An Advanced Application to Decrease Household Power Consumption and Save Energy Detecting the Weather Condition

Taoseef Ishtiak
Department of Electrical and Computer Engineering
North South University
Dhaka, Bangladesh
taoseef13@gmail.com

Rahman Masuk Orpon
Institute of Information Technology
Jahangirnagar University
Dhaka, Bangladesh
r.masuk_orpon@yahoo.com

Nowfel Mashnoor
Department of Computer Science and Engineering
Rajshahi University of Engineering and Technology
Rajshahi, Bangladesh
nmmashnoor@gmail.com

Moonmoon Ahmed
Department of Electrical and Computer Engineering
North South University
Dhaka, Bangladesh
moonmoon_tonimaeee@yahoo.com

Mohd. Azfar Nazim
Department of Electrical and Computer Engineering
North South University
Dhaka, Bangladesh
azfar.nazim@northsouth.edu

Abstract—To **save resources and for a greener planet, saving electricity is a must. Many of the common people use electricity without any calculation or thoughts if it is possible to save electricity with less usage but fulfilling their needs. In this paper an advanced application has been introduced where any user can plan for his wished electricity bill at the end of the month, can plan for a less consumption than the previous day based on a pre-given priority list and weather condition. The application runs an algorithm to calculate the best way to lessen down power consumption and electricity bill while using all the household electrical appliances that a user wants. Currently, users can have no predetermined idea about how much he wants to consume power daily or there is no way to plan a time schedule to run each of the appliances that the user wants for lessening down the electricity bill. As a result, accumulating daily usage the user has no idea about the ways to consume less power saving both energy and expenditure for a country. To make a way for informing the usage and cost of power, this application has been developed. Through this application a user can save the energy and money as well; which on large scale can raise a massive awareness to consume less power, positively effecting national grids. In addition, the application can detect weather information using API (Application program interface) and can intelligently inform the customer to run the more needed appliances according to weather condition with respect to the user's monthly and daily budget and usage of electricity units through an advanced algorithm**.

Key Words—API **(Application program interface), JAVAFX Maven Application, Load reducing, Power consumption, Weather condition**

I. INTRODUCTION

The earth's mineral resources need to be saved for future. Therefore, we need to save more energy and resources. Although renewable energies are in high focus of researches for fulfilling the future demand of power and energy, we also need to focus on ways to control energy usage, removing energy wastages and adjusting a decent budget for common people to remove economic crisis. When a user uses power, only the reading of units is stored in the house meters. However smart metering extends new features but a user cannot get to know if there is any way to consume less power on daily basis. As a result, at the end of the month the user suddenly gets the utility bill with more than expected expenditure. On the contrary, many of the users cannot use their needed appliances accordingly for the fear of extra usage of power and expenditure. To solve this crisis, an advanced and intelligent system should be brought where any user can plan for a budget at the beginning of the month and have the suggestions about daily usage to meet the budget accordingly. The user should have the access to modify the budget any time within the month in the context of sudden needs; which allows the user to have the freedom of using all the needed appliances. To make the best optimization of power, weather information should be captured aiding the user to get any appliances to use more efficiently according to the weather. Meeting these needs, a user can have a well-planned budget to make the best use of power. For the versatility of the application, user can make plans both with respect to dissipation and power consumption units (in wattage).

II. RELATED WORK

Smart metering has allowed people to get a wide range of information about environment variables and power usage of a house. In this project, we have developed an application where user can get to know how he or she can reduce the household power usage based on weather conditions while satisfying user's demand. To do so, we had studied previous researches and works on Smart Meters [1][2] to explore its features and appliances that use less power and are eco-friendly. We have gone through researches on GSM module

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[3] and on data sending to servers [4][5] from hardware to extend this application's work in future where it can be embedded with House Meters or Smart Meters offering users advanced features for consuming less power (detailed in Future Works Section). Integrating all these technologies and research works, we have planned to utilize these researches to aid common people specially in the developing countries where saving both power and money is one of the most important ways to benefit human lives.

III. SOFTWARE DEVELOPMENT

The research goal of this project is to develop an application for optimizing household power consumption. This application suggests and helps users to get the idea of an optimized use of household power consumption executing every need of the users. Moreover, for smart and better result an advanced algorithm runs in the backend with the database where the application combines user preferences, weather conditions and generate a smart result for the users' best use of electricity. The application is developed with JAVAFX Maven where on given list of compounds, the application gets the idea of what kind of instrument it is and what it works for from the user. Later, based on user preference and weather condition, it generates the result. The weather condition is processed using an Open Source API [6]. For the development of the advanced algorithm, the received data is processed with the result of a weather based Researches and Projects [7] [8] [9] where the amount of humidity relating with temperature, rain and seasonal effects combine with user preference to generate the output.

IV. Designing Components:

The research is currently software based to predict such power usage where the user can consume less power but fulfilling all the needs. In the research, we have used:

1. JAVAFX Maven
2. My SQL Database Server connected with JAVA JDBC

V. WORKING PROCEDURE

Basic model of this application stands on an algorithm where on given power input comparing with the previous day's power usage; it can determine schedules to run all the appliances in unit of hours throughout the day to meet the budget. The application is a desktop application developed by JAVAFX MAVEN built for any operating system, users should be able to use the application for their respective houses. Afterwards users need to have the regular usage of power from House Meters and can plan the usage and budget on the application. Environment variables such as: temperature, humidity, wind speed, precipitation and other weather conditions will be read by the API. At the very beginning, user needs to add the list of appliances in the house with its wattage, number of each appliance and purpose of using. The list of appliances will be saved in the database and can be updated anytime. After saving the list of appliances, the user will collect previous day's usage and bill for the particular day also with the input of the percentage that user wants to consume less than the previous day. The user can input both in unit of wattage or currency to make suitable plan for budget and later will give priorities for the appliances that are more likely to be used. Based on the given priority and collaborating weather information extracted by the API, the user will get a visual suggestion in the application where it will be mentioned which appliance to run for what amount of time to meet the power consumption or to maintain the predetermined budget. In the calculation part, each unit of electricity is assumed to be priced 7 taka (BDT) for simplification, but it will be different in country wise unit price of electricity.

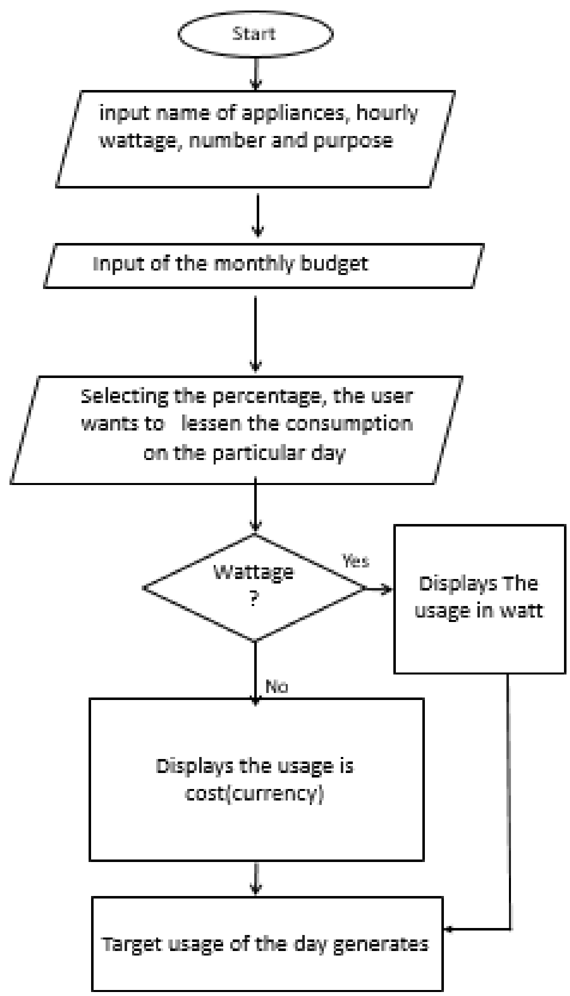

Fig 1. Flow chart for input of appliances

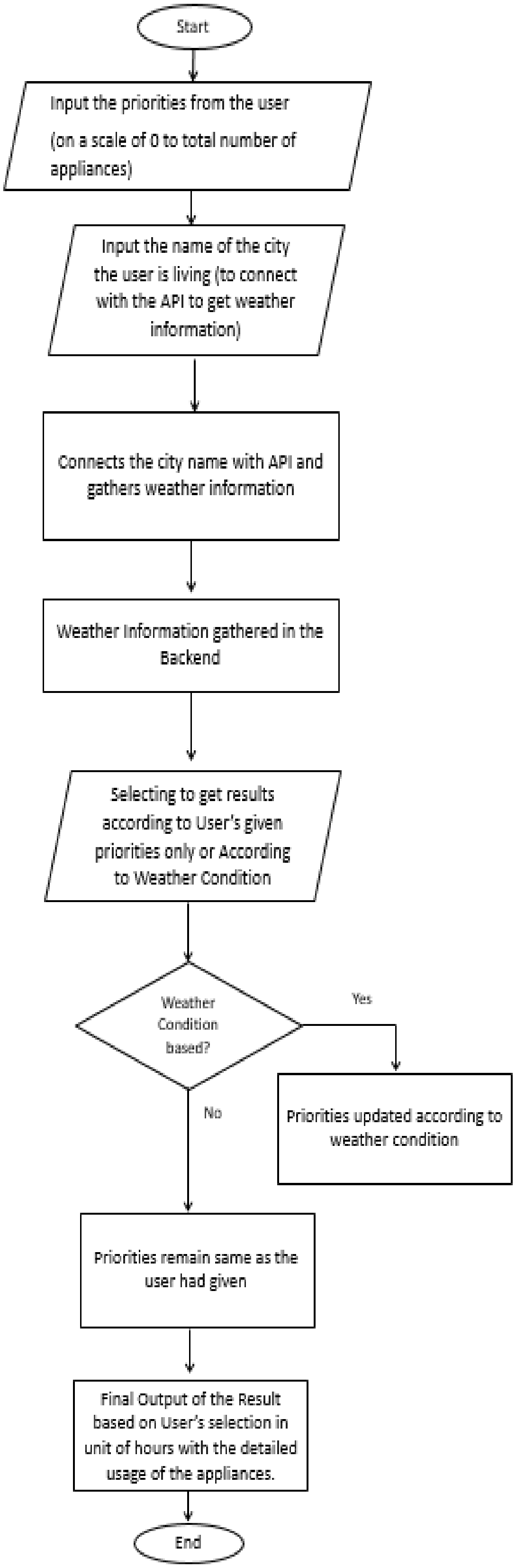

Fig 2. Flow chart for input of priorities working procedure

VI. ALGORITHM ANALYSIS

The application runs on two separate algorithms; one for: calculating the result from user preference and another one: with the detection of weather information the preference gets updated correspondingly. When the application stores the preference of the user in forms of digits, it takes the purposes of the appliances parameter as well. Afterwards the survey over temperature, humidity, wind speed; the algorithm determines whether the day is a hot summer day or cold winter day or a rainy day or an average day. Based on the decision gained by the algorithm, it modifies the priorities on the basis of given purposes. The modification done with the increment of those appliances' priorities which purposes are more likely to be used for the day. The algorithm takes O(n) time complexity to generate the result.

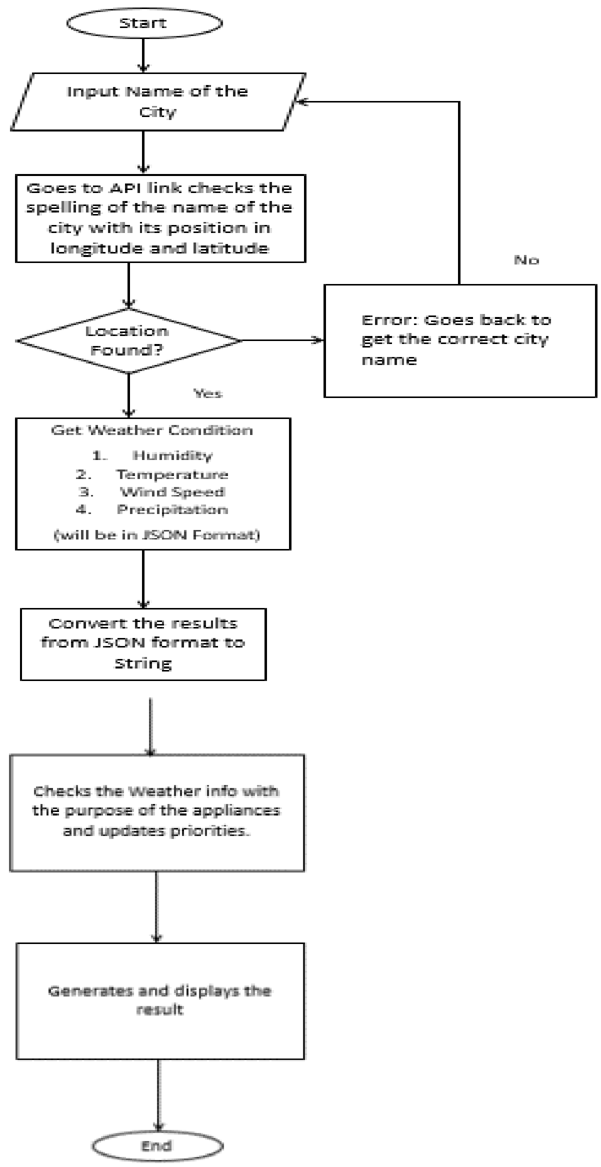

Fig 3. Flow chart for the algorithm

```
for(int I = 0; I<1; I++){
    if(temp >=25 && temp <=40 && humidity>=40 && humidity <=50 && variables.purpose[I] == "cooling"){
        tprio = tprio+2;
        System.out.println("it is assumed as a hot day");
    }
    else if(temp < 25 && temp >= 10 && humidity >= 30 && humidity <40 && variables.purpose[I] == "heating"){
        tprio = tprio+2;
        System.out.println("it is assumed as a cold day");
    }
    else if(temp < 25 && temp >= 10 && humidity >= 30 && humidity <40 && variables.purpose[I] == "air conditioni
        tprio = tprio-variables.I;//minimum priority for Air Conditioners
        System.out.println("it is assumed as a cold day");
    }
    else if(temp >= 30 && temp <= 50 && humidity > 60 && humidity <= 90 && variables.purpose[I] == "air conditio
        tprio = tprio+2;
        System.out.println("it is assumed as a extremely hot day with very high humidity");
    }
    else if(temp >= 20 && temp < 30 && humidity>60 && humidity<=100 && variables.purpose[I] == "ligtining"){
        tprio = tprio+2;
        System.out.println("it is assumed as a rainy day");
    }
```

Fig 4. Part of the code to determine weather condition

```
for(int I= 0; I<i;I++){
    if(temp >=25 && temp <=40 && humidity>=40 && humidity <=50 && variables.purpose[I] == "cooling"){//for summer/hot
        System.out.println("for summer/hot temp");
        tprio = tprio+2;
        finalAppUsage[I] = (((prio[I]+2)*Double.parseDouble(usage))/tprio);
        String frac2 = String.format("%.2f", finalAppUsage[I]);
        finalAppUsage[I] = Double.parseDouble(frac2);
        System.out.println("all the "+apps[I]+"will consume "+ finalAppUsage[I]+" W and each of the apliance will con
        b.append("all the "+apps[I]+" will consume "+ finalAppUsage[I]+" W and each of the apliance will consume "+fi
    }

    else if(temp < 25 && temp >= 10 && humidity >= 30 && humidity <40 && variables.purpose[I] == "heating"){//for win
        System.out.println("for winter/cold temp");
        tprio = tprio+2;
        finalAppUsage[I] = (((prio[I]+2)*Double.parseDouble(usage))/tprio);
        String frac2 = String.format("%.2f", finalAppUsage[I]);
        finalAppUsage[I] = Double.parseDouble(frac2);
        System.out.println("all the "+apps[I]+"will consume "+ finalAppUsage[I]+" W and each of the apliance will con
        b.append("all the "+apps[I]+" will consume "+ finalAppUsage[I]+" W and each of the apliance will consume "+fi
    }

    else if(temp < 25 && temp >= 10 && humidity >= 30 && humidity <40 && variables.purpose[I] == "air conditioning"){
        System.out.println("for winter/cold temp");
        tprio = tprio-variables.I;//minimizin the priority of Air Conditioner in Winter/Very Cold Environment
```

Fig 5. Part of the code to update the priorities based on weather condition

VII. RESULT

The application was practically applied for demonstrating its effectiveness and the result was up to the mark. For checking the effectiveness, 5 users had volunteered to use the application inside their houses. They input their appliances list, collected previous day's usage from the House Meter and then had given their priorities. In the API result they had found almost similar weather information compared to the local source with an error of less than 2% on an average.

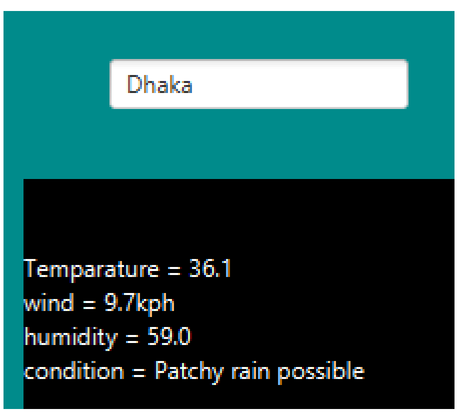

Fig 6. Weather Information gathered from API

The users then ran both of the options to generate final result by their own given priorities and priorities updated by the algorithm. Both of the results had cooperated the users to consume fewer power fulfilling their minimum demands yet the results generated by the weather based algorithm were found to be more effective.

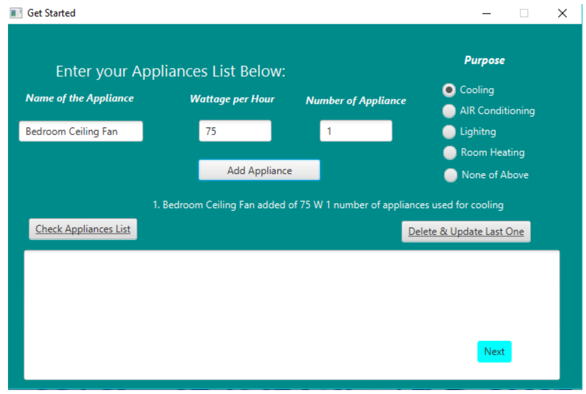

Fig 7. Input of the appliance's name, wattage, quantity, purpose

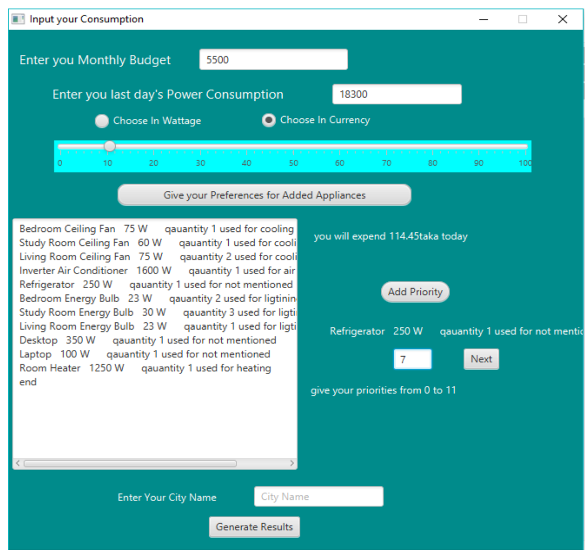

Fig 8. Input of the appliance's priority

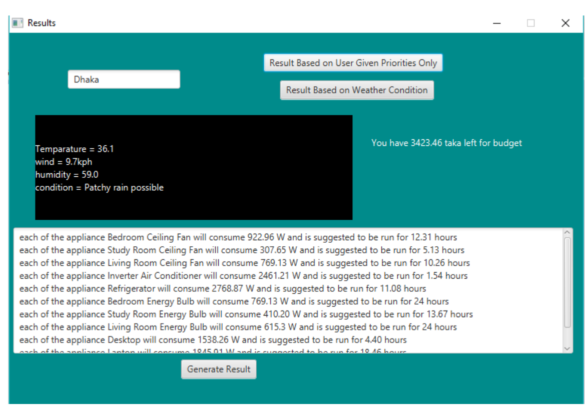

Fig 9. Result by the user's priority only

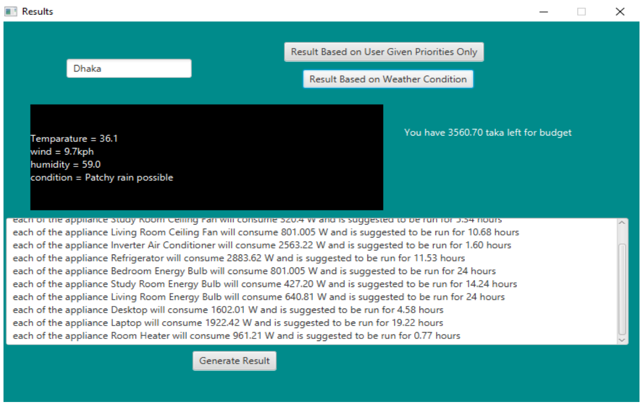

Fig 10. Result by the weather based algorithm

The 5 volunteered users were asked to use the application in their house for 7 days and from their response, it was confirmed that they were able to successfully reduce the power consumption in their house. The average reduction of the power was satisfying; showing within 7 days on an average about 5887 W had been saved.

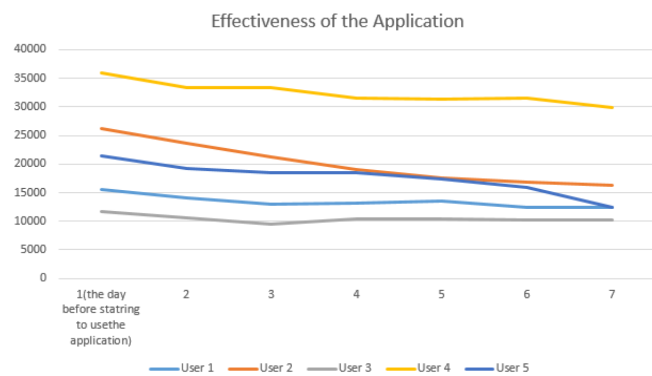

Fig 11. No. of days Vs power usage graph (based on the results of weather based algorithm)

VIII. DISCUSSION

The result generated by the application displays in hours, so the user can be assured that the resultant appliances can be used for such amount of time without the fear of extra expenditure. However, the result generated by the application is suggesting the user how the appliances should be used to consume comparatively less power but the user may appear to use less power than the application suggests. If there is no use of such appliances or even if necessity appears to use more power the user can readjust the plan anytime. In 2015, the average annual electricity consumption for a U.S. residential utility customer was 10,812 kilowatt hours (kWh), an average of 901 kWh per month. [10] If 10 houses use this app and on a day on an average 10% less power, for that day a significant amount of energy can be saved which means a lot for any developing or underdeveloped country. Thus, the application chief priority is to use less power while accomplishing the demand.

IX. FUTURE WORKS

Currently the main working procedure is working off line; the first task for further development of the project would be developing the whole working project online with a chat bot that shall be get to get all the information about the household power system and deliver it to the user anytime. A mobile application can also be developed with the same feature for a more versatile use of the research work.

The previous day's usage is input manually in the application but the process can be made automated where a hardware based server system will be connected with the House Meters/ Smart Meters so that power usage for any period of time can be saved in the server. The chat bot can then get the information of previous power usage and cost for any period of time and then can inform the user anytime to check the user's budget maintenance energy consumption. To get a more perfect result based on weather condition, data loggers can be implemented inside the house to work alongside with the API so that the actual internal environment of the house can be detected and work with the application system. Besides, determination of weather condition can be done with country and region wise selection in the application; so city's weather condition from any country can be detected more efficiently and preferred choice of appliances can be pre-determined as well. The application and research is done on household power supply but the future research can be done upon the industrial optimization of power. Thus, the research project can be implemented both on houses and industries. As a result, a large scale of power can be saved, reducing pressure on national grid.

X. CONCLUSION

The research project is done keeping the aim to reduce household power consumption while fulfilling the needed demands of electricity of users. The project can also be modified to be used to optimize industrial power consumption and other places to reduce load on grids. Connecting it with a chat bot or make a web application based on the same concept can increase the efficiency of the project to a great extent. With the application load consumption can be reduced as achieved from the results and pressure on mineral resources for electricity production can also be reduced. For a greener planet, the application can raise a massive awareness. The general people, especially from the developing countries are hoped to be benefited by this research work.

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