupling. Now in the last step, the induced alternating current is converted into required DC Voltage through a series of filters and Rectifier. At last, the Stable current is fed into the battery for charging. Consequently, in this way, the wireless charging takes place.

#### 3.1. BLOCK DIAGRAM

In our Proposed System ESP32 Microcontroller is the heart of the project where all the Inputs and Outputs are connected which has inbuilt Bluetooth and Wifi Module along with that the transcutaneous power transfer for the Pacemaker of the heart can be done by the principle of mutual induction. The primary coil and secondary coil present in this transformer should be positioned in such a way to enable the transfer of power from the transmitter section to the receiver section wirelessly. The mutual induction process will take place when we keep both the coils parallel. The receiver coil should be positioned inside of the body and the transmitter coil should be positioned outside of the body.



***Fig 3.1:Block diagram of the of the proposed system***



***Fig 3.2:Block diagram of the oled display***

## 3.2 EXISTING SYSTEM

The current implantable pacemaker is powered with a lithium-iodine battery, which can last from 5 to 10 years or more – on the average about seven years. Once, the battery is fully drained, the patient must be advised to replace the pacemaker with a new unit, which is carried out by surgery. Major complications of surgeries include malfunction due to mechanical factors such as pneumothorax, pericarditis, infection, skin erosion, hematoma, lead dislodgment, and venous thrombosis which can sometimes be life threatening.

### 3.2.1 *Disadvantages*

- The battery should be replaceable with in years
- It will cause many complications while removing
- While removing the leads there will be even more complications

## 3.3 PROPOSED SYSTEM

In our proposed system ESP32 Microcontroller is the heart of the project where all the Inputs and Outputs are connected which has inbuilt Bluetooth and Wifi Module along with that the transcutaneous power transfer for the Pacemaker of the heart can be done by the principle of mutual induction. The primary coil and secondary coil present in this transformer should be positioned in such a way to enable the transfer of power from the transmitter section to the receiver section wirelessly. The mutual induction process will take place when we keep both the coils parallel. The receiver coil should be positioned inside of the body and the transmitter coil should be positioned outside of the body. The voltage regulator will provide or regulate the required output voltage. The Internet of things technology is used here to observe the charging level of the battery. The inductive power transfer method eliminates they should risk of infection caused due to surgery along with that other parameters as Solar Panels are used as a renewable source to charge the batteries.

### **3.3.1 Advantages**

- It can be recharged anytime where ever you want and can monitored from where you are and be can be monitored by the doctors.
- The battery can be charged without removing it
- The process is done wireless
- Low cost because of the use green energy

## CHAPTER – 4

### MATERIALS AND METHODS

#### 4.1 WIRELESS CHARGING

Wireless charging also known as wireless power transfer, is the technology that enables a power source to transmit electromagnetic energy to an electrical load across an air gap, without interconnecting cords. This technology is attracting a wide range of applications, from low-power toothbrush to high-power electric vehicles because of its convenience and better user experience Macharia J (2017). Nowadays, wireless charging is rapidly evolving from theories toward standard features on commercial products, especially mobile phones and portable smart devices.

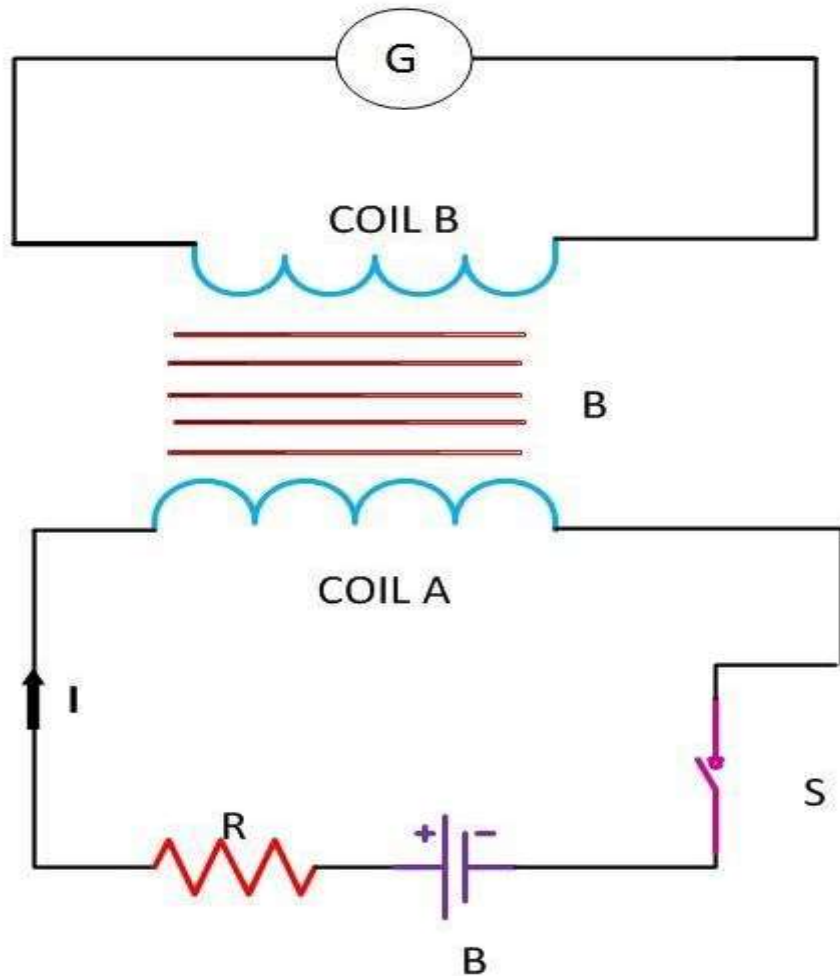
##### ***4.1.1 Mutual inductance***

Mutual Inductance is the basic operating principle of the motors, transformers, generators and any other electrical component that interacts with another magnetic field Farid Jolani,et.al,(2020). Then we can define mutual induction as the current flowing in one coil that induces an EMF in a neighbouring coil.

Hence the Mutual Induction is defined as a property of two coils by the virtue of which each coil opposes the change in the strength of the current flowing through the other by inducing an emf in itself Macharia J (2017). (or in simple words, whenever magnetic flux linked with one coil changes, an emf is induced in the neighbouring coil.)

If one coil is positioned very close to the other coil, Ravi Jon,et al., (2015) then nearly all of the magnetic flux generated by the first coil will interact with the coil turns of the second coil inducing a relatively large emf and therefore producing a large mutual inductance value.

If the distance between the coils is considerably large the small amount of magnetic flux from the primary will link with the coil turn of the secondary coil, inducing a small emf in the secondary coil.



**Fig 4.1: Circuit diagram of mutual induction**

## 4.2 CONCEPT OF WIRELESS CHARGING

The steps associated with the process of Wireless Charging are:

The complete charging process has two circuits that are the:

- Transmitter Circuit
- Receiver Circuit

The purpose of the Transmitter circuit is to transform the received voltage into high-frequency alternating current. After the high-frequency current is generated by the transmitter circuit it is fed to the transmitting coil in the very circuit. As the high-frequency alternating current is relinquished through the coil, it induces the magnetic field in the coil and the coil now operates as an electromagnet in accordance with the 2 and Law of Electromagnetic Induction. Now, as the magnetic field in one coil changes, and if the other coil is placed in the sufficiently close distance, the emf will

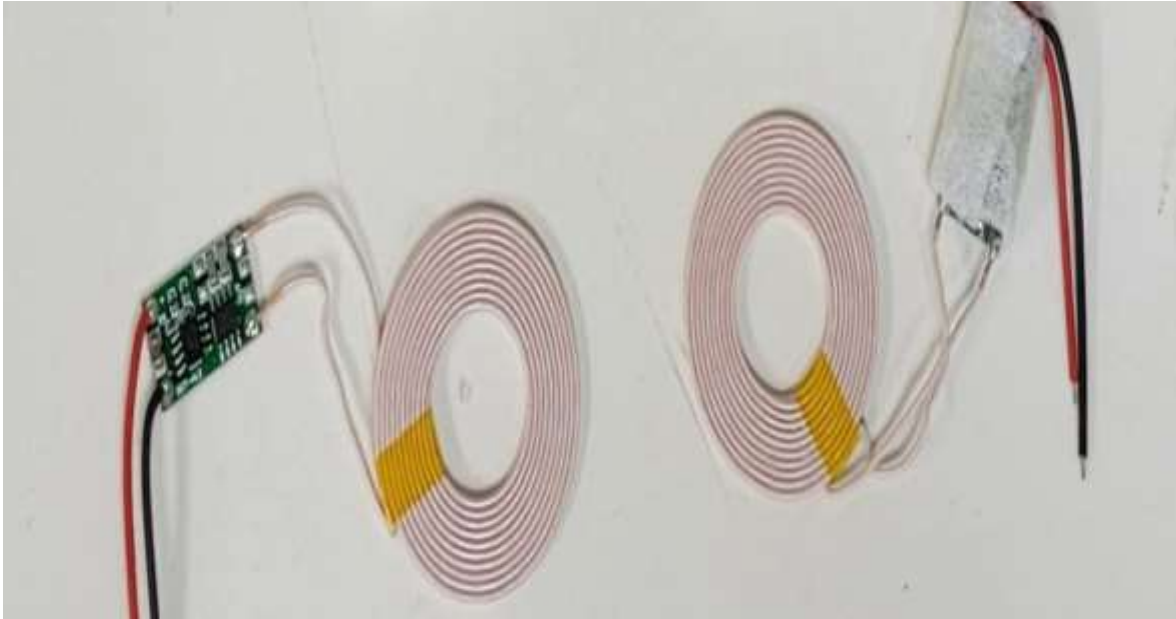
be inducted into the neighbouring coil. The alternating current induces alternating flux in the transmitting coil which induces an alternating magnetic flux in the core. As the core extends through secondary so some magnetic flux is linked with secondary also. Now, again the same reversed phenomenon will take place, the induced magnetic field in the Receiver coil will generate the alternating current into the receiver circuit in accordance with the faradays Law of induction. Hence the energy is transmitted from the transmitter circuit to the Receiving circuit through induction or coupling. Now in the last step, the induced alternating current is converted into required DC Voltage through a series of filters and Rectifier. At last, the Stable current is fed into the battery for charging. Consequently, in this way, the wireless charging takes place.

#### 4.3 HARDWARE REQUIREMENTS

- Esp32 Microcontroller
- Wireless Transmitter Coil
- Wireless Reciever Coil
- Voltage Sensors
- Oled Display
- Lithium Polymer Battery
- Dc – Dc Booster
- 12v Power Supply
- Solar Panel

##### **4.3.1 Wireless transmitter & Receiver coils**

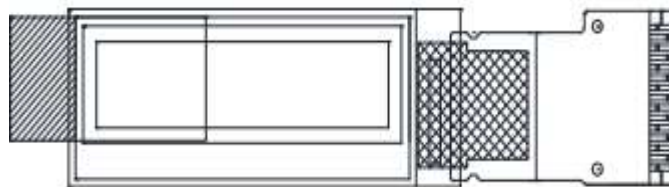
These coils are used to transfer the energy/charge the pacemaker battery which is done in mutual induction C. R. Valenta,et.al,(2018). Wireless charging technologies can be broadly classified into non-radiative coupling-based charging and radiative RF-based charging. The former consists of three techniques: inductive coupling, magnetic resonance coupling and capacitive coupling, while the latter can be further sorted into directive RF power beamforming and non-directive RF power transfer. In capacitive coupling, the achievable amount of coupling capacitance is dependent on the available area of the device. However, for a typical-size portable electronic device, it is hard to generate sufficient power density for charging as shown fig 4.2.



***Fig 4.2: Transmitter and Receiver coil***

#### ***4.3.2 OLED Display***

- Type: graphic
- Display format: 128 x 32 dots
- Built-in controller: SSD1306BZ
- Duty cycle: 1/32
- +3 V power supply
- Interface: 6800
- With polariz



***Fig 4.3: OLED configuration display***



***Fig 4.4: OLED display***

#### ***4.3.3 Lithium Polymer Battery***

If you want to take your project portable, you'll need a battery pack! For beginners, we suggest alkaline batteries, such as the venerable AA or 9V cell, great for making into larger multi-battery packs, easy to find and carry plenty of charge as shown (fig 4.5). If you want to go rechargeable to save money and avoid waste, NiMH batteries can often replace alkaline. Eventually, however you may want to upgrade to the shiniest new technology - rechargeable lithium ion/polymer batteries.



***Fig 4.5: Lithium Polymer Battery***

There are nearly a dozen different chemistries of rechargeable lithium ion batteries but we will be specifically talking about Lithium Ion and Lithium Ion Polymer as a group. On the left you can see two Lithium Ion Polymer cells. On the right, two packs made of cylindrical Lithium Ion batteries. Lithium Ion cells tend to be either rectangular or cylindrical. They are hard-shelled with a strong casing. They often weigh a little more and come in larger capacity but they are also more sturdy and are hard to puncture shown in fig 4.5. They're often used for laptop batteries and other big packs.

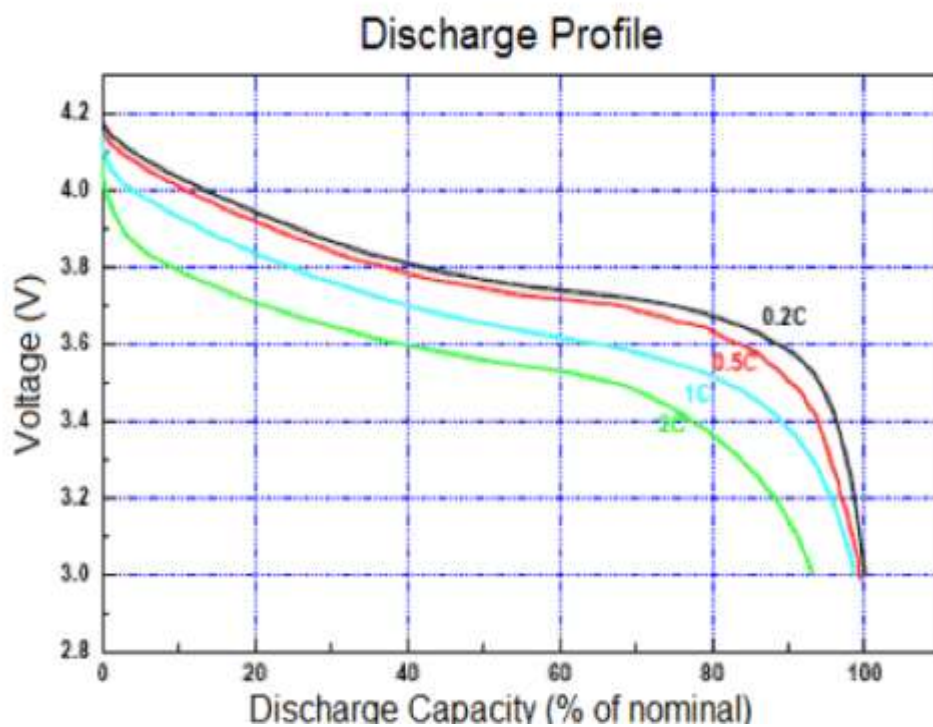
These are often called:

- Lithium Ion
- Li-Ion
- Lilon
- LiCo (lithium cobalt, the anode chemistry)

Lithium-Ion Polymer cells tend to be thin rectangles in a silvery bag. They are soft-shelled and have an easy to damage casing. They often weigh a little less and come in smaller capacity. You can fit them into smaller devices such as tiny iPods. These are often called:

- Lithium Ion Polymer
- Li-Poly
- LiPoly
- LiPo

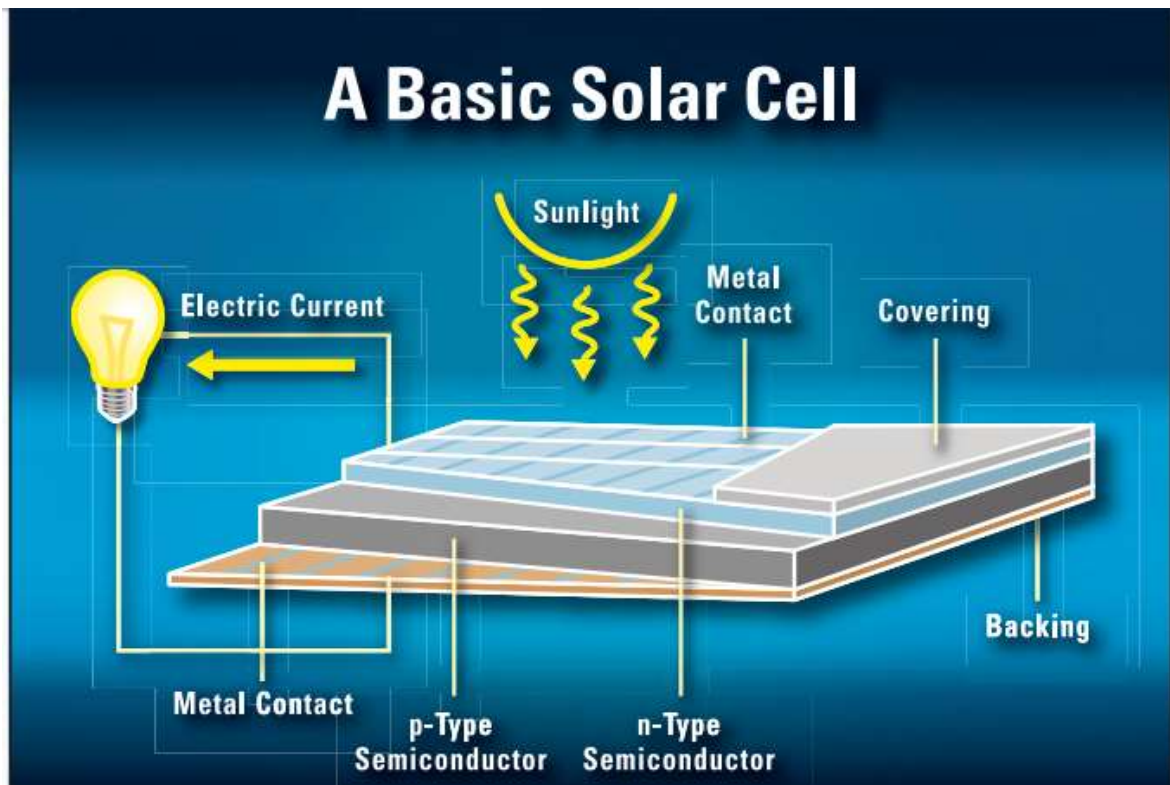
Depending on the design and chemistry of your lithium cell, you may see them sold under different nominal "voltages". For example, almost all lithium polymer batteries are 3.7V or 4.2V batteries. What this means is that the maximum voltage of the cell is 4.2v and that the "nominal" (average) voltage is 3.7V. As the battery is used, the voltage will drop lower and lower until the minimum which is around 3.0V. You should see the number 3.7V written on the battery itself somewhere shown in fig .6. For example, here is a profile of the voltage for a 'classic' 3.7V/4.2V battery. The voltage starts at 4.2 maximum and quickly drops down to about 3.7V for the majority of the battery life. Once you hit 3.4V the battery is dead and at 3.0V the cutoff circuitry disconnects the battery (more on that later).



**Fig 4.6: Graphically Representation of lithium Battery Discharge**

#### **4.3.4 Solar Panel**

Another way to make electricity uses sunlight the sunlight that hits the Earth in an hour has more energy than the people of the world use in a year. A little device called a solar cell can make electricity right from sunlight . A solar cell doesn't give off any gases. It doesn't even make any noise. A solar panel is a group of solar cells that work together.



**Fig 4.7: Basic Solar Panel**

Only part of the energy sent toward Earth by the Sun actually makes it to Earth's surface. Some solar energy gets bounced back into space. Some gets absorbed by the air. Most of the solar energy that does make it to Earth's surface is in the form of visible light. Solar cells can use the energy of this light to make electricity. But they don't work equally well with all forms of light. Different types of solar cells use different wavelengths shown in fig 4.7. The cell can use only some of the solar energy that it receives.



***Fig 4.8: Solar Panel of 9V***

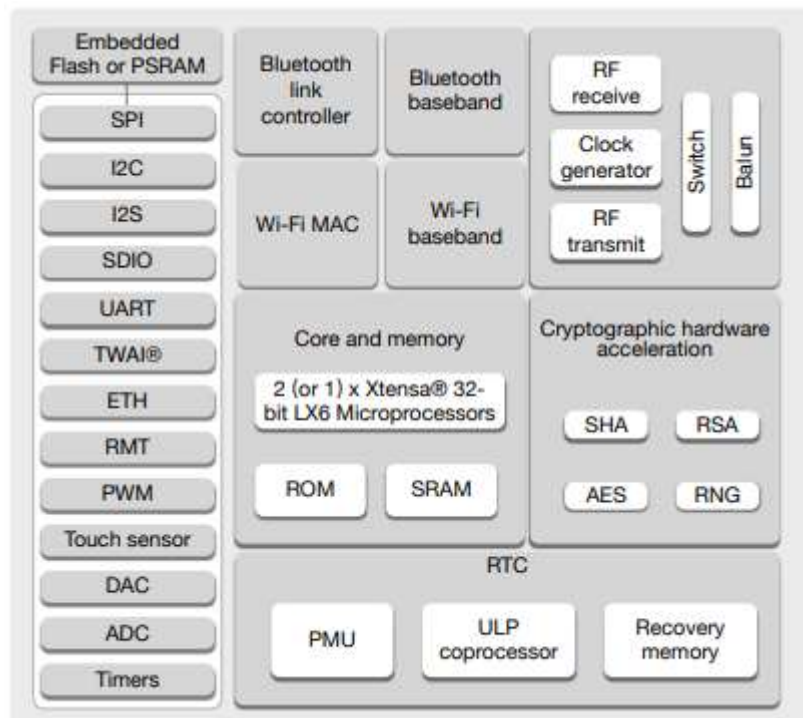
The process of making electricity begins when the silicon atoms absorb some light. The light's energy knocks some electrons out of the atoms. The electrons flow between the two layers. The flow makes an electric current. The current can leave the cell through the metal contacts and be used. When light hits a solar cell, much of its energy is wasted. Some light bounces off or passes through the cell. Some is turned into heat shown in fig 4.8 . Only light with the right wavelengths, or colors, is absorbed and then turned into electricity.

A typical simple solar cell uses some sunlight to make electricity that flows between the two semiconductor layers. This electric current leaves the cell through the metal contacts and can be used.

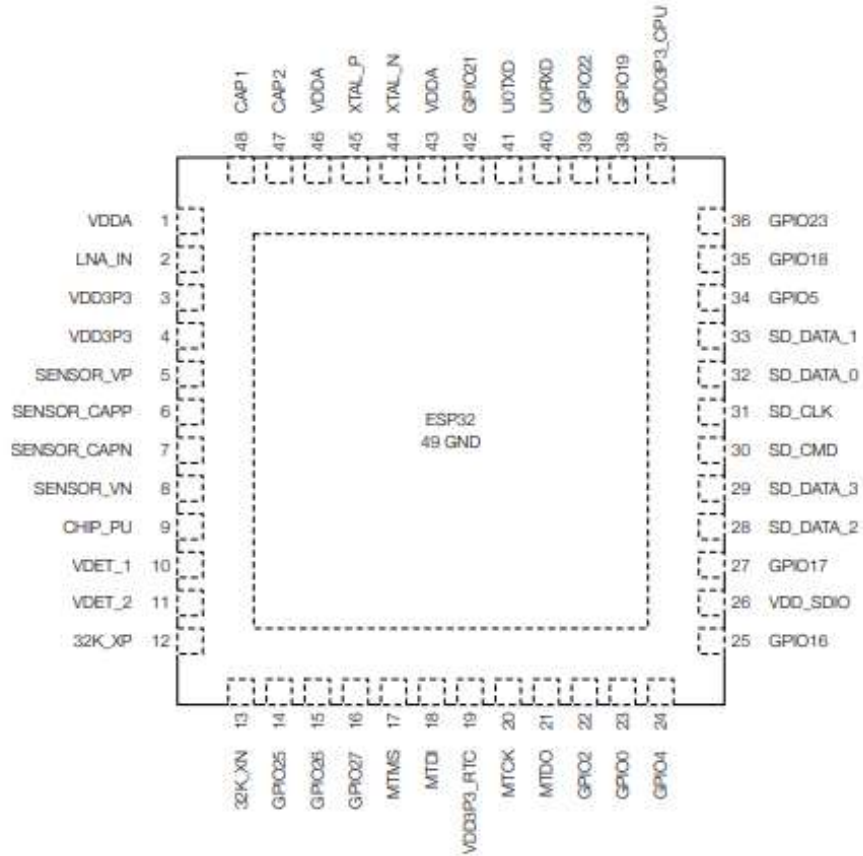
Here the solar panel is connected to the transmitter kit which passes the energy received from the solar panel and passed to receiver kit which the cardiac pacemaker.

#### 4.3.5 Esp32 Microcontroller

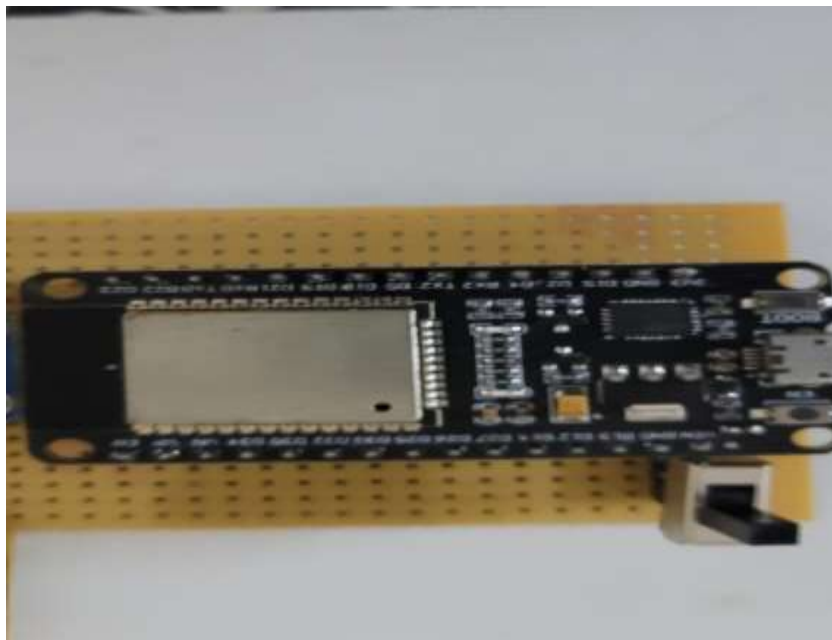
ESP32 is a single 2.4 GHz Wi-Fi-and-Bluetooth combo chip designed with the TSMC ultra-low-power 40 nm technology. It is designed to achieve the best power and RF performance, showing robustness, versatility and reliability in a wide variety of applications and power scenarios. The ESP32 series of chips includes ESP32-D0WD-V3, ESP32-D0WDR2-V3, ESP32-U4WDH, ESP32-S0WD, ESP32-D0WDQ6-V3 (NRND), ESP32-D0WD (NRND), and ESP32-D0WDQ6 (NRND), among which, ESP32-D0WD-V3, ESP32-D0WDR2-V3, ESP32-U4WDH, and ESP32-D0WDQ6-V3 (NRND) are based on ECO V3 wafer shown in fig 4.9 and 4.10.



**Fig 4.9: Block Diagram of ESP32**



**Fig 4.10: ESP32 Pin Lay Out**



**Fig 4.11: ESP32 Module**

#### **4.3.6 Hardware Design**

- Design and assemble the circuit using the ESP32 development board, wireless charging module, circuit, solar panel, lithium-polymer battery, voltage regulator, capacitors, and resistors.
- Test and troubleshoot the hardware components to ensure proper functionality.

### **4.4 SOFTWARE REQUIREMENTS**

- Arduino IDLE
- Blynk

Arduino iintegrated Development Environment (IDE) v1 Learn how the Arduino IDE v1 works, such as compiling & uploading sketches, file management, installing dependencies and much more.

The Arduino Integrated Development Environment – or Arduino Software (IDE) – contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

#### **4.4.1 Writing Sketches**

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

#### **4.4.2 IDE Verify File**

Verify Checks your code for errors compiling it.

#### **4.4.3 IDE Upload File**

Upload Compiles your code and uploads it to the configured board. If you are using an external programmer with your board, you can hold down the "shift" key on your computer when using this icon. The text will change to "Upload using Programmer

#### **4.4.4 IDE New File & IDE Open File**

New Creates a new sketch and open Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content. due to a bug in Java, this menu doesn't scroll; if you need to open a sketch late in the list, use the File | Sketchbook menu instead.

#### **4.4.5 IDE Save File & IDE Sermon File**

Save Saves your sketch & Serial Monitor Opens the serial monitor and additional commands are found within the five menus: File, Edit, Sketch, Tools, Help. The menus are context sensitive, which means only those items relevant to the work currently being carried out are available.

#### **4.4.6 File**

New Creates a new instance of the editor, with the bare minimum structure of a sketch already in place. Open Allows to load a sketch file browsing through the computer drives and folders. Open Recent Provides a short list of the most recent sketches, ready to be opened. Sketchbook Shows the current sketches within the sketchbook folder structure; clicking on any name opens the corresponding sketch in a new editor instance.

#### **4.4.7 Tools**

**Auto Format** This formats your code nicely: i.e. indents it so that opening and closing curly braces line up, and that the statements inside curly braces are indented more.

**Archive Sketch** Archives a copy of the current sketch in .zip format. The archive is placed in the same directory as the sketch.

**Fix Encoding & Reload** Fixes possible discrepancies between the editor char map encoding and other operating systems char maps. **Serial Monitor** Opens the serial monitor window and initiates the exchange of data with any connected board on the currently selected Port. This usually resets the board, if the board supports Reset over serial port opening. **Board** Select the board that you're using. See below for descriptions of the various boards.

**Port** This menu contains all the serial devices (real or virtual) on your machine. It should automatically refresh every time you open the top-level tools menu.

**Programmer** For selecting a hardware programmer when programming a board or chip and not using the onboard USB-serial connection. Normally you won't need this, but if you're burning a bootloader to a new microcontroller, you will use this. **burn Bootloader** The items in this menu allow you to burn a bootloader onto the microcontroller on an Arduino board. This is not required for normal use of an Arduino board but is useful if you purchase a new ATmega microcontroller (which normally come without a bootloader).

#### **4.4.8 Tabs, Multiple Files, and Compilation**

Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp), or header files (.h).

Before compiling the sketch, all the normal Arduino code files of the sketch are concatenated into a single file following the order the tabs are shown in. The other file types are left as is.

## 4.5 SOFTWARE DEVELOPMENT

- Develop the code in Arduino IDE to control the charging process of the pacemaker simulation circuit using the wireless charging module.
- Develop the code to send the charging status and battery level data to the Blynk IoT platform.
- Integrate the hardware and software components to create a functional system.
- Test and debug the software to ensure proper functionality.

## 4.6 Blynk IoT

Blynk is a user-friendly IoT platform designed to help developers and makers build IoT applications quickly and easily. The platform provides a suite of tools and services that simplify the development of IoT applications, making it easier for developers to create interactive, connected projects.

In this detailed description, we will explore the different features and functionalities of the Blynk IoT application, its architecture, and its benefits for developers and makers.

The Blynk IoT application is a mobile and web application that allows developers and makers to connect their IoT devices and create custom applications that can be controlled remotely. The application provides a range of tools and features, including a drag-and-drop interface, a variety of widgets, and cloud connectivity.

The Blynk IoT application is designed to work with a range of microcontrollers, including Arduino, ESP32, and Raspberry Pi. This flexibility makes it an excellent choice for developers and makers who want to create IoT projects with different microcontrollers as shown in fig 4.12.

#### **4.6.1 Blynk IoT Platform Integration**

- Set up a Blynk IoT platform account.
- Configure the ESP32 development board to connect to the Blynk IoT platform.
- Develop the code to send the data to the Blynk IoT platform and display it in the Blynk mobile app.
- Test and troubleshoot the Blynk IoT platform integration.

#### **4.6.2 Architecture of Blynk IoT Application**

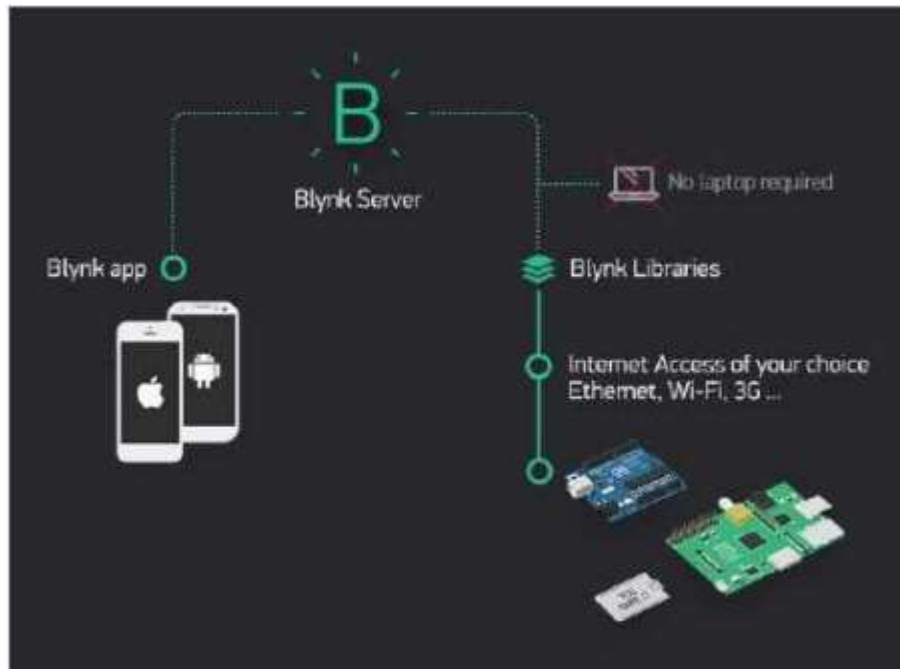
The Blynk IoT application consists of three main components: the Blynk App, the Blynk Cloud, and the Blynk Library. Let's explore each of these components in more detail.

1. Blynk App: The Blynk App is the user interface that allows users to control their IoT projects remotely. The app is available for both iOS and Android devices and provides a variety of widgets, including buttons, sliders, and gauges, that can be used to interact with the IoT device.
2. Blynk Cloud: The Blynk Cloud is the backend infrastructure that allows the app to communicate with the IoT device. The cloud provides secure connectivity and real-time data exchange between the IoT device and the app.
3. Blynk Library: The Blynk Library is a collection of software libraries that can be used to program the microcontroller to communicate with the Blynk Cloud. The library provides a range of functions and features that simplify the development of IoT applications.

#### **4.6.3 Features and Functionalities of Blynk IoT Application**

The Blynk IoT application provides a range of features and functionalities that simplify the development of IoT applications shown in fig 4.12. Here are some of the key features of the Blynk IoT application:

**Drag-and-Drop Interface:** The Blynk App provides a drag-and-drop interface that allows users to easily create custom interfaces for their IoT projects.



**Fig 4.12: Blynk IOT**

**Customizable Widgets:** The Blynk App provides a range of customizable widgets that can be used to control and monitor IoT devices. Widgets can be customized to display real-time data, such as sensor readings, and can be used to control devices remotely.

**Cloud Connectivity:** The Blynk Cloud provides secure connectivity between the IoT device and the app, allowing real-time data exchange between the two. The cloud also provides cloud storage for data logging and analytics.

**Notifications and Alerts:** The Blynk App provides notifications and alerts that can be triggered based on specific events or conditions. For example, users can set up notifications to alert them when a sensor reading reaches a certain threshold.

**Sharing and Collaboration:** The Blynk App allows users to share their projects with others and collaborate on projects. Users can share their projects via email or social media and invite others to contribute to their projects.

#### 4.7 WORKING

When the pacemaker is placed on the wireless charging module, the ESP32 development board controls the charging process of the circuit, ensuring that the pacemaker is charged to the required level. The charging process is highly efficient and consumes minimal power due to the use of green energy sources, such as the solar panel and lithium polymer battery. The voltage regulator ensures that the voltage supplied to the circuit is regulated and stable. The Blynk IoT platform is used to store the charging status and battery level data generated by the system. The ESP32 development board is programmed to send this data to the Blynk IoT platform via Wi-Fi connectivity. The Blynk mobile app is used to monitor the charging status and battery level of the pacemaker. The app provides a real-time view of the charging status and battery voltage, allowing users to track the progress of the charging process and take necessary actions, such as replacing the pacemaker's battery. Overall, the IoT and Green Energy Based Wireless Pacemaker Charger Development System using esp32 and storing the data in the Blynk IoT platform is an advanced and eco-friendly system that provides an efficient and reliable way to charge pacemakers wirelessly, while also reducing the dependency on traditional power sources and minimizing the carbon footprint.

## CHAPTER – 5

### RESULT AND DISCUSSION

When the pacemaker is placed on the wireless charging module, the ESP32 development board controls the charging process of the circuit, ensuring that the pacemaker is charged to the required level. The charging process is highly efficient and consumes minimal power due to the use of green energy sources, such as the solar panel and lithium polymer battery. The voltage regulator ensures that the voltage supplied to the circuit is regulated and stable. The Blynk IoT platform is used to store the charging status and battery level data generated by the system. The ESP32 development board is programmed to send this data to the Blynk IoT platform via Wi-Fi connectivity. The Blynk mobile app is used to monitor the charging status and battery level of the pacemaker. The app provides a real-time view of the charging status and battery voltage, allowing users to track the progress of the charging process and take necessary actions, such as replacing the pacemaker's battery. Overall, the IoT and Green Energy Based Wireless Pacemaker Charger Development System using esp32 and storing the data in the Blynk IoT platform is an advanced and eco-friendly system that provides an efficient and reliable way to charge pacemakers wirelessly, while also reducing the dependency on traditional power sources and minimizing the carbon footprint. The integration and system testing:

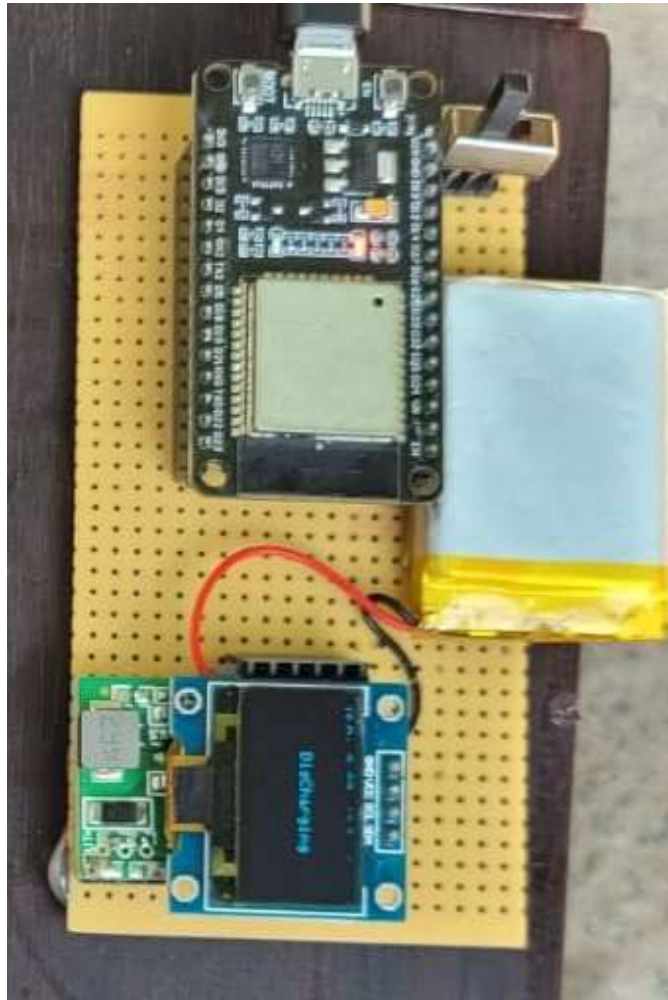
- Integrate the hardware, software, and Blynk IoT platform components to create a complete system.
- Test the system to ensure that it meets the project requirements and objectives.
- Identify and resolve any issues or bugs.



***Fig 5.1: Prototype of the kit***

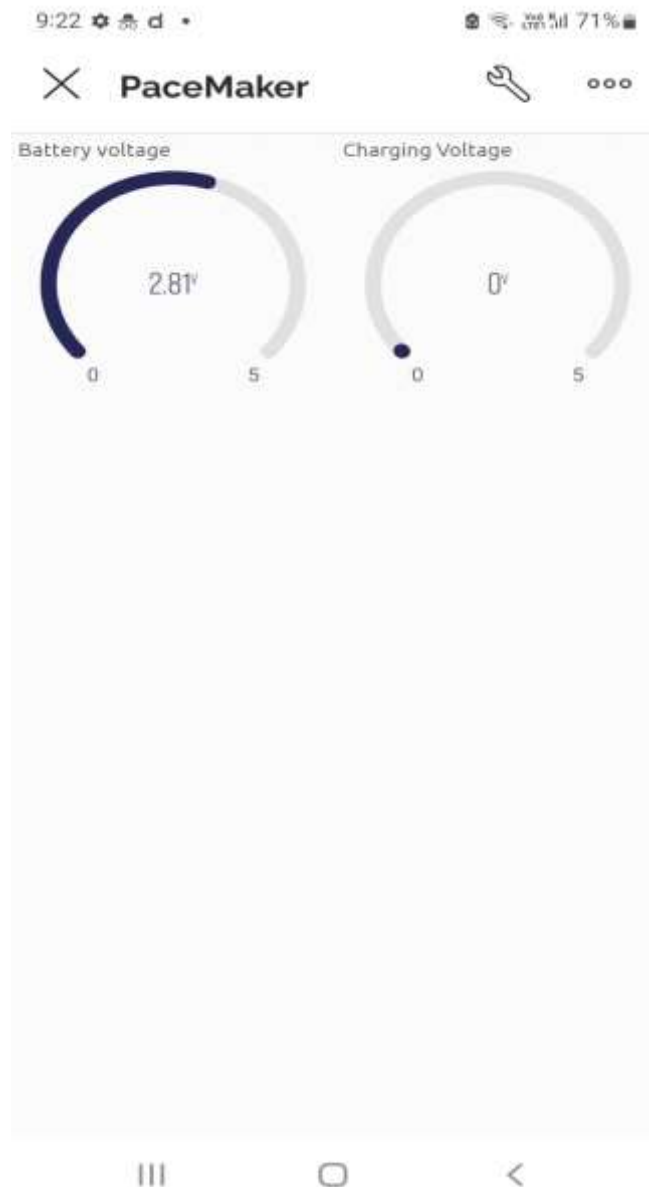
The prototype shows the working of the kit which shows the charging process of artificial cardiac pacemaker battery by taking the energy source from sun which is a green energy.

The energy is drawn from sun through a solar panel and transferred wirelessly by mutual inductance using coils and, in the transmitter, & receiver shown in fig 5.1.



***Fig 5.2: Charging Status Displayed***

The fig 5.2 shows the charging status of artificial cardiac pacemaker and shows the voltage source. It shows the battery voltage and also transfers the data to the blynk app.



**Fig 5.3: Battery voltage & charging voltage shown in the Blynk App**

This shows the charging voltage and battery voltage, which is displayed in the app where the doctors and the patient can see it from anywhere of the corner.

The fig 5.3 shows doctors has the access to use this app and the patient where ever they are and around the world.

The charging values are:-

- Battery voltage-5v
- Charging voltage-5v

## PROJECT APPLICATIONS

**Healthcare Industry:** The system can be used in hospitals, clinics, and other medical facilities to charge pacemakers wirelessly, reducing the need for invasive procedures, such as replacing the pacemaker's battery.

**Personal Use:** The system can be used by individuals with pacemakers to charge their pacemakers wirelessly at home, work, or on-the-go, providing them with greater convenience and mobility.

**Eco-Friendly Initiatives:** The system promotes the use of green energy sources, such as solar power, to reduce the carbon footprint and help combat climate change.

**Research and Development:** The system can be used by researchers and scientists to study the efficacy and efficiency of wireless charging technology in the medical field and to develop new and innovative solutions for charging medical devices wirelessly.

## CHAPTER – 6

### SUMMARY AND CONCLUSION

In conclusion, the IoT and Green Energy Based Wireless Pacemaker Charger Development System using esp32 and storing the data in the Blynk IoT platform is an innovative and eco-friendly solution for charging pacemakers wirelessly. The system uses advanced IoT and wireless charging technologies, along with green energy sources, such as solar power, to charge pacemakers efficiently and conveniently, without the need for invasive procedures, such as replacing the pacemaker's battery. The Blynk mobile app provides real-time monitoring of the charging status and battery voltage level, allowing users to track the progress of the charging process and take necessary actions. Overall, this system offers several advantages over traditional pacemaker charging methods, including greater convenience, mobility, and eco-friendliness, while also promoting research and development in the medical and technology industries. Currently, the system is designed to work with a specific pacemaker model. Future enhancements could focus on making the system compatible with multiple pacemaker models, allowing a wider range of patients to benefit from the technology. While the system uses green energy sources, such as solar power, to charge pacemakers, there is room for further improvement in charging efficiency. Future enhancements cou

ld focus on optimizing the charging process to reduce the charging time and improve overall efficiency. While the system uses green energy sources, such as solar power, to charge pacemakers, there is room for further improvement in charging efficiency. Future enhancements could focus on optimizing the charging process to reduce the charging time and improve overall efficiency. The system can be integrated with other health monitoring systems to provide a more comprehensive solution for patients. For example, the system could be integrated with a patient's electronic health record to provide real-time updates on their pacemaker's battery status and charging history. The system currently uses wireless charging technology, but there is potential for further innovation in this area. Future enhancements could focus on the development of new and more efficient wireless charging technologies for medical devices.

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