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RENEWABLE POWER GENERATION FOR SMART SECURITY SYSTEM

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Abstract : In response to the increasing demand for sustainable energy solutions and rising energy costs, there is a growing need for transition towards renewable energy sources. This paper presents a system that integrates the renewable power generation and a security system which is used in critical applications such as banking security, street lighting that presents a promising avenue for promoting sustainability and ensuring reliable access to energy. This system is based on piezoelectric effect that helps to generate renewable energy using pressure incurred by the footsteps of human movement and thus ensures uninterrupted power supply in critical situations. This system has been incorporated with various sensors which are being powered by the generated energy to ensure high end security for the valuable places like banks, ATM's, lockers, etc. These sensors were integrated in an IOT based environment which enables it to be in collaboration with the warning systems that alerts the owners, security guards incase of any kind of security breach with the help of buzzers and telegram bot.

Index terms - **power generation, security, piezoelectric effect, footsteps, sensors**

I. INTRODUCTION

This paper focuses on sustainable and innovative energy harvesting system designed to convert the mechanical energy generated by human footsteps into electrical power [1]. This system utilizes the place beneath the floor surface to detect foot pressure and movement. When a person walks or steps on the piezoelectric plates [2], they undergo mechanical stress, which is then converted into electrical energy [4]. This power source is also supported by a solar panel. An Arduino microcontroller processes this energy and stores it in batteries [7] or capacitors that can be further used for various applications such as powering small electronic devices, lighting, or charging portable devices. This eco-friendly and cost-effective solution has the potential to contribute to renewable energy sources and reduce our dependence on conventional power supplies while harnessing the everyday movement of people to generate electricity. The piezoelectric plate is a very sensitive device [3]. It can detect very small vibrations and small pressure as well. When the pressure is applied, the charges will be formed at the edges of the plate and when connected to a load we see voltage being generated [9]. The generated power is directly dependent on the amount of pressure applied.

This power generation system does not have any effects on the environment making it a renewable power source and the walkways will always be busy with people, also making this a continuous power source[6]. The generated energy is transferred to the security system and street light system in and around the installed venue. The model consists of fire sensors, motion detection sensors and vibration sensors to detect unusual activity at the bank lockers and is processed by Arduino microcontroller that sends an alert message to the security wing and will ON the lights and buzzer indicating the situation to the people around the place. This system also integrates LDR sensors that can recognize the night time or power failure and switch on the power supply to lights. In this way the system efficiently uses the renewable power generated using human footsteps.

II. PROPOSED SYSTEM

2.1 Development tools

2.1.1 Power generation module

One of the main parts of the proposed system is the generation of power using piezoelectric crystal plates. When the crystal inside the plate experiences pressure, charges are formed and small AC current is generated. The generated voltage will be varied with amount of force applied on the piezoelectric plate. A solar panel is also utilized for more support in this model.

2.1.2 Security system

The security system is designed with a motion detection sensor that can detect the presence of any person with a detection range of 2-30cm and will alert the user with a warning message. The vibration sensor detects vibrations or movement and warns the user with a buzzer sound. A fire sensor is also used to detect any fire breakage with a warning message and buzzer sound. LDR sensor helps to detect presence of light. During the night when there is no presence of light, it helps to ON the street lights around the place.

2.1.3 Integration with IOT platform (Telegram bot)

To facilitate seamless monitoring and communication, the proposed system integrates with the telegram bot. This is a robust and efficient platform for data transfer enabling real time monitoring i.e, receive real-time updates, sensor readings, or status reports, etc. This allows users to monitor the place remotely. The telegram bot is supported with the help of ESP8266 WiFi module which communicates with user through telegram application on mobile.

2.2 Implementation

The arrangement of all the hardware is shown in the below diagram.

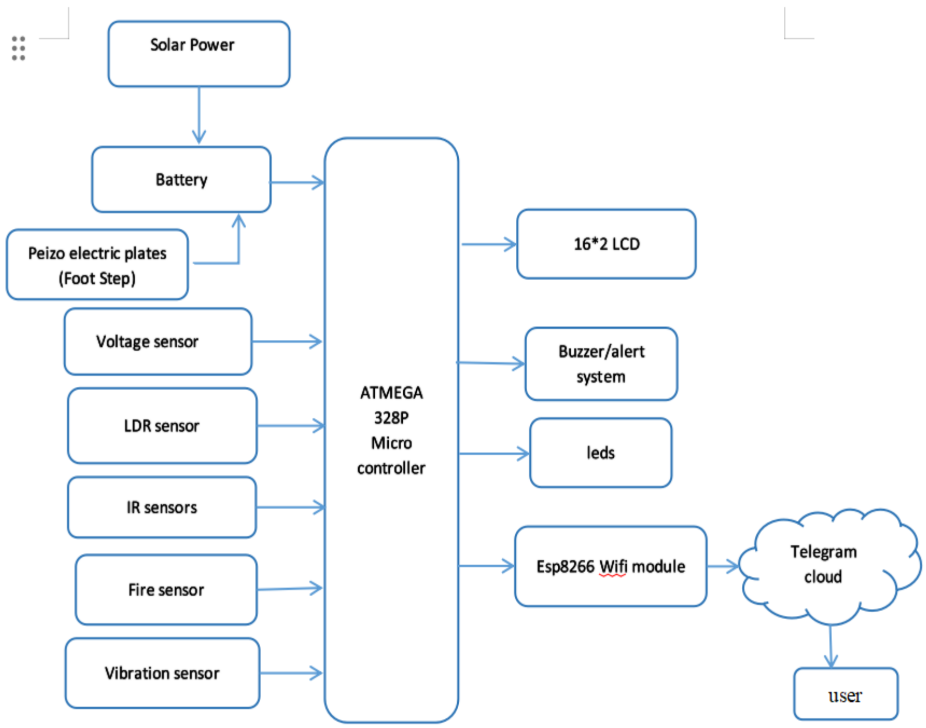

Fig 1: Block diagram

2.2.1 Hardware setup

The hardware setup in this project contains the piezoelectric plates and a solar panel connected to the battery and the security system that comprises of four different sensors namely fire sensor, motion detection sensor, vibration sensor and LDR sensor connected to the Arduino programming board. A buzzer is used as a warning system and a LCD module to showcase the status of the sensors. To be able to interface with IOT, a module that supports integrating this hardware to WiFi is required. this model uses ESP8266 WiFi module for this purpose. Because of its built-in WiFi capability, it allows devices to connect to local WiFi networks and communicate with other devices or the internet.

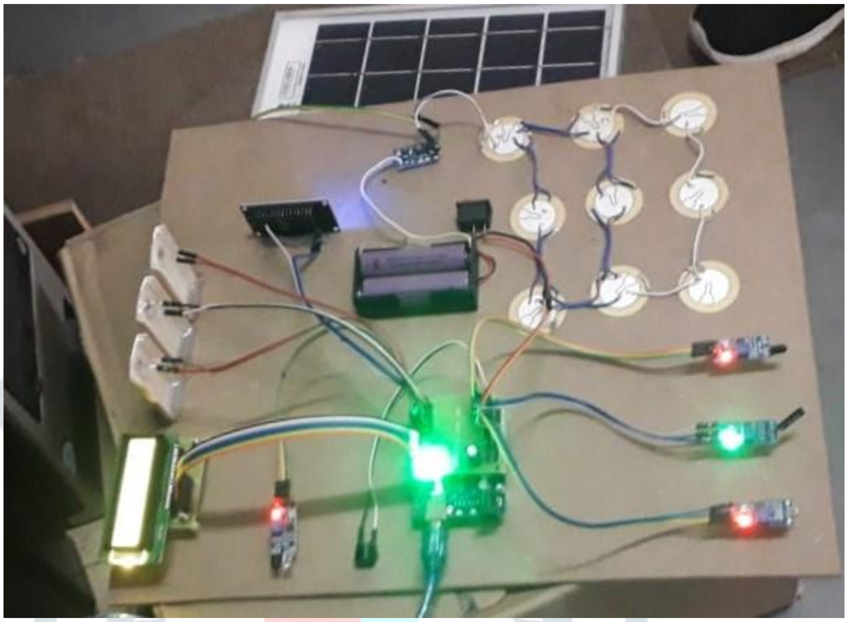

Fig 2: Hardware setup

2.2.2 Software development

The software development segment encompasses two main components: the backend system responsible for analyzing and acquiring the data and the frontend mobile application for user interaction. The platform that helps transmit the data from hardware onto the WiFi is Arduino IDE. This is used to program the WiFi module as per the user requirements. The backend communicates with IOT platform ensuring seamless integration.

The mobile application used in this project is the telegram. In telegram we access ‘botfather’ which is a chat bot that gives the user a token number. That token number along with the network credentials of the user is given in the backend program which is written in Arduino IDE tool hence enabling the user to get alert messages and notifications regarding security system implemented in this paper.

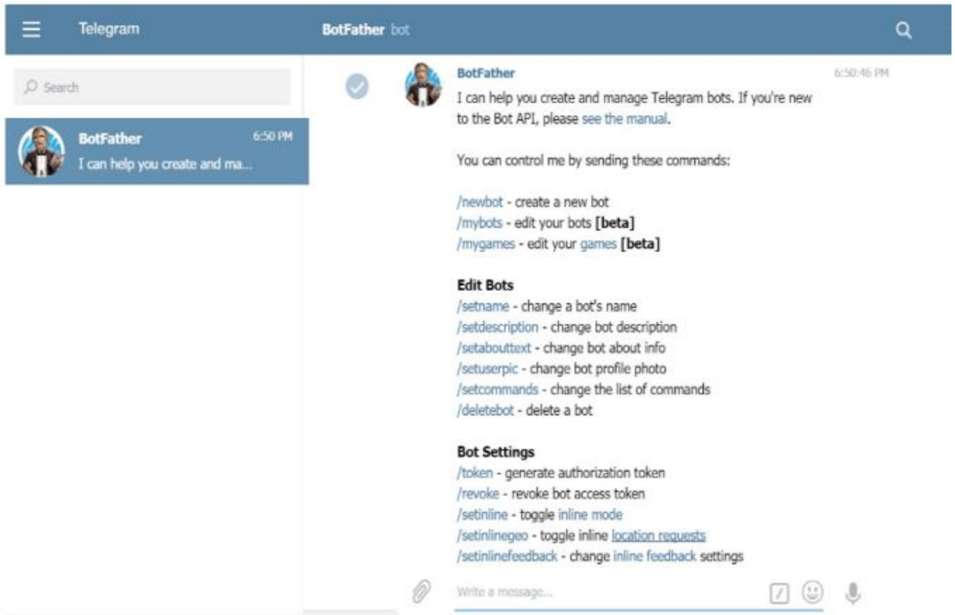

Fig 3: Telegram bot interface

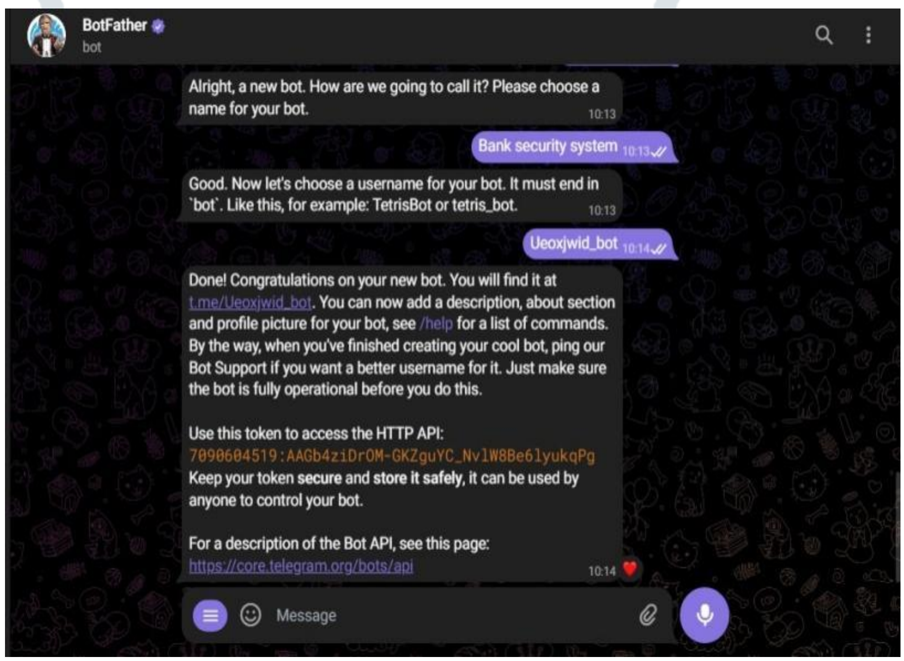

Fig 4: Token generation in telegram bot

The figure 3 shows the process of getting token number to enable remote access to the sensor data and alert messages. Figure 4 shows the token generation in telegram bot for WiFi module to interface telegram bot to the hardware WiFi module.

III. RESULTS AND DISCUSSION

The results of this paper Renewable power generation for smart security system showcases the system's efficiency in harnessing energy from footsteps and underscores its viability as a reliable and eco-friendly solution for powering security applications. Also, the consistent and reliable performance of the footstep power generation system highlights its practicality and adaptability in real-world security scenarios. These positive results suggest that the integration of such energy-harvesting technology can contribute significantly to enhancing the autonomy and sustainability of security systems, thereby reducing reliance on traditional power sources.

The below figure shows the status of the sensors in the LCD in the project when there is no motion or fire detected the status remain as value 1. If it is detected the values change to 0 as shown in second figure.

In below figure, the letters 'L' and 'V' in the LCD represents the current values of light sensor and vibration sensor respectively. 'F' and 'O' represents the status of fire sensor and object detection sensor respectively.

Fig 5:Initial LCD status

Fig 6: LCD status after motion detection

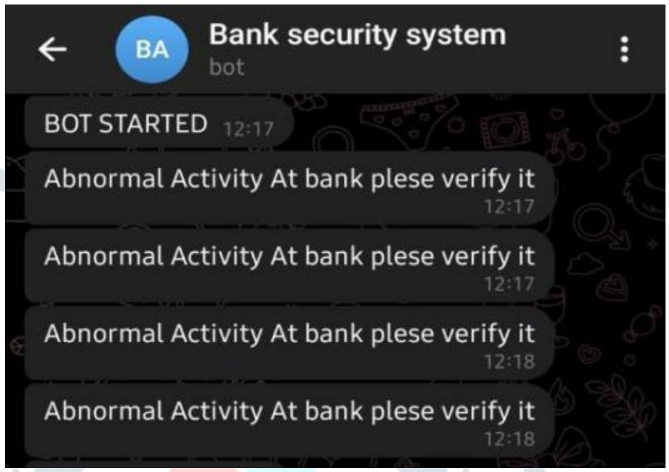

Fig 7: Alerts in user's telegram

Coming to the power generated, in this project, we connect nine piezoelectric plates and the power thus generated is stored in batteries. The amount of electrical power produced fluctuates at each stage within the piezoelectric array's operation. Practical observations have revealed varying voltage outputs at different steps.

- Minimum voltage generated per step is 1V
- Maximum voltage generated per step is 10.5V
- Assuming the average weight of the person stepping on nine plates is 50kg, then the calculation is:
  Number of steps required to fill the battery's 1 V charge. = 700
- To completely charge up the battery's 12 volts:
  Total number of steps = (12 × 700) =8400

For example, if we implement this system at places like biometrics at college or staircases at malls, where footsteps are the main source and are easily available, then consider the time required to place 2 steps is 1 second, then time takes for completing 8400 steps = 8400/ (60 × 2) = 70 minutes.

Hence, it can be observed that the system effectively converted human footsteps into electrical energy, showcasing its potential for sustainable power generation.

IV. CONCLUSION

In conclusion, the renewable power generation and the security system based on the power that is generated in this system represents a significant advancement of renewable and sustainable power generation techniques. The integration of Internet of things and user friendly interfaces has resulted in a comprehensive solution that excels in accuracy, responsiveness and user experience. This footstep based power generation system presents itself as a promising and innovative solution for addressing the energy needs of security applications. Through extensive experimentation, it became evident that the system effectively transforms human footsteps into a sustainable and reliable source of electrical power. The consistent and successful generation of power underscores the system's potential to contribute significantly to the autonomy and efficiency of security infrastructure. This eco-friendly approach not only reduces the reliance on traditional power sources but also aligns with the growing emphasis on sustainable technologies. The demonstrated feasibility and practicality of the footstep power generation system suggest its potential for widespread adoption in various security contexts. As the world navigate towards a future with increasing energy demands and environmental consciousness, this technology holds the promise of transforming how we power security systems, offering a greener and more self-sufficient alternative.

Further research and development in this field could lead to even more advanced iterations, solidifying the role of footstep power generation as a sustainable and effective solution for enhancing security applications.

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