

Original Research Article

Power Generator with Health Monitoring IoT Framework

Abstract

Reducing the load on conventional sources of energy is the need of the hour. The pandemic has forced people to stay indoors and thus increased the dependence on conventional sources to meet the energy needs. Pedaling is an effective alternative to generate usable energy. It has multiple benefits - like providing a means of exercising to the user and generating DC energy through pedaling setup which can be converted into AC as per the requirement. Proposed system is beneficial for individuals who find little to no time to exercise and can provide them an interesting way to exercise and recharge their electronic appliances using the charging setup on-board. A health monitoring framework helps in keeping track of the energy expended by the person on the system and can act as a dataset for further research. Using various sensors, the parameters like O₂ level, heart rate, calories burnt can be calculated and displayed on the on-board display or the IoT cloud platform like Blynk, Arduino IoT Cloud etc. The system is aimed to be deployed in rural areas where electricity is scarce which can power basic electric appliances and thus play a crucial role in energizing villages.

Keywords: Renewable Energy, Internet of Things, Health Monitoring, Pedal Power.

1. Introduction

The COVID-19 pandemic has brought transformational changes in the way people work. People's movements were restricted owing to the lockdown. Thus, people started exercising indoors. More and more people have switched to remote mode of working. Due to this there has been a tremendous rise in the use of devices such as mobiles, laptops, tablets, etc. These devices were the saviours of students and everyone alike as people were able to connect remotely. These devices use electricity to recharge themselves. During the pandemic days it was reported that the overall household electricity usage has increased. In India primarily this demand is met by using conventional sources of energy such as burning of fossil fuels. Renewable energy share is low in the overall power sector. Alternative ways to generate energy are being sought after to reduce the load on the grid. Also, the pandemic has left people following unhealthy routines and hence they cannot find any time to exercise. Indoor cycling can provide a relief to people by providing them a way to burn calories (Megalingam et al. 2012). Also, it has been reported that pedaling generates large amounts of energy which if stored could be used meaningfully. By using batteries with a pedaling setup, we can create an effective system capable of helping people exercise as well as charge their appliances (North Arizona University, 2011). The proposed solution in the paper provides a fun way to exercise and recharge the devices.

2. Methodology

The basic idea behind the project is to convert manual energy into electrical energy. The pedal and chain sprocket assembly are connected to a DC motor (Megalingam et al. 2012). This DC motor generates electricity when pedaling starts. This electricity can be used to supply electric energy to the on-board plug point to recharge devices such as mobile phones, laptops, etc. Simultaneously the electricity is stored by a 12V/7.5A battery (Popular Mechanics, 2014). Once

pedaling stops this battery can act as a source of energy for charging devices. The setup can be connected to an Arduino Mega Microcontroller or an ESP32 board. This controller helps to monitor health parameters of a person using the system. Sensors such as SPO₂, heart rate monitor, motion sensor, are interfaced with the microcontroller (Akhila et al. 2017). The SPO₂, heart rate monitor would be placed in a band/plate like contraption which can be worn/placed by the person and it is interfaced with the MCU. This will help to monitor the person's health parameters.

The figure below shows our proposed design -

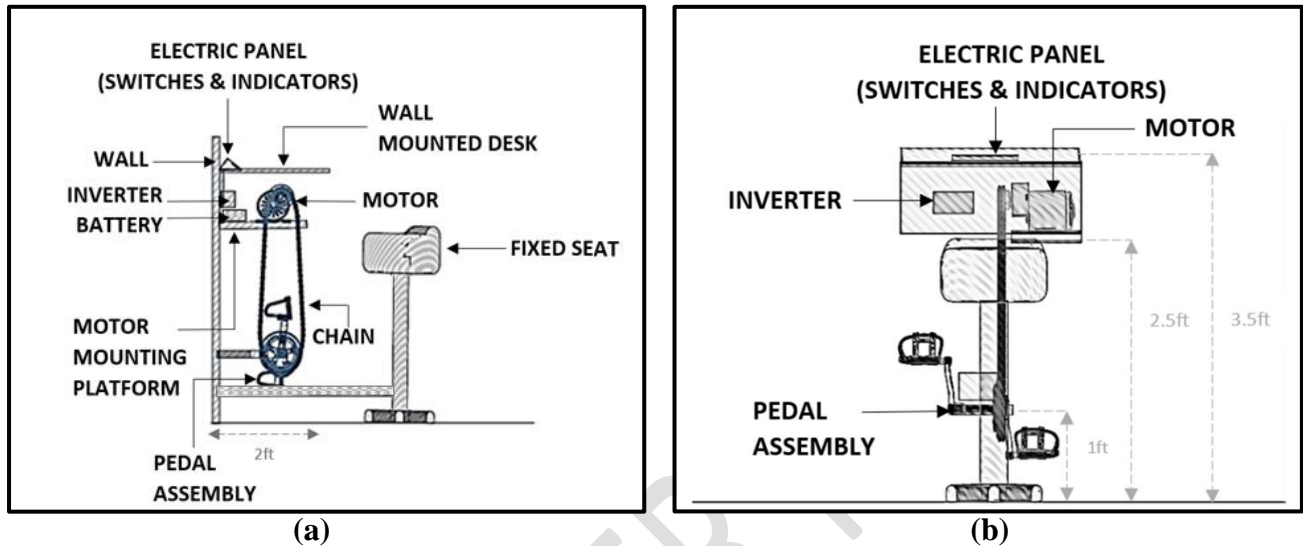


Fig.1. Pedal's power generation system (a) side view (b) front view

The systems will also be able to display the calories burnt by the user during a particular session. An onboard LCD display would show the various parameters to the user while pedaling. Also, we would be sending the data to a cloud application (Blynk, Arduino IoT Cloud, etc.) wherein we can store the data for future research. The system would store the data of a particular user on its IoT platform, if the same person uses the system again then they will be able to see their data from previous sessions displayed online. Most systems proposed till date use an actual cycle assembly and do not provide scope for storage of energy. Our proposed design is compact and provides energy storage. The inverter helps to convert the DC power generated into usable AC. The device uses ESP8266 module which can easily connect with a mobile network's 2.4GHz band frequency range (Udara et al. 2018). So, we don't need to install any additional network infrastructure to support the IoT framework.

3. Results And Discussion

The need of the hour is to switch from conventional energy sources to renewable ones (Yadav et al. 2018). With this idea in mind, we are proposing a system which can be installed in places where access to energy is scarce. Using manual effort, we can convert the mechanical energy into electricity. This electricity can then be used to power up home appliances or recharge various types of electronic devices (mobile phones, laptops, tablets, etc.) This helps in achieving two things -

1. People using the system get to exercise at a place of their convenience.
2. Their devices are getting charged by using the energy expedited by them on the system.

The portability of the proposed solution helps in installing it in compact places. Pedaling is an effective way of generating electricity as found out in the late 19th century. It is the most efficient way of generating electricity/power in terms of energy expended per person. Humans can generate approximately 150W of power while riding a bicycle (Megalingam et al. 2012). The proposed system consists of two stages -

1. Generation Stage
2. Energy Management Stage

1. Generation stage - This stage will mainly constitute a pedal system on a fixed support so that it can be rotated manually. Bicycle pedals are connected to the motor using chain-sprocket assembly, as we go on, the pedal motor also rotates thus producing dc power. The rotatory motion of the pedal will drive the drive belt connecting the pedal to the motor. Here, the motor will act as a dynamo and will generate power on a rotary actuator which will in turn charge a battery through a diode. In our proposed system the DC motor is coupled to a pulley which is rotated by a belt and chain-sprocket system of a bicycle structure. We use a brushless DC motor for electricity generation. The generated electricity is stored in a battery. The battery supply is provided to the onboard switch board. We can plug the appliances on this board and derive energy from the system. The power supplied by the battery is 12V/7.5A which is sufficient for powering up almost all household appliances and electronic gadgets. The DC energy from the battery is passed through an inverter to convert it into usable AC prior to supplying it to the switch board.

The following block diagram can help in explaining the Generation Stage a bit better -

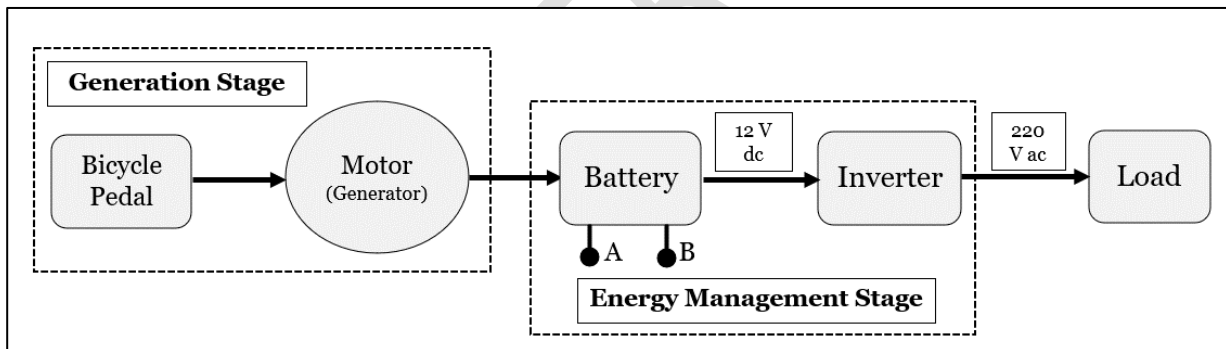


Fig.2. Block Diagram (Part I)

2. Energy Management Stage - The generated energy is stored in the battery and can be used for various applications related to charging and driving home appliances. A diode is connected in between motor and battery to stop reverse flow of voltage. The voltage at the end of the motor is dc, it will charge our battery. Here we can use a 12-volt 7.5/12 Ahr amps battery. If we want dc power, we can get that directly from the battery, but we will need a regulator, for constant and regulated power. For Ac use, the output of the battery is given to a 12-volt dc to 220-volt 50hz inverter. The inverter will convert the DC to usable AC.
3. The simulation of the inverter system was carried out using Multisim software. The following figure displays the same -

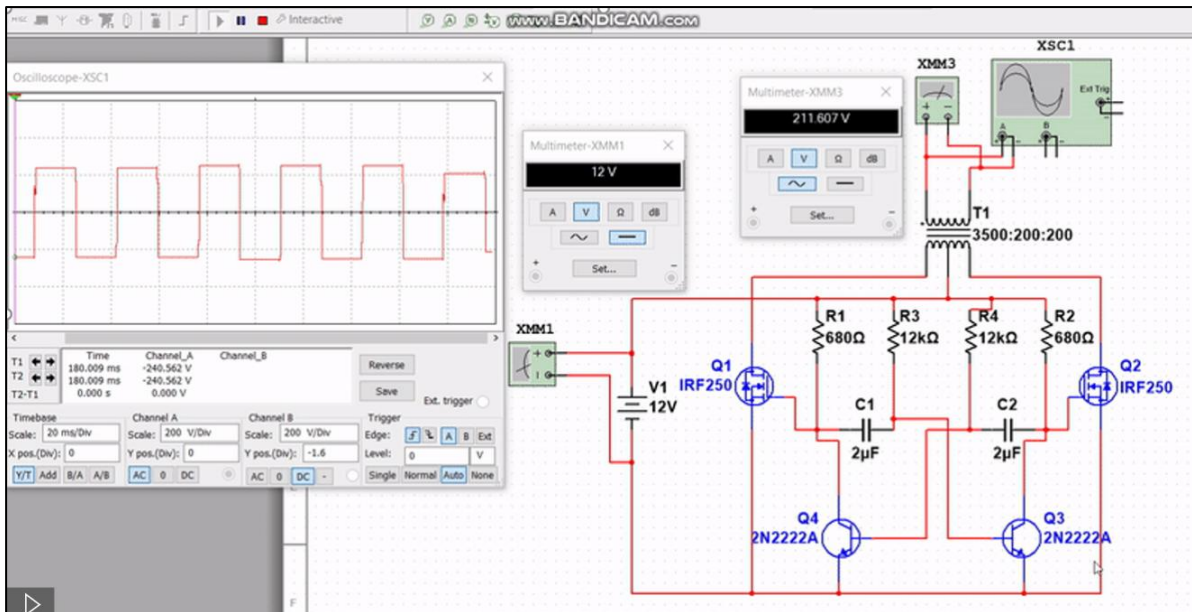


Fig.3. Simulation of Inverter circuit in MultiSim Software

An Arduino Mega microcontroller/ESP32 is connected to the battery which acts as a backbone of the IoT based health monitoring framework. The following block diagram helps in visualizing the same -

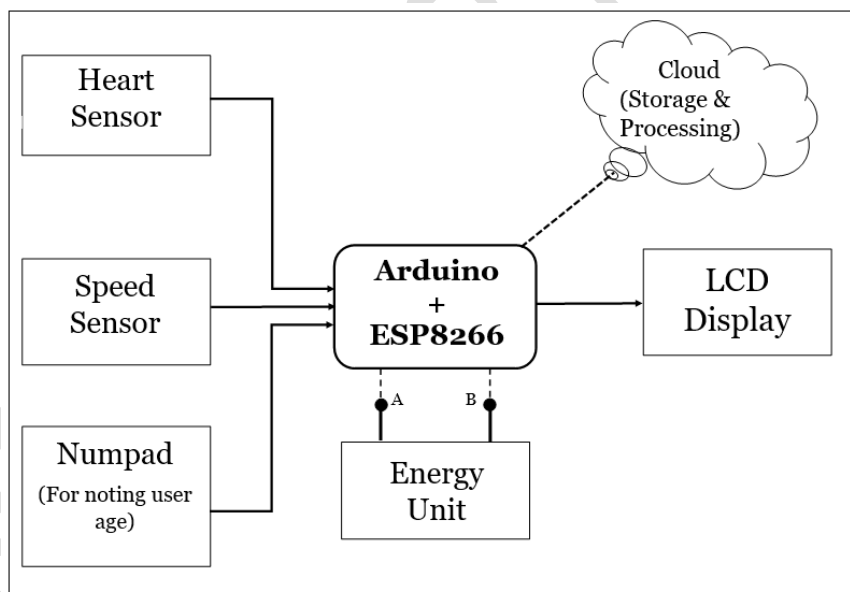


Fig.4. Block Diagram (Part II)

We interface hall sensor, heart rate sensor, speed sensor, a numpad and some additional sensors with the MCU to help monitor the health of the individual using the system. The MCU is connected to the cloud application via Wi-Fi technology. We use an ESP8266 module for achieving this as the ESP module can easily connect with a mobile hotspot (Udara et al. 2018). Thus, it acts as a gateway between the system and cloud. A user comes and sits on the system. The motion sensor detects the movement and turns on the system. The onboard LCD displays a welcome message and asks the user to enter his name and age. Then the system asks the user for their mobile hotspot credentials i.e., their SSID and password. Once the system gets the SSID and password it tries to connect to the mobile network. If connected the system displays the message conveying the same on

the onboard LCD display. Then a user can check the IoT dashboard. The data entered by the user is stored on the IoT cloud application.

We can see that there is provision of monitoring the speed of users using the system, we can also observe that the system can monitor the heart rate and oxygen level of the user. Once the user starts pedaling the hall sensor starts measuring the speed of the user. The LCD displays the speed, heart rate, oxygen level and calories burnt while the system is running i.e. The user is pedaling. Simultaneously the user can view the same parameters on the mobile application. The system will store some critical data and monitor the parameters of the user to check if the levels have exceeded a set threshold. If the threshold has been exceeded then a warning message is displayed on the IoT application as well as LCD. The cloud application helps in storing the user data which can be used later for conducting further research (health related). All the while the user can make use of the switch board to recharge their electronic gadgets.

4. Conclusion

The proposed system is compact and robust and can be easily installed in small spaces. Further, the system can generate enough energy to power up most electric appliances with the right duration of pedaling. Further this project can help in electrifying villages where power supply is scarce. The health monitoring system can update the patient's health parameters in real time and the data is stored in the cloud. This data can help predict patterns for different age groups of people relating to the energy generated by a particular age group in a session. The health parameters of recovering patients can also be monitored by doctors at real time remotely. This can help them provide better treatment to the patient. These systems will prove beneficial for the users in a lot of ways relating to physical exercise and conversion of energy to promote the use renewable energy.

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