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Advanced Footstep Power Generation using RFID for Charging

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Abstract: ***Day by day, the population of the country is increasing and the requirement of the power is also increasing in many ways. So, reforming this energy back to usable form is the major solution for future needs. In this Footstep power generation project, power is generated by human's footsteps, so as to charge the battery by storing the power generated with the help of piezo sensors. The power stored in the battery, used to charge the mobile phones using RFID card. This system is powered by Atmega 328 microcontroller, it consists of Arduino IDE, RFID Sensor, USB Cable and LCD. When power is on in the system, the system enters into the registration mode. Three users can registered. Once all the users entered in the system, then the system asks to swipe the card and connect the charger. Initially all the user is given 5 minutes of charging time as default. When card is swiped and the user is authorized, the system turns on for charging the Mobile phone within a given time period.***
Keywords: Arduino Uno, Arduino IDE, Piezoelectric Sensors, RFID (Radio Frequency Identification), LCD

I. INTRODUCTION

The demand of electricity are increasing day by day and its use has become so advanced and applicable in the present lifeline of a human being. The arising value of new technology each day demands more power of electricity as the population of human beings is increasing day by day and hence the energy demand is increasing rapidly.

Advanced Footstep Power Generation using RFID for Charging is a new advanced system, in which new technology i.e. RFID technology is used. Due to this technology system provides charging to the Mobile Phone within a provided time period. Hence, the system innovated here does not consume more time. In this system, piezo sensors were used to store the waste energy by our footsteps, due to which power shortages were reduced and hence, the system develops much cleaner cost effective way of power generation method using RFID, which helps to bring down global warming. Microcontroller based footstep power generation is used to generate voltage using footstep force. The proposed system works as a medium to generate power using force. This project is very useful in public places like bus stands, theaters, railway stations, shopping malls, etc. So, these systems are placed in public places where people walk and they have to travel on this system to get through the entrance or exits.

TABLE 1
Main compnents of the system

Components	Description
Mechanical Frame	Designed to concentrate on energy that is generated by people's footsteps. Mechanical frame depends on the principle by which electricity is generated. Here, electricity generates through human footsteps by pressing piezoelectric sensors.
Electricity Generated Module	Electricity generating module may be thermo-couple, Piezo-electric module, electromagnetic generator or thermal electricity generator. This generators convert different forms of energy into electrical energy. Here, piezoelectric sensors were used to convert the mechanical energy into electrical energy.
Battery Storage	Power that is generated from footsteps is generating in real-time and this power is no eventual in magnitude. Therefore, it is necessary to store power generation for future usage. For this purpose, battery backup system is used.
Control Circuits	This circuits is used to control and regulate power generation and backup it to a battery. Some indicators are displayed for the status of working system.

The scope of this system is very wide in future. By implementing this system, waste energy is utilized with the help of human footsteps and by converting this waste energy into electrical energy, charging of Mobile Phone is done within a limited time period i.e. allocated in Arduino Uno. For simulation purpose, system uses Arduino IDE.

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Fig. 1 Proposed system concept

A. *Necessity of the System*

Power generation will be depend on thermal and wind energy. So everyone depend on this power sources only. This system is used to develop much cleaner cost effective way of power generation method using RFID, which in turn helps to bring down the global warming as well as the power shortages.

This system is used to generate power from renewable energy sources; system makes use of piezo. The system monitors the parameters coming from the piezo sensors, energy from piezo sensor values displayed on the LCD. The energy from the piezo sensors is used to charge the mobile. To charge the mobile phone battery with the help of USB point, system uses RFID Technology.

II. LITERATURE REVIEW

A. *Historical Survey*

The fundamental principles of electricity generation were discovered in the 1820's and early 1830's by British scientist "Michael Faraday". His method, still used today, for electricity to be generated by the movement of loop of wire, or Faraday disc, between the poles of the magnet. Joydev Ghosh, Supratim Sen, Amit Saha and Samir Basak from IEEE paper has initiated the design methodology of "Electrical power generation using foot step for urban area energy applications". This system is proposed to innovate idea of storing waste energy by using footsteps to reduce pollution in a polluted countries.[1] Piezoelectricity was discovered in 1880 by "Pierre and Paul-Jacques Curie", who found that when they compressed certain types of crystals including quartz, tourmaline, and Rochelle salt, along certain axes, a voltage was produced on the surface of the crystal. This effect is known as piezoelectric effect. By using piezoelectric sensors, which uses piezoelectric effect for working purpose, another system is proposed known as "Footstep Power Generation using Piezoelectric Sensors". In this system, energy is generated by using piezoelectric sensors. By pressing this sensors, using human footsteps, energy is stored in the battery for further process. Due to this project size and cost is reduced and system become less complicated.[2] In our proposed system "Advanced Footstep Power Generation using RFID for Charging", RFID technology is used. RFID was, officially invented in 1983 by Charles Walton when he filed the first patent with the word 'RFID'. By using this RFID technology in our project, the power is distributed among users according to their user identification number with the help of electromagnetic waves.

B. *Evolution of RFID Technology*

Radio-frequency Identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects.

Table 2
Inventions done from 1945 to 1983

Year	Inventor	Invented
1945	Leon Theremin	Listening device for the Soviet Union
1945	Allies and Germany	The Identification Friend and Foe Transponder
1948	Harry Stockman	"Communication by Means of Reflected Power" (Seminar paper)
1973	Mario Cardullo	Passive radio transponder with memory
1973	Steven Depp, Alfred Koelle, Robert Frayman	Demonstration of reflected power usind RFID tags, both passive and semi-passive
1983	Charless Walton	First patent to be associated with the abbreviations RFID

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Advances in semiconductor technologies led to significant improvements of the technology. Within the same time frame, commercial success of the marked applications generated a dramatic reduction of cost and an ever-increasing interest from businesses. There are many indications that the proliferation of applications using RFID technology is only at its beginning. According to a Gartner Study (2005), the RFID markets revenue grew over 33% between 2004 and 2005 and will be worth USD 3 million by 2010. Research firm IDTechEx predicts a global market for RFID including systems and services of USD 26.23 billion in 2016 and a total number of tags delivered of 585 billion, 450 times the amount of 2006. Benefits of RFID technology for business and individuals are very promising (OECD, 2006a). One important driver for market growth today is that of improving traceability of goods in the supply chain in order to increase supply chain in order to increase supply chain efficiency, reduce theft and fraud, and realise significant cost savings. In addition, many other types of RFID applications have been reported, and the use of RFID technology is common in areas including passports, hospitals, transportation, ticketing, libraries, museums, counterfeiting, baggage tracking in airports and livestock tagging.[3]

As stated by the European Article 29 Working Policy (2005), "the specific functions that RFID tags can deliver in different sections is also increasing and its possibilities are just beginning to emerge".[3]

Table 3
The Decade of RFID

Decade	Event
1940 – 1950	Radar refined and used, major World War II development effort. RFID invented in 1948.
1950 – 1960	Early explorations of RFID technology, laboratory experiments.
1960 – 1970	Development of the theory of RFID. Start of applications field trials.
1970 – 1980	Explosion of RFID development. Tests of RFID accelerate. Very early adopter implementations of RFID.
1980 – 1990	Commercial applications of RFID enter main stream
1990 – 2000	Emergence of standards. RFID widely deployed. RFID becomes a part of everyday life.

From evolution part applications of RFID technology in past was learned, due to which I proposed new system. In this system, power is utilized with the help of human footsteps and piezoelectric sensors. The waste power is stored in the battery, which is used for charging purpose when users need. By using RFID technology, assigning of user is done with the help of identification card. This card, detected by EM-18 reader through which Arduino provide charging according to time assign in the coding.

Table 4
Research Papers studied

Reference No.	Title	Author	Publisher	Date of Publication	Summary
3	Radio Frequency Identification (RFID): A focus on Information and Security and Privacy	The Secretariat with the assistance of Nick Mansfield (consultant to the OECD)	OECD Ministerial Meeting on the Future of the Internet Economy, Seoul, Korea	17-18 June 2008	This paper presents comments and suggestions from OECD member countries, buisness, and civil society. The report was discussed by the Working Party on Information Security and Privacy in October 2007 and declassified by the Committee for information, Computer and Communications Policy on 17 December 2007. It is

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					published under the responsibility of the Secretary-General of the OECD. The deployment of the RFID in a large number of application areas is promising. This paper introduces the main characteristics of RFID technologies and focuses on the information security and privacy aspects of RFID in the short term. It will be complemented by an overview of RFID applications and an analysis of economic aspects of RFID carried out by the OECD Working Party on the Information Economy (WIPE).
4	RFID Field Guide: Developing Radio Frequency Identification Systems	M. Bhuptani, S. Moradpur		2005	RFID Field Guide is comprehensive guide to planning, designing, and deploying RFID technologies. Two leading RFID consultants draw on their extensive experience to cut through the hype associated with RFID technology and present the realities: True costs and benefits, practical technical and organizational obstacles, and solutions that work. The author begin by explaining how RFID works, and identifying mature and emerging RFID applications that can reduce expenses, increase revenue, and drive competitive advantage.
5	An Efficient and Flexible Way to Protect Privacy in RFID Environment with Licenses	Shi-Cho Cha Kaun-Ju Huang Hsiang-Meng Chang	IEEE International Conference RFID	April 16-17, 2008	This paper proposes a new technical and legal approach for responding to concerns about the privacy of personal data in RFID systems by extending the framework of online personal data licensing (OPDL) and applying the framework to RFID environment.
6	RFID Technology Based Attendance Management System	Sumita Nainan, Romin Parekh, Tanvi Shah	IJCSI International Journal of Computer Science Issues	January 2013	This paper introduces the distinctive components of RFID technology and focuses on its core competencies: scalability and security. It will be then supplemented by a detailed synopsis of an investigation conducted to test the feasibility and practicality of RFID technology.

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III. PROPOSED SYSTEM

Innovate efficient method of "Advanced Footstep Power Generation using RFID for Charging", which stores energy when piezoelectric sensors senses weight with the help of human footsteps. This stored energy is stored in the battery, from which the stored energy is distributed among different users using RFID cards. This cards have human identification number i.e. 12 digit number, which is used to get information regarding each user. RFID technology uses electromagnetic waves for this purpose. The system works according to the provided software code, in which certain minutes is provided for each user at a time. Hence, this system reduces pollution and saves time, due to which our future generation get more help to get pollution free environment and time consuming requirements.

A. Block diagram of Advanced Footstep Power Generation using RFID for Charging

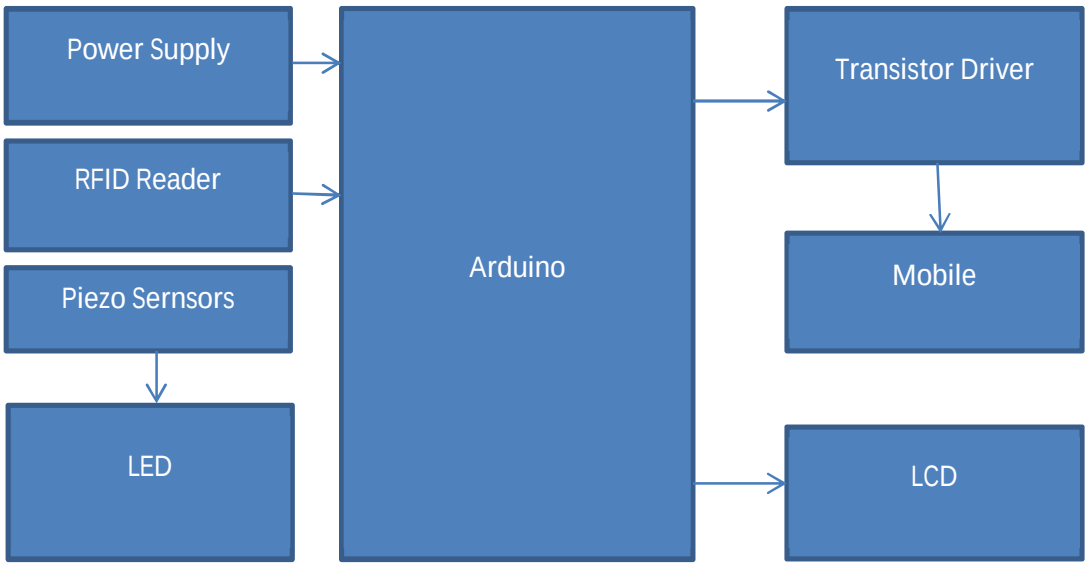


Fig. 2 Block diagram of proposed system

TABLE 5
Description of Components

Components	Description
Power Supply	The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to the rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So, in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure dc voltage.
Arduino Microcontroller	The Arduino Uno is an open-source microcontroller based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. the board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (6 capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE, via a type B USB cable or by an external 9V battery, though it accepts voltages between 7 and 20 volts.
RFID Reader and Tag (EM-18)	This is a low frequency (125KHz) RFID reader with Serial Output with at range of 8-12cm. It is a compact unit with built in antenna and can be directly connected to the PC using RS232 protocol. Since this also outputs Serial TTL Level Data (Tx/Rx), this can also be directly connected to the Serial Port of any Micro-controller. RFID tag includes microchip with radio antenna mounted on substrate which carries 12 Byte unique

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	identification number.
Liquid Crystal Display (LCD)	16x2 Character LCD – Black on Green is a 16 character wide, 2 rows character LCD module. It utilizes industry-standard controller, works in 4/8-bit parallel interface. Display area is LED back-lit in yellow color. This alphanumerics display can be easily interfaced with any host controller such as 8051 derivatives, PIC Series, AVR, ARM Series of controllers or using development boards such as Arduino or Raspberry Pi. it fits in quite well for any electronic device design.
Transistor Driver Circuit	The transistor used in this system to drive the buzzer is BC547. This transistor provides charging to the mobile phone using chord.
Piezoelectric Sensor	A piezoelectric sensor is a device that uses the piezoelectric effect to measure changes in pressure changes in pressure, acceleration, temperature, strain, or force by converting them to an electrical charge.

IV. SYSTEM DESIGN

A. *Methodology*

The system designed here, is relatively efficient and also affordable. The advantage of our model is that the system provide charging to the user within a limited time as allocated to the system software. Our methodology for the project:

1) Creating an idea for design and construction of a Advanced Footstep Power Generation using RFID for Charging. Designing a block diagram and circuit diagram to know which components to be connected/implemented in hardware.
2) Implementing all the components according to circuit diagram and programming the Arduino by using Arduino IDE to control the whole system.
3) Assemling all the blocks in a board and to run the system and for checking purposes**.**
4) Atlast, to get the work done such as mobile phone charging, this is main task/output of the proposed system.

B. *Hardware/Software Requirements*

Table 6
Hardware/Software requirement

Component Name	Usage
Piezoelectric Sensor	It is used to convert mechanical energy into electrical energy.
Arduino Uno	A microcontroller which is easy to use as a software and hardware. It is used to take inputs from the sensors, RFID reader and card and output the result by using LCD and Mobile.
Liquid Crystal Display (LCD)	This apparatus has been used to display the current status of the proposed system.
RFID Reader	It is used to transmit and receive signal with Arduino Uno and used to detect user identification number using RFID cards.
RFID Cards	Used to give signal to the RFID reader according to user requirements.
Power Supply	Used to provide 5V, 1A supply to the system.
Breadboard	Used to implement the required circuitry to connect the system.
Connecting Wires	Used to connect the components and devices for hardware implementation.

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C. Circuit Diagram of Advanced Footstep Power Generation using RFID for Charging

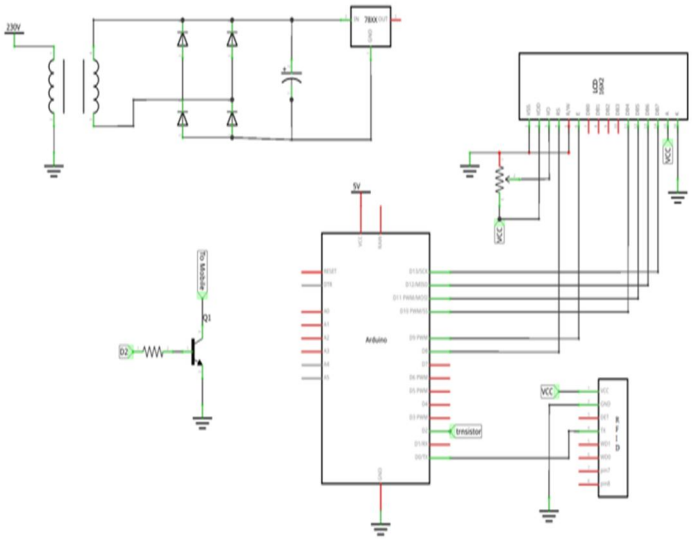
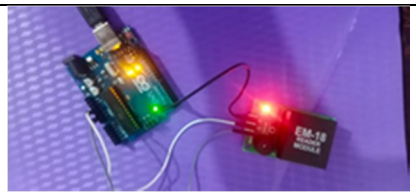
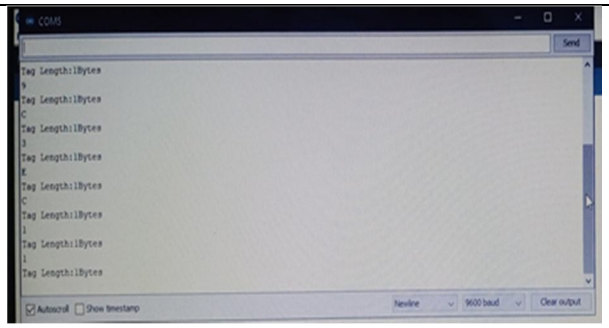
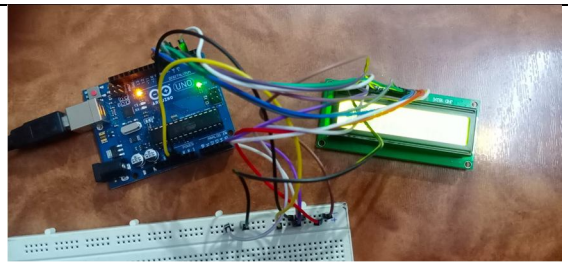
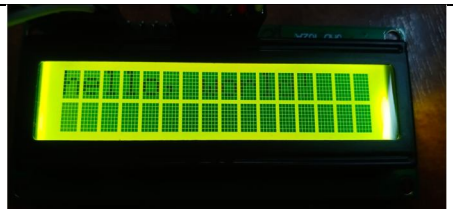


Fig. 3 Circuit Diagram of proposed system

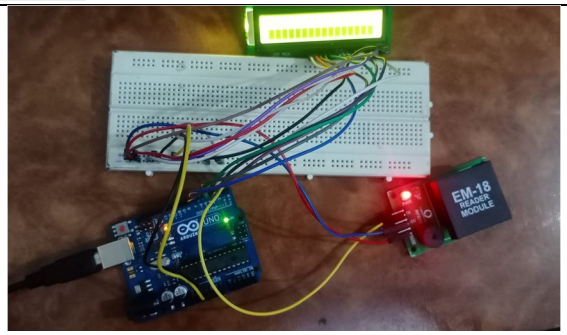
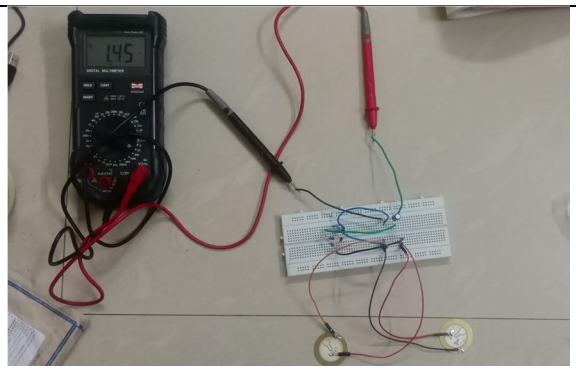
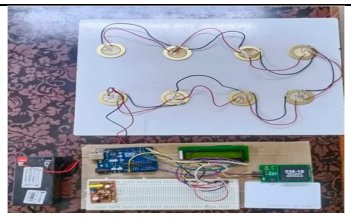
The circuit diagram shown above is of "Advanced Footstep Power Generation using RFID for Charging", in which various devices and components to be implemented according to the user requirements. Firstly, input of 230V is fed to the power supply from which output of the range 5V, 1A is generated. This power supply output is provided to battery and piezoelectric sensors. Piezoelectric sensors connected in parallel, to control the voltage and to provide electrical energy to the battery. Then, our system implemented by interfacing EM-18 RFID reader and LCD with Arduino due to which system works according to the user needs.

D. Hardware Implementations Steps

TABLE 7
Implementation and Output

Steps	Hardware Implementation	Output	Comments
1	 Fig. 4 Interfacing EM-18 with Arduino Uno	 Fig. 5 Output Generated on Arduino IDE	Detection of user using RFID Technology is done.
2	 Fig. 6 Interfacing LCD with Arduino Uno	 Fig. 7 Displayed Message on Screen	Message displayed on LCD.

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3	 Fig. 8 Interfacing LCD and EM-18 Reader with Arduino Uno	 Fig. 9 Displayed output i.e. user identification number	User Identification done and message is displayed.
4	 Fig. 10 Voltage generation using Piezosensors	 Fig. 11 Displayed voltage on Multimeter	Voltage generated through piezoelectric sensors
5	 Fig. 12 Designed system	Charged Mobile	Mobile Phone is charged by identifying user at a time.

E. Software Requirements

The proposed system works through Arduino IDE software. The Arduino IDE is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. This software is used to provide instruction to the proposed system i.e., to detect user and provide efficient charging to the user within a limited time period as allocated in the commands.

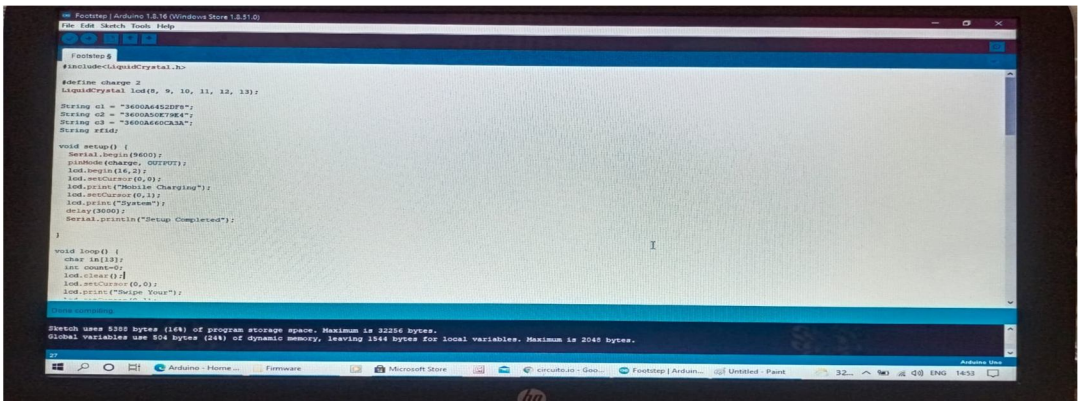


Fig. 10 Simulation of Software Code

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When system is power on, the system enters into registeration mode. Three users registered in the system. Once all the user is entered in the system then the system asks to swipe the card and connect the charger. Initially all the user is given 5 minutes of charging time as default. When the card is swiped, the user is autorized, the system turns on for charging purpose and will charge the Mobile Phone with given time in coding.

V. RESULT AND DISCUSSION

Performance analysis of the system based on following parameters shown below:

A. Linearity Test

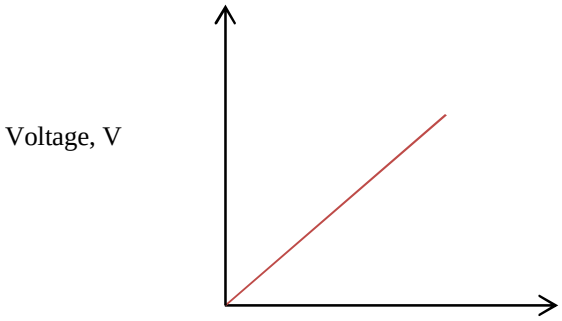


Fig. 11 Voltage vs Pressure Curve

The voltage generated by the piezo-electric sensor is according to the amount of pressure exerted by the human footsteps. The output shows 0V when no force exerted on the piezo-electric sensor. It is shown that the amount of voltage generated keep increasing as the amount of pressure exerted increases. For high pressure, the voltage generated is high. Similarly as more pressure, the voltage increases suddenly.

All the generated voltage will then be store in a battery for future needs. The existence of electric current produced by the piezoelectric sensor can be proved by using a mobile phone which acts as the output to show that the rechargeable battery which has been charged by the piezoelectric is well functioning. The functionality of the circuit is checked by connecting USB cable from the USB port in the circuit to the mobile phone.

The screen of the mobile phone shows the charging symbol. A user can charge his/her mobile phone with the help of an authorized RFID Tag. It can be summarized that the amount of voltage generated by the piezoelectric sensor is depending on the amount of pressure exerted into it. The voltage then can be stored in the rechargeable battery and beneficial for future requirements. From this project, a new source of renewable energy with low-cost budget was developed. Besides that, the knowledge of conventional process in transforming mechanical energy to electrical energy has been gained.

B. Temperature Test

In 1 square ft. we have used 8 piezo sensors.
As piezo sensors the power generating varies at different steps, hence we get
Min voltage = 1V per step
Max voltage = 10.5V per step
Also taking an average of 50kg weight pressure that form a single person. Likewise, considering the steps of a 50kg weighted single person, the average calculation comes out to be:
Increase of 1V charge in the battery it takes 800 steps.
So, increment of 12V in battery total steps needed=(8*800)=6400 steps
As the proposed system is done in a polluted area where footstep as source will be available, average of 2 steps in 1 second is considered.
For 6400 steps time needed = 6400/ (60*2)=53 minutes. (Approx.)

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C. Performance Test

TABLE 8
Performance test of the designed system

User identified	Time duration	Delay	Output on LCD
user 1	1 minute	2000	Completed
user 2	2 minutes	2000	Completed
user 3	5 minutes	2000	Completed

D. Battery Consumption

1) Calculation of battery pack capacity, c-rate, run-time, charge and discharge current

Voltage of battery=12V
Rated capacity of battery=3Ah=36Wh
C-rate: 1 or Charge or discharge current I: 3 A
Time of charge or discharge t (run-time)=1 h
Time of charge or discharge in minutes (run-time)=60 min

2) Calculation of energy stored, current and voltage for a set of batteries in series and parallel

Number of batteries in series= 1 elements
Number of series in parallel= 1 series
Total number of batteries: 1
Voltage of the storage system=12V
Current of the storage system=3A
Capacity of the storage system (energy stored)=3Ah=0.036kWh

VI. FUTURE SCOPES

With a view of future prospects in case of densely populated nations. The optimum use of energy wasted is of very much importance.

1) Japan is only the first liner to use electric principle for generating mechanical energy from Flooring tiles i.e. by using this plates on bus stairs. When someone step in the energy is Generated which leads to increase of steps as well as energy also increased.
2) Secondly, Europe is setting another milestone in the field by using such plates on dance floors, so if anyone step on to these tiles and dance again the energy is released with which even one can charge their mobile and other handy objects.

In coming days, this will prove a great boon to the world, since it will save a lot of electricity of power plants. As the conventional sources are depleting very fast, then it's time to think of alternatives. We got to save the power gained from the conventional sources for efficient use. So this idea not only provides alternative but also adds to the economy of the country. Now, vehicular traffic in big cities is more, causing a problem to human being. But this vehicular traffic can be utilized for power generation by means of new technique called "power hump". It has advantage that it does not utilize any external source. Now the time has come to put forte these types of innovative ideas, and researches should be done to upgrade their implication.

VII. APPLICATIONS

The various other applications of the proposed system are listed below

A. It can be used in crowded places like Railway Station, Airports and Bus Stands.
B. Can be broadly utilized as the part of colleges, schools, public transport places and universities.
C. In rainy season, it can operate street lights rather than using solar lights.
D. This framework can be actualized in swarmed places like shopping centers, pathways, and so forth.

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VIII. ADVANTAGES

A. No need of fuel input.
B. It is authentic and genuine device.
C. Usage of Non-sustainable power sources are less.
D. It is self producing device using our footsteps.
E. No moving parts – long administration life.
F. Power generation is strolling on the step.
G. Compact yet highly sensitive.
H. The system is reduced yet exceedingly touchy.
I. It is reliable, Economical, Eco-friendly and non-conventional system.
J. Less consumption of renewable energies.
K. Power also generated by running or exercising on the step.
L. Battery is used to store generated power.
M. Extremely wide dynamic range, almost free of noise.

IX. DRAWBACKS

A. Only applicable for the particular place.
B. Initial cost of this arrangement is high.
C. Output affected by temperature variation.
D. Care ought to be taken for batteries.
E. It isn't reasonable for estimation in static conditions.
F. Since the device operate with a small electric charge, they, need high impedance cable for electrical interface.
G. The output may vary according to the temperature variation of the crystal.

X. CONCLUSIONS

A. The system gives an effective power generation in very populated nations as it diminishes control request without contamination. As a reality, just 11% of sustainable power source adds to our essential vitality. On the off chance that this undertaking is sent at that point not just, we can conqure the vitality emergency issue yet, besides make a solid worldwide ecological change.
B. The project undertaken is effectively tried and actualized which is the best conservative, reasonable vitality answer for average citizens of our country.
C. As India is a creating nation where vitality administration is a major test for gigantic populance. By utilizing this task we can drive both A.C, and besides, D.C loads as indicated by the power we connected on the piezoelectric sensor.
D. The project "Advanced Footstep Power Generation System using RFID for charging" is successfully tested and implemented which is the best economical, affordable energy solution to common people.
E. RFID technology is most efficient to produce the desired output for user in a required time domain.

XI. ACKNOWLEDGEMENT

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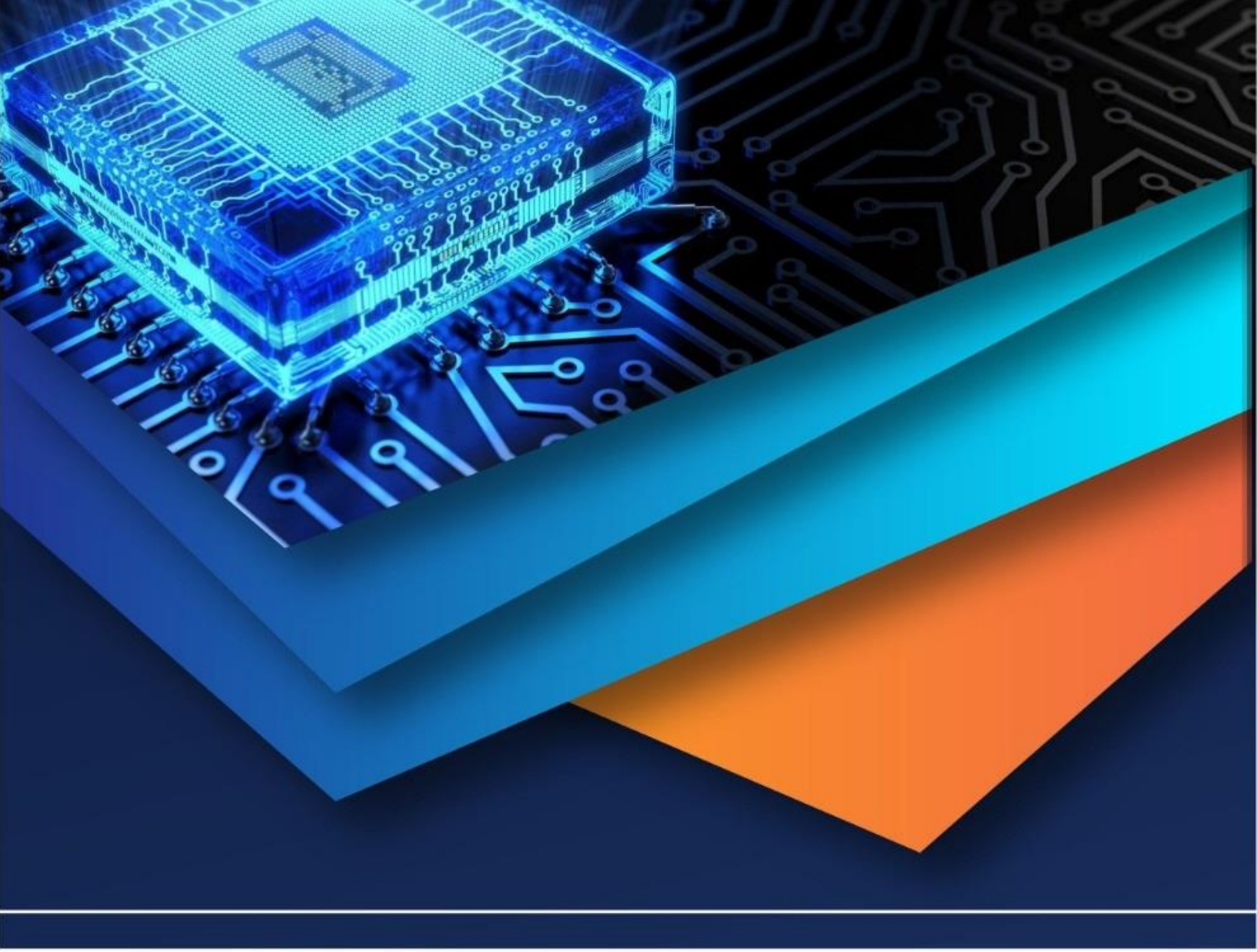
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