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Smart Vending Medicine and Energy Conservation

EDITED BY

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CIIR SCIENTIFIC PUBLICATIONS

Contents

Preface

Energy conservation is the process of lowering energy consumption so that the energy source can start to reassemble itself. The best method to accomplish this is frequently to use energy from a different source in lieu of the one being used. To reduce expenses and protect the resources for future use, energy must be saved. By releasing hazardous chemicals into the atmosphere, conventional energy sources damage the ecosystem. The supply of conventional energy sources is finite and might eventually run out.

By utilising low energy services, energy conservation aims to cut down on unnecessary energy use. This can be accomplished by altering one's behaviour to consume less service or by using energy more efficiently (using less energy for ongoing service). (for example, by driving less). Through effective energy use, which has a number of benefits, including a decrease in greenhouse gas pollution and a reduced carbon impact, as well as expense, water, and energy savings, energy conservation can be accomplished. Green engineering techniques extend the life of machine parts that transform energy from one form to another.

Reducing waste and losses, increasing efficiency through technological advancements, improving operations and maintenance, changing user behaviours through user profiling or user activities, monitoring appliances, shifting load to off-peak hours, and offering energy-saving suggestions are all ways to conserve energy. It is possible to identify user routines and behaviours in energy consumption by keeping an eye on device usage, creating an energy usage profile, and spotting trends in situations where energy is being used inefficiently. The identification of inefficient equipment with high energy load and consumption is made possible by appliance energy profiling. Seasonal changes have a significant impact on energy consumption as well because more air cooling and heaters are used during milder and cooler months, respectively. Although challenging, striking a balance between user comfort and energy load is crucial for energy conservation. A small number of variables, such as governmental problems, technical advancements, economic expansion, and environmental worries, have a significant impact on patterns in energy usage. Energy saving is significantly influenced by user behaviour. User activity tracking, user analysis, and device engagement behaviours are all involved. Smart vending machines are one such gadget with many uses.

Our usual perception of vending machines has been totally altered by smart vending machines. These vending machines offer an incredible variety of goods, including soups, desserts, gadgets, health products, and just about anything else you can think of. Products of all colors, sizes, and designs can be dispensed using sensitive balances and moving conveyors. Customers can avoid the queues by using the memento dispensing devices at the official goods shop inside the Tokyo Olympics' media centre. Customers can buy Olympic Games memorabilia like cups, totes, eyeglasses, and traditional daruma figurines with just a few taps on an interactive screen.

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CHAPTER 1

INTRODUCTION TO ELECTRICAL ENERGY

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One of the key issues in energy systems is energy usage. After the energy crises of the 1970s, energy usage was taken into account. Additionally, it has been shown that the world's energy consumption is rising quickly. Each nation thus strives to utilise as little energy as possible across their nation, in everything from buildings to farms, from industrial processes to cars. As energy comes from three distinct sources fossil fuels, renewable energy sources, and nuclear energy it takes a lot of work to keep track of how much of each form of energy is used where. However, by doing so, we can forecast how much energy is used in various locations and attempt to build plans that are tailored for a particular consumption and location [1]–[3]. Decision- and policy-makers may benefit from calculating the utilisation of all the energy categories indicated above. Knowing how much energy would be used throughout their process or job will enable them to think of improvements that may be made to minimise the quantity of energy utilised. Short-term and long-term energy use forecasting will enable us to identify the primary energy sources and attempt to buck the trend, as was done recently with fossil fuels and the advent of renewable energy sources. Distinct elements like water, wind, and temperature have a different impact on how much energy is utilised in various locations. Energy consumption forecasting is a challenging task due to the many variables involved. 41 Because they are beneficial and behave like a function that optimally translates the input data to output, ML models are being used in a variety of fields. Energy consumption predictions may be produced using machine learning models with excellent accuracy. Governments may utilise them to execute energy-saving programmes.

Academic research must address many diagnoses of the environmental sustainability problem. This will assist in gathering crucial data for civil society and policy decisions [4]–[6]. Any kind of seed investment that enhances the partnership between utility companies, university researchers, and small- to medium-sized businesses is very beneficial for putting the findings into action. Numerous environmental advantages are provided by the creation and use of energy-efficient technology, including:

Less hazardous emissions, less waste, financial gains by using less energy and other resources, and improved recycling systems.

It takes a lot of preparation on the part of the government, private utility companies, and policy makers to be on track for one or more of the sustainability targets outlined above. Basic and more advanced energy prediction algorithms have both been utilised to obtain an accurate estimate of future global energy consumption. Machine learning algorithms have been able to improve or, in the long term, replace traditional energy forecast techniques since the development of artificial intelligence.

Tariffs on carbon emissions have been steadily rising in the industrial sector. Energy consumption efficiency is crucial to fighting growing energy bills and lowering tariffs.

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Numerous strategies are being considered internationally with reference to the sustainability aim as a result of the current fast climate change. To replace existing policies and more effectively meet the sustainability goals for the century, a number of new policies are being explored. More ambitious energy efficiency goals have been developed for the year 2050 as a result of growing interest in this field. Goals must be appropriately appraised in order to achieve these objectives. Creating effective and trustworthy tools is becoming harder. With more instruments available, there are now more system- and procedure-specific sustainability objectives.

The top five energy challenges are as follows:

Rising energy consumption: The industrial revolution in the 1800s and 1900s started a pattern of explosive development in the world's need for energy. Nearly every forecast for the use of energy in the future assumes that the world's energy consumption will continue to rise, albeit the data are very different between studies. According to a variety of academic sources, the average global energy growth by the end of the twenty-first century would be a factor of three.

According to the range, it may be anywhere between 2.5 and 5.5. Even though it has been shown that energy efficient technologies have extremely cheap or even negative costs, there are a number of obstacles to their implementation. We have seen a number of such hurdles from our experience with the Industrial Center at Clemson University. The following obstacles seriously compromise the decision-making leadership's intention to support energy projects: • Significant capital outlay and protracted payback times

SMEs face more risks from long payback times; • Production cannot be stopped in order to update systems;

The management's presumption that the firm's primary production goals and revenue come before energy initiatives.

A high cost of labour (in case of companies with no in house electricians)

Limited access to energy: Access to energy varies considerably throughout the globe. It can be shown that just 10% of the world's total energy consumption is used by the lowest 75% of the economic population. 1.5 billion people worldwide do not have adequate access to electricity, and 3 billion do not have access to modern energy equipment. The majority of rural households in developing nations continue to rely on more traditional techniques for cooking and heating/cooling.

Climate change: The yearly rise in energy usage has to be cut in half. Emissions of greenhouse gases are a significant factor in climate change. It is clear that the greatest single source of greenhouse gas emissions, energy production and consumption, is rising each year. If there are no significant policy changes, this is anticipated to increase quicker by the end of the twenty-first century. This is consistent with the projections made by the International Energy Agency that were covered previously in this chapter. In comparison to pre-industrial levels, a rise in the global mean surface temperature of 4 to 5° C is anticipated.

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CHAPTER 2

TECHNOLOGY FOR ENERGY PREDICTION

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There will be a rise in demand for cleaner electrical energy as the globe moves away from fossil fuel-based energy sources. To lessen reliance on fossil fuels, these electrical energy sources must be clean. As the globe fights climate change, producing firms must keep up with the rising demands for electrical energy to support electrical mobility, artificial intelligence, and other cutting-edge technology [1]–[3].

With the use of an energy forecasting tool, industries, home customers, and generating businesses may all plan out their future producing schedules. Consumers may also utilise energy forecasting systems, therefore they are not only for power producing businesses. If customers can forecast their energy needs, they can take greater action to increase the efficiency of their energy use. Additionally, customers may participate actively in the grid via distribution generation and demand side control strategies when networks support bidirectional power flow and real-time energy pricing systems. This may be used to plan activities in an energy pricing system with dynamic price. Energy forecasting may assist in determining grid prices, and customers can make educated decisions about when to utilise their devices to lower their energy bills.

All industries in the modern world are heavily dependent on energy. Numerous studies have shown that the construction industry alone uses more than one-third of all energy. Energy-efficient technology must be used in this sector to minimise power consumption, which raises the requirement for controlling energy efficiency in buildings. From 2015 to 2040, the energy consumption in the construction industry is projected to increase by an average of 2.7% annually, about double the average worldwide energy consumption. The management of a building's energy efficiency involves a lot of building automation. The methods for regulating the energy in a building must take into consideration maintaining visual and thermal comforts [4]–[6].

The past ten years have seen incredible advancements in machine learning. We can accurately anticipate future energy use with the aid of these machine learning algorithms. As one parameter is always time, time series algorithms are mostly employed to forecast future energy usage. There are techniques and models for time series prediction, including Prophet, Exponential Smoothing, and Autoregressive Integrated Moving Average. The Long Short Term Moving Average and Regression model was selected for this project.

Energy prediction takes into account the fan load at an institution. A dataset is created while taking into account the use information for fans and energy utilisation. The dataset is used to feed time series prediction algorithms that forecast the university's future energy use (Fan load). The outcomes of both algorithms are compared using Root Mean Square and R square values, with the energy consumption predicted for two months.

Because extra power cannot be stored without being transformed into other forms, which requires additional resources and expenses, it is essential to match electrical energy demand with the appropriate amount of supply. Nevertheless, underestimating energy use may be catastrophic, since excessive demand can strain the supply chain and even result in blackouts. Clearly, there are practical advantages to carefully monitoring a building's energy use, whether it be an office, a business, or a home.

Future energy usage can now be predicted with growing accuracy thanks to machine learning. Accurate forecasting has two advantages. First, managers receive important insights into the variables influencing their building's energy consumption, opening them opportunity to address them and increase energy efficiency. Forecasts also provide managers a baseline to identify abnormally high or low energy use and notify them of building issues.

The challenge, however, is in the non-linearity and volatility of real-time energy use, which is very subject to changes in outside influences. For instance, it is well known that the outside temperature has a substantial impact on a building's energy use for heating and cooling. The use of energy may also fluctuate erratically owing to supply failure, equipment malfunction, or even unpredictable swings that are difficult to pinpoint.

For this reason, predicting how much energy a building would need will help it use less energy. Due to the intricate differences in building profiles and the many types of energy consumed, the physical process of energy consumption is highly complicated. Since many elements, including weather, occupancy and behaviour, and system independent energy consuming devices, such as lighting, greatly impact energy consumption, it is exceedingly challenging to generalise energy usage in any particular structure and to reliably estimate energy consumption. Because of the complexity of buildings, it is difficult to anticipate their energy usage accurately.

The neighbourhood must have access to the necessary amounts of reliable electricity. As more and more nations experience economic growth, the world's need for energy will rise quickly. Customers will hold utility companies accountable for maintaining and enhancing their service, particularly the major ones that provide a significant geographic region. Utility firms keep databases on energy use patterns and trends in the industrial and home sectors to satisfy customer expectations. The most popular techniques for predicting utilising databases today, even after the development of artificial intelligence, are statistical regression techniques. However, the fast growth in acceptance of data mining and other estimating techniques has prompted the use of increasingly complex algorithms, such as decision trees and neural networks.

People spend the bulk of their lives inside their homes or businesses.

Governmental, public, and private utility firms across the world place a high value on building energy performance. It is crucial to have a reliable energy prediction algorithm that can be applied to pertinent accessible data in order to execute changes in building efficiency and track the results in terms of energy and cost savings. Because it is urgently necessary to estimate peak energy demand, which might then resolve difficulties with the electric distribution network, the future energy demand forecasting technique is now of great interest to the energy sector. This strategy may address important problems including inconsistencies in estimating future energy needs and variations in the quantity and source availability over time.

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CHAPTER 3

INTRODUCTION ENERGY CONSERVATION

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There is a thermodynamics issue with conventional power generating. The majority of the energy is lost when fuel is burned to produce electricity due to waste heat. Two-thirds of the initial energy is wasted in the process before power even reaches your outlet. The term "thermal generation" of electricity, which covers coal, natural gas, and nuclear power, is the only one for which this is true. Renewable energy sources like wind, solar, and hydroelectricity do not need the conversion of heat into motion, preventing energy loss.

Internal combustion engines also have a problem with significant energy losses. Around 80% of the energy in a gasoline-powered car's petrol tank never makes it to the wheels. For further information, check a previous article contrasting the effectiveness of internal combustion engines with electric cars. Despite being more effective than a car's engine, fossil-fueled power plants nonetheless face the same problem. Both times, changing energy from one form to another only leaves a little amount of the original energy to do the desired activity.

Most of the energy entering conventional thermal power plants is lost. Thermal production, which starts by producing heat, has historically been the most popular method for producing electricity. Using that heat, water is then brought to a boil and turned into steam, which drives a turbine and produces an electric current. Although the process is similar and very inefficient, the fuel source may be coal, natural gas, or nuclear fission. A thermal power plant releases waste heat as the bulk of its energy input. Energy utilised to run the power plant itself results in some additional modest losses [1]–[3].

In modern thermal power plants, energy loss during conversion ranges from 56% to 67% of the energy input. However, the complete quantity of fuel utilised at the upstream end of the process, not just the fraction that finally reaches your outlets, is subject to the effects of mining, processing, greenhouse gas emissions, particulates, and other types of pollution. The same holds true for the cost, which is obviously higher given the rising price of natural gas.

The heat rate, or number of BTUs of energy used to produce one kWh of electricity, is a key indicator of a power plant's efficiency. This straightforward calculation contrasts the total energy input into the power plant with the quantity of electricity that leaves the facility and travels to the grid [2], [4], [5].

Renewable energy efficiency

How about the effectiveness of renewable energy? An average wind turbine has an efficiency of 35 to 47%. Then then, doesn't it have the same poor efficiency as coal and gas power plants? Since renewable energy doesn't need fuel, it's impossible to compare it fairly to fossil fuels. Even with a 32% efficiency rate, a coal plant still consumes all of its coal. The effect of burning coal depends on how much coal is burnt, not on how much power is produced in the end.

However, a wind turbine that produces electricity by converting 32% of the airflow is not using any energy. Because wind is free, non-polluting, and constantly supplied by the atmosphere, even if wind turbines only catch a portion of the air passing by them, this is not as troublesome as the inefficiencies of fossil fuel facilities. Gas and coal cannot be compared, though.

However, the fewer wind turbines that are required, the more effective a particular wind turbine is. Therefore, efficiency is important, but in a different manner. With consistent improvements over the last several years, the efficiency of solar panels ranges from around 18% to 25%. A solar panel's inefficiency, like that of wind, does not need the Sun to provide extra energy in order to power the panel. However, more effective solar panels produce more power from each panel, which saves resources and space.

Hydropower is the efficiency king, transforming flowing water into electrical current with a 90% efficiency rate. Dams channel water directly through turbines, while wind turbines just sit in the middle of flowing air and convert part of it to energy. This contributes to the outstanding efficiency of hydroelectricity.

Overall energy consumption is reduced by replacing thermal power production. 24 % of greenhouse gas emissions in the US are caused by the production of electricity. The fact that all of the fuel that is used for waste heat simply does not need to be replenished at all is an underappreciated advantage of switching from fossil fuels to wind, solar, or hydropower to generate thermal electricity. The issue is moot due to more effective ways to produce power.

Take a look at a coal power plant that uses 1,000 megawatts of coal per hour and generates 320 megawatts of energy per hour. Only the lower amount need replacement with an alternative energy source. However, the replacement would result in fuel and emission savings of 1,000 megawatts. Changing to energy sources that are naturally efficient also results in a reduction in the total amount of energy required.

Lower energy losses result from energy storage and transmission. Electricity must be transported from the power plant to the final consumers, regardless of the source. According to the EIA, transmission and distribution result in a negligible loss of electricity—around 5% on average in the U.S. Transmission lines lose more power the farther they are used, and this energy loss is constant regardless of the kind of energy that is sent into the grid.

In order to decarbonize the power system, energy storage is becoming a more regular component of the electricity supply. How much power are batteries losing? In 2019, the massive lithium-ion batteries used by utilities had a round-trip efficiency of around 82 percent, which means that 18% of the initial energy was lost throughout the storage and release processes. Since batteries are becoming more efficient over time, the Department of Energy's grid storage study bases its projections on a battery efficiency of 86%.

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CHAPTER 4

ENERGY LOSS AND CONSERVATION

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The issue facing the whole globe is energy, a little word. specifically, when discussing electrical energy. Energy-saving technologies lower energy use and increase the energy-efficiency of electrical equipment. More businesses and organizations are becoming aware of the need to lower their energy impact. In both the public and commercial sectors, the implementation of energy-saving technologies offers effective energy-saving solutions [1]–[3].

Approximately one-third of all energy used worldwide is now used by the building industry, and a large portion of this consumption is directly related to HVAC systems. As a result, the construction industry is heavily responsible for balancing energy supply and demand, which makes energy conservation desirable. Energy conservation in the construction industry may be accomplished in two different ways: either by increasing the effectiveness of various devices like lighting and HVAC systems, or by lowering building loads by employing natural ventilation and shadings. However, it was shown that energy-saving contributions from shadings that are controlled optimally pale in comparison to the benefits of natural ventilation. According to reports, warm summer climates like those in Europe are optimal for natural ventilation in buildings.

Research has demonstrated that pristinely natural ventilation systems are unable to support the appropriate thermal comfort in more astringent conditions, such as warm and humid areas excluding certain coastal locations. The issue facing the whole globe is energy, a little word. specifically when discussing electrical energy. If you use more electricity, you'll have a hefty bill at the end of the month. always strive to reduce electrical energy usage, and we also evaluate energy prices from various suppliers. Imagine you are a person and you switch on your room fan. Normally, you forget to turn it off, which causes your bill to keep going up. Automation is the only tool that can help you prevent this, thus. For example, there must be a system that determines if somebody is still in the room and, if so, automatically turns off the lights. You may quickly cut your power costs in this method. This project presents the exact same idea; Buildings make up one of the greatest energy end uses, and the demand for electrical energy is continually rising.

Larger portions of such energy are lost owing to pointless cooling and lighting. Numerous research have shown that inadequate controls and a lack of feedback information are the main causes of this behaviour. A new management system is created and used in this project in order to save electrical energy. This system is made up of a microcontroller and several sensors, including temperature sensors, LDRs (light dependent resistors), and PIRs (Passive infrared sensor). This system's primary function is to assess the room's temperature, light level, and human presence before sending that data to the main control device, which uses superior controls and feedback information to switch on/off. Once the fan or lights are turned on, the fan speed and light intensity change depending on the ambient temperature and light [4]–[6].

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Utilizing the proposed approach may reduce the cost of power for each test instance, according to a straightforward measurement. In this, we provide a technique for home automation and a day lighting phenomenon combined with a power regulating system. Daylighting is a kind of natural illumination that offers visual, thermal, and sociable indoor environments to its users. The best quality light source is daylight as it has the greatest colour rendering index. A smart energy-saving system is a collection of highly intelligent devices that detect physical events, interpret them into data streams, and enhance safety, security, comfort, and energy-saving. In other words, a smart energy-saving system is a mechanism that replaces human contact with programmed electronic systems in as many internal operations as is theoretically feasible and desired.

In the end, it is a system that seeks to improve people's quality of life. Due to the recent threat of oil and gas pipeline vandalism, Nigeria as a whole has seen a significant decrease in power production of roughly 1000Mw, reducing the country's current produced power to about 2,500Mw as opposed to the peak demand of 12,800Mw. A smart energy-saving system that can effectively control power usage in households is now required due to this development and the continuously rising cost of electricity consumption. The traditional method of turning off the lights for a while to save money is uncomfortable in some sense.

Decisions made by the intelligent energy-saving system might be based on information acquired or gained from the environment. It will determine whether to switch on or off the lights after assessing the level of lighting in the specified area and the presence of people. It will also change the light intensity to account for natural light and the temperature of the fan to account for the ambient temperature. The asymptotic growth of technology has transformed human living and ushered in the digital age. The need for a reliable power supply and electrical energy is always at its highest due to the growing use of technological devices in daily life.

The cost of energy per unit has increased due to the steady rise in demand, and India is struggling to fulfil the rising demand for electricity from a rapidly developing economy. Multiple difficulties have only intensified as the electricity sector has been rebuilt. The development and implementation of a smart energy-saving system has as its major goal the achievement of an effective, dependable, and secure system that can save energy. Other objectives include making the most of sunshine, automatically balancing electric and natural lighting, controlling fan speed according to room temperature, and turning fans and lights on and off when no one is in the classroom.

In terms of electrical availability, the crucial issue is not which of these solutions should be used, but rather how a mix of these solutions should be used. The best option would depend on a number of factors, including the availability of resources, the regulatory and legislative environment, the institutional and technical capabilities, and the relative costs of each solution for each nation. Each has its own benefits and difficulties, and the greatest effect will be made when grid, mini-grid, and off-grid solutions are properly balanced and then integrated to address the issues in each distinct market.

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CHAPTER 5

FUTURE OF GLOBAL ENERGY CONSUMPTION

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Global energy consumption is anticipated to rise by over 50% by 2050 compared to 2020. The industrial sector's increased energy use is one example of this. Oil, gas, and electricity costs are especially high at the time of writing, in the first quarter of 2022, which has resulted in considerable additional energy expenditures for businesses. Prices are also anticipated to rise. As a consequence, major participants on the international stage, such as corporations and governments, are searching for strategies to achieve and support sustainable development, and new laws demand more energy efficiency and a decrease in emissions. Adopting energy-efficient technology is one of the most promising methods to accomplish these objectives since doing so will increase business sustainability and profitability. There are now approximately 300 million industrial motor-driven devices in use, and electrical motors utilise around 70% of the power used by industry. Therefore, increasing the effectiveness of electrical motor systems may significantly contribute to helping the world achieve "net-zero" CO_2 emissions and minimise waste [1]–[3].

The steps required to do this are doable, attainable, and efficient, and they may also lower energy expenditures for business. In fact, it's predicted that we might cut the world's power use by up to 10% if all 300 million motor systems were replaced with more energy-efficient machinery. 3 New kinds of digital services now provide even more potential to save energy use, thanks to the Internet of Things and digitization. These services make better judgements on energy efficiency by using linked digital technologies to deliver fresh data insights into energy usage. The status of equipment and even whole processes may be examined at any time, from any location, using remote connections and services. Additionally, fresh adaptable business models are beginning to emerge that may provide services for ongoing energy efficiency. ABB Motion, for instance, can help clients get the most out of their assets by sharing the responsibility for steadily enhancing the energy efficiency of equipment over time [4]–[6].

A number of foundational elements for universal energy access emerge as prerequisites, at both national and international levels, based on the lessons learnt from programmes throughout the globe to offer access to electricity and modern fuels. All of these will be dependent on the proper amount of resource and support mobilisation from a variety of players in various nations. more specifically.

Governments must prioritise energy access, establish ambitious national goals for universal access, and put policies and the right conditions in place to make those goals a reality. Government aims and priorities that guide a meticulous planning process serve as the foundation for large-scale electrification programmes that are successful. In order to promote these goals and private sector engagement, it is also required to put in place the relevant laws, programming capacities, tariff structures, and incentives. It will be necessary to quickly

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transform these policies into rules and laws. Multilateral organisations, international organisations like the IEA and IRENA, and non-profit organisations should all assist this process.

Financial assistance is necessary from the international community for poor nations to reach the AGECC-proposed global objectives of universal energy access and energy efficiency. According to the IEA's reference model, with an average capital expenditure of roughly $35 billion per year, it will be able to give the great majority of the world's energy-poor people with access to power adequate to satisfy the MDGs in the next 20 years.

Building local institutions' capabilities and capacities to provide delivery, quality monitoring, finance, operations, and maintenance services will be necessary in addition to addressing the issues with access to financing and lowering the costs of energy access and end-use appliances in order to improve energy access. Such capacity building is required in the public and commercial sectors, at all levels (national, sub-national, and community), and it should draw on the know-how and data base amassed by multilateral organisations and international organisations.

Utility performance: Since public utilities in developing nations often have technical losses that are four or five times larger than those in wealthy nations, improving utility performance will be essential for the grid's expansion and the achievement of the universal access goal. These utility improvements should be driven by private sector expertise from both developed and developing nations.

However, it is crucial to weigh this perspective of the advantages against the many obstacles and distortions that may reduce the financial gain and make it challenging to capture energy efficiency. These obstacles are readily apparent when one takes a sectoral or household view as opposed to the society viewpoint utilised to determine the total energy saving opportunities. The attractiveness of an investment depends on factors like the cost of capital, taxes, and subsidies, and transaction expenses like programme and administrative fees may greatly limit the potential savings offered. Energy subsidies are a significant disincentive to invest in energy efficiency and skew pricing signals in many nations. 92 Other significant barriers exist in both the industrialised and developing worlds, albeit their relative significance differs.

In the developing world, capital limits are a particular problem. For instance, this element by itself prevents the development of new power infrastructure, which may considerably improve generating efficiency. Even at the home level, more cost-effective appliances are sometimes out of reach because of the larger initial outlay, even if they would save money in the long run. This is often made worse by bureaucracy that restricts access to funds.

Lack of knowledge and comprehension of energy saving prospects may prevent end users from taking action and discourage financing institutions from supporting energy efficiency programmes. Energy-efficient technology are often primarily marketed to high-end customers, which creates a significant hurdle for emerging economies and low-income consumers. Energy-efficient technology's weak appeal, for instance because of bad design or few features, might discourage investment. The decision maker does not always reap the financial rewards of energy efficiency due to agency difficulties and divided incentives. For instance, while tenants reap the rewards, landlords have little motivation to invest in energy-efficient

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structures, and appliance makers won't use efficient technologies unless customers are ready to pay for them.

Another barrier is the inability of many developing nations to create and put into place the necessary laws, financial systems, and energy efficiency measures. Because they lack the essential implementation skills, many participants today would not be able to take advantage of the entire spectrum of possible efficiency savings, even if they had access to adequate resources.

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CHAPTER 6

COMPONENTS FOR ALTERNATE ENERGY

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LCD (Liquid Crystal Display)

For E-blocks, this LCD display was created. The LCD display has a single 9-way D-type connection and has a 16 character, 2 line alphanumeric display. The majority of E-Block I/O ports may now be used to connect the device as a result. According to the user manual that follows, the LCD display needs data in a serial format [1]–[3]. A 5V power source is furthermore needed for the display. A 5V maximum should be adhered to in order to prevent gadget damage. The E-blocks Multi programmer or a fixed, controlled power source with a 5V output are the best ways to create 5V. In order to optimise the display's contrast for the environment it is being used in, the potentiometer RV1 should be utilised as a contrast control.

Data must be supplied in two steps—the MSB and then the LSB—in order to send a command to the LCD. For the LCD to recognise each byte that is transmitted to it, B5 must first go high and then go low. The LCD performs the instruction after the second byte's acknowledgment. Before the next command can be issued, the PIC micro board must wait for at least as long as the execution time for that command. Among its features are: compatibility with E-Blocks; affordability; suitability for the majority of E-Block I/O ports; and ease of use in the creation of programming code thanks to flow code icons.

Solar panel

In order to produce electricity or heat, solar panels employ the sun's rays as a source of energy. Using the photovoltaic effect, a solar panel may produce energy [4]–[6]. Solar (or photovoltaic) cells are what make up a solar panel.

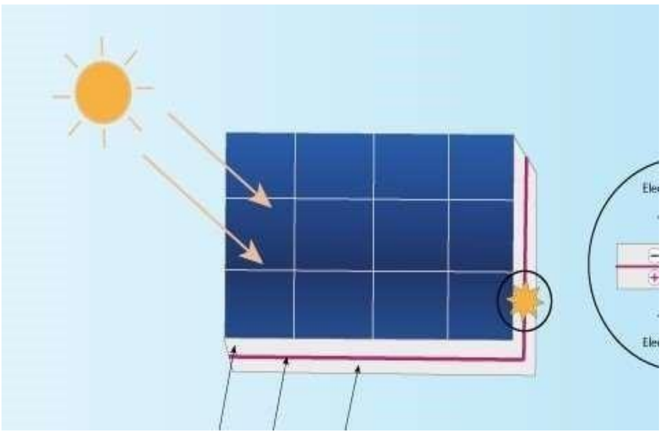

Figure 1: Solar Panel

Water sensor

The amount of water in the soil is determined using a soil moisture sensor. The soil's ability to withstand electricity is used. Here, it is utilised to detect the moisture in the air and send that information to the microcontroller, which it uses to regulate the water pump's ON/OFF switch.

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ESP 8266

The ESP8266 provides a full and independent Wi-Fi networking solution, enabling it to either host the application or offload all Wi-Fi networking duties to another application processor. It can boot up straight from an external flash when the ESP8266 is the host of the programme and the sole application processor in the gadget. The system's speed in these programmes is enhanced by the inbuilt cache, which also helps to reduce the amount of memory needed.

Alternately, any microcontroller-based device may provide wireless internet access by acting as a Wi-Fi adaptor with straightforward communication through the UART interface or the CPU AHB bridge interface. The on-board processing and storage capabilities of the ESP8266 enable it to be coupled with sensors and other application-specific devices via its GPIOs with minimum work up-front and minimal loading during runtime. It has a high level of on-chip integration, which includes the antenna switch balun and power management converters, reducing the need for external circuitry. The complete solution, including the front-end module, is also designed to take up the least amount of PCB space.

When it rains and when it stops raining, the roof automatically opens and closes in this instance using a DC motor. A device that transforms D.C. electrical energy into mechanical energy is known as a D.C. motor. The basis for the operation of a D.C. motor is the idea that when a current-carrying conductor is placed in a magnetic field, a mechanical force is applied to the conduction of a magnetic field, the direction of which is determined by Fleming's left-hand rule, and as a result, the conductor moves in the direction of force. "If the forefinger, middle finger, and thumb of the left hand are extended at right angles to each other, then if the fore-finger points towards the direction of magnetic field, the middle finger points towards the direction of current in the conductor, then the thumb will point towards the direction of motion of the conductor," according to the left-hand rule.

Features

High output: High heat dissipation and heat resistance generate greater output. Long life: Intermittent operation over 1 million cycles with improved brush design. Constant operating life of 3000 hours.

A wide variety of gear heads and reduction ratios are available to fulfil all applications. They feature:

- High strength: High radial load capacity owing to sturdy construction, a large diameter output shaft, and ball bearings.
- Low noise and enhanced insulation.

Rain sensor

The terms "rain switch" and "rain sensor" refer to switching devices that are engaged when it starts to rain. There are wireless and hard-wired versions of rain sensors for irrigation systems. A photodiode measures the quantity of rain by detecting how much infrared light from an LED is reflected off of the windscreen surface. The rain detecting device features a circuit that compensates for the glass's transmission rate so that it can always detect rain.

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CHAPTER 7

INDUCTORS AND THEIR APPLICATIONS

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When electric current passes through an inductor, it stores energy in the form of magnetic energy, which is employed in the majority of electrical circuits. Various other names for it include coil, choke, and reactor. The inductance of this two-terminal electrical component is what makes it unique. The relationship between voltage and current change rate is referred to as inductance. Henry, after the American physicist Joseph Henry, is the name of the inductance unit used in the SI system [1]–[3].

When electric current passes through a passive two-terminal electrical component known as an inductor, also known as a coil, choke, or reactor, it stores energy in a magnetic field. A coil of insulated wire twisted around a magnet is the conventional construction of an inductor. The electromotive force (emf) voltage in the conductor is induced by the time-varying magnetic field as the current through the coil varies, as stated by Faraday's law of induction. The induced voltage has a polarity (direction) that is opposed to the change in current that caused it, according to Lenz's law. Inductors thus resist any modifications to the current flowing through them [4]–[6].

The ratio of the voltage to the rate of change of the current, or inductance, is what distinguishes an inductor. The Joseph Henry (H) is the name of the 19th-century American physicist who invented the inductance unit in the International System of Units (SI).

Typically, the values of inductors fall between 1 and 20 Hertz (10 to 6 Hertz). To enhance the magnetic field and hence the inductance, many inductors incorporate an iron or ferrite magnetic core within the coil. One of the three passive linear circuit components that make up electronic circuits is the inductor, along with capacitors and resistors. Radio equipment, in particular, uses inductors often in alternating current (AC) electrical devices. Chokes are inductors made specifically for blocking AC while allowing DC to flow. As well as being employed in tuned circuits, which are used to tune radio and television receivers, they are also utilised in electronic filters to separate signals of various frequencies.

The tuning of circuits uses inductors

The tuning circuits' ability to choose the appropriate frequency is aided by inductors. The kind of capacitors and the inductor are used in a variety of electronic equipment, such as radio tuning circuits and televisions, in order to adjust frequency and aid in frequency selection among many channels.

As sensors, they are used

Since they are contactless, inductive proximity sensors are very dependable in use. Its basic working principle is inductance, in which the magnetic field inside the coil opposes the passage

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of electric current. To gauge traffic density, traffic lights employ a technology called proximity sensors.

Additionally, a gadget uses it to store energy.

Due to the fact that the energy that is being stored as a magnetic field in an inductor would dissipate when the power source is turned off, inductors can only store energy temporarily. In computer circuits that allow for power supply switching, inductors are used.

Within induction motors, inductors are used

When alternating current is present in an induction motor, a magnetic field created by that current causes the motor shaft to revolve. The frequency of the source's power supply may be used to control the motor's speed. A motor's speed may be adjusted by the use of inductors.

As transformers

Transformers may be created using a mix of several inductors with a common magnetic field. Systems for transmitting electricity are among the main applications of transformers. As step down or step up transformers, they are used to change the amount of electricity transmitted.

The filtering action of inductors

Capacitors and inductors work together to create filters. The employment of these filters limits the frequency of the incoming signal as it enters the circuit. The impedance of the inductor increases as the frequency of the supply rises.

Inductors are used in chokes.

As is well knowledge, when AC current passes through an inductor, it induces a current flow that is going the other way. Due to this, the inductor restricts the flow of AC current and allows DC current to flow. In order to convert an AC supply into DC, a power source uses a mechanism.

Ferrite beads are made from it.

In computer components and mobile phone charging cords, ferrite beads have been shown to be employed. Reduced frequency of radio interface caused by cable thanks to inductors employed in ferrite beads.

Utilized as relays

As an electrical switch, relay operates. A magnetic field is created whenever the switch comes into contact with an AC current flow thanks to the inclusion of an inductor coil in the switch.

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CHAPTER 8

PROTECTION PROVIDED IN TRANSFORMER

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Under-voltage and over-voltage are induced by the power supply's propensity to fluctuate the power source. When the mains input voltage grows above or falls below a certain allowable threshold, the equivalent DC voltage elevates or decreases as a result. This leads to excess motor heating, increased armature and rotor losses, and a great influence on machine insulation. When a motor is working too hard, it is said to be overcrowded. Overcurrent, inappropriate torque, and overheating are the three main signs of motor overload. In fact, high engine heat is a significant contributing factor to the early failure of the electrical and mechanical parts. Unbalance: But when comes to the number of turns, location of the unwinding, and unwinding resistance, all three phases of something like the winding of three-phase induction machine are meticulously calibrated. Unbalanced currents flow in the commentator when line voltages applied to something like a poly phase induction motor are not exactly equal, with the strength depending on the degree of unbalance. Even a slight voltage differential might cause the current to rise excessively. The motor may encounter a significant effect and overheat to the point of meltdown. As nearly as a commonly available commercial voltmeter can read, the voltages should be regulated evenly [1], [2].

Analyses of the transformer's economic aspects with a remote predictive maintenance system that provides the details needed about its operating status Transformer revenue loss to providers, consumers, and the economic development pipeline are compared between those with and without condition - based maintenance. To improve the transmission line and prevent excessive losses, it is vital to deploy any effective methods. In fact, studies have discovered that a major portion of a transportation and distribution system's overall losses come from losses in converters. A transformer self-protection system is devised and put into use employing the internet of things (IoT). Where, if the generator is not rapidly serviced, it will segregate low-importance loads (workshops, homes) and keep the high-importance loads (hospitals). However, if the transformer is unable to supply specific loads of critical importance, it will separate all loads and remain in the no-load state while continuously monitoring its conditions [3]–[5].

Technologies Used In Design and Implementation of Smart Transformer:

- Real-time transformer development and operation using GSM technology,
- Internet of Things-based power distribution condition monitoring system (IoT),
- Demand Side Management Technique for Load Control & Monitoring System Design and Simulation,
- A application software called PROTEUS for monitoring transformers parameters,
- Develop and use a remote transformers monitoring system that is reasonable,
- Online Distribution Transformers Condition Monitoring.

Design and Implementation of Real Time Transformer:

This device has the potential to simultaneously track the distribution transformer's overall health. The author describes the development of a portable embedded system for load monitoring. This solution integrates a single chip microprocessor, sensors, and a Global Service Mobile (GSM) modem. The system's main weakness is the use of GSM, which increases the expense of implementation and also shown in Figure 1. In this study, an intelligent monitoring program that can continuously check the transformer's temperature and projected faults like overheating and electrostatic discharge will be created. The fault diagnosis will then be communicated to the base station via the Global System for Mobile Communications (GSM) modem. This idea is put into practice by retrieving the distribution transformer's present incarnation in real time utilizing the internet of things. The distribution transformer's temperature, voltage, and current are measured by the proposed health-monitoring system, which incorporates a digital thermometer, a potential transformer, and then a current transformer. This documentation is sent to a remote computer where it is monitored and any immediate precautions to prevent a power cut can be taken.

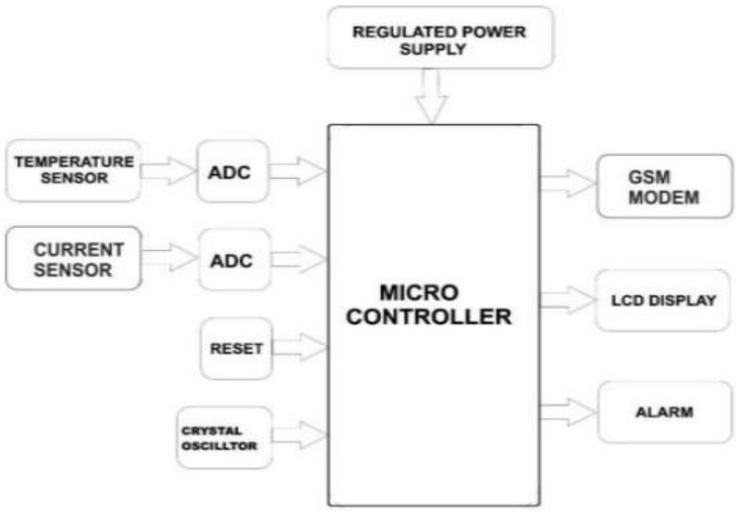

Figure 1: Illustrated that the Block diagram of the GSM System.

Testing Process

Units of the hardware and software were partitioned. The system was constructed and tested in smaller pieces, which made it more straightforward to manage and more effective. To ensure it was capable of supply the circuit with the necessary power, the power supply unit was show the amount. The temperature sensing device was tried before being connected to the microcontroller, in which it was found to be capable of providing an exact output signal matching the changing temperatures. Before connecting the current sensor to the computer, it was first validated. Once it was determined that the temperature as well as current sensors provided accurate data, the module's outputs then conditioned and delivered to the microcontroller. Before connected to the microcontroller, the GSM modem performed testing with a DC 9V battery. The device has been confirmed to be functional following the final stage of testing and module coupling, as illustrated in Figure 2.

Figure 2: Represented that the Testing of GSM Modem.

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CHAPTER 9

INTERNET OF THING (IOT)-BASED DISTRIBUTION TRANSFORMER CONDITION MONITORING SYSTEM

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Keep track of and log distribution feeder’s metrics including current, temperature, vibration, and humidity. At the installation of the distribution transformer, a master terminal unit is placed. The embedded system's 8-channel analogue to digital converter (ADC) interprets and stores parameters in the internal storage. The system will need additional time to accumulate and convey the data thanks to the ADC. Electricity distribution and distribution processes depend heavily on electrical transformers of the most vital and sophisticated parts of the electrical sector is the transformer. We all know that the distribution transformer is a significant component of the energy system and that the smooth functionality of the system dependent on its proper operation. The creation of a modular embedded system to monitor as well as record distribution inductor data such current, temperatures, rise or fall in oil level, vibration, and wetness is discussed in this work [1].

The distribution transformer site really does have a remote terminal unit installed, and the incorporated system's 8-channel analogue to digital converter (ADC) is used to process and enter the aforementioned parameters in the system memory. In the event of an anomaly, the system sends alarm messages to cell phones and monitoring equipment, along with programmed commands encoded in the microcontroller that can provide information on the problem. In order to continuously track the health of the transformer while the operator is not on site, we have developed an imbedded system called a multiple communication system between the transformer as well as operator, which is display in Figure 1. Every time an associated parameter's value exceed the set limitations, this system has been designed to deliver alarm messages [2]. This system suggests a small-scale construction of a distribution transformer remotely monitored system. The major objective of this endeavor is to create a mobile intelligent system that will assist the authorities in making the best use of the transformer transmission lines protection and detect issues in order to avoid catastrophic failure.

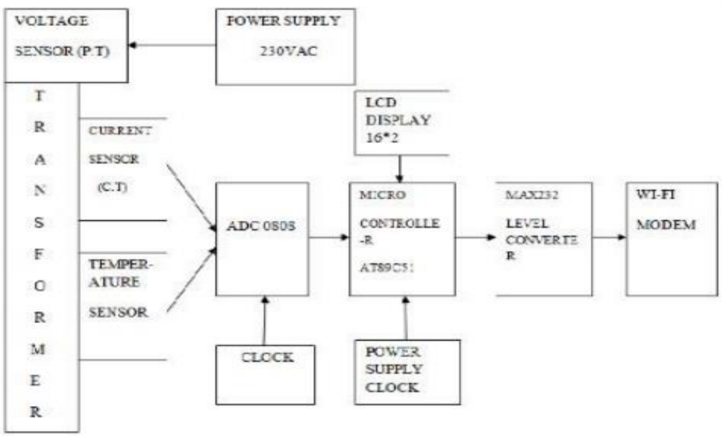

Figure 1: Represented that the block diagram of system using Internet of Things (IoT) [3]**.**

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GPRS Technology

By using the network of mobile communication enterprises, GPRS offers a perfect communication route, particularly for rural areas. The great performance, ease, and affordability of GPRS transmission of data make it an excellent choice for distribution feeders monitoring systems. The mobile and data communication technologies are mixed in GPRS. Utilizing all existing frequency resources, GPRS achieves broadband data transfer. The system's GSM and GPRS parameters function independently. For voice and text, GSM and GPRS technology is utilized, while GPRS is used for data. Voice and data results may be sent and received concurrently. This GSM/GPRS system relates to particular individuals [4]. GPRS supports the internet protocol (IP) for telecommunications since it is a packet-switched technology because GPRS employs the same protocols as the internet, the services it supplies are equivalent, making GPRS and the World Wide Web analogous.

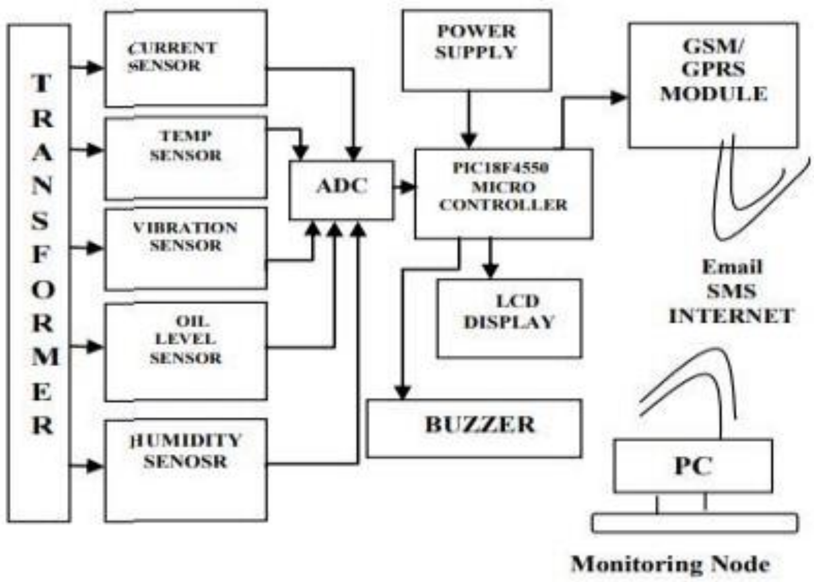

Figure 2: Represented that the Block Diagram of Condition Monitoring Transformer [5]**.**

In comparison to continuous measurement, the GSM/GPRS-based measurement of transformer health is highly advantageous. It is also dependable given that it is not always feasible to manually check the current, temperature, oil level, vibrations, and humidity. A PIC 18F4550 microcomputer, which serves as a data collecting and transportation system, forms the foundation of something like the system's architecture as mention in Figure 2. When we get a communication about such an irregularity at the monitoring node, we might act right away to stop any transformer malfunctions that might be devastating.

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CHAPTER 10

TRANSFORMER PARAMETER MONITORING SYSTEM

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Temperature monitoring put a halt to the transformer's functioning. GSM and wireless microcontroller disclosures. Using a GSM module is banned that whenever a transformer's voltage, current, or temperature is involved. Send an SMS to the separate place after that. The method is marginally more expensive and inefficient when GSM is used. A transformer is a mechanism for increasing and sinking modern and electrically energy. Transformer is a critical component in the estate region, resulting in its significance to the network's transmission and distribution. The purpose of this project is to provide a safeguarding environment for the transformers that transport electricity to specialist domains [1]. Using a microcontroller-based sensor, the transformer was rigorously protected from the main supply. Distribution systems may become poles apart attributable to aberration settings that include circuitry, winding heat, oil heat, ambient heat, bushing matter, load current issues, and unwinding issues [2]. So, we have internal flaws as a trade and in Figure 1 shows the Algorithm Flow Chart. This development effort includes a transformer's eventual security plan [3].

- The transformer's primary safety measure,
- Overcurrent protection back-up protection
- Sensing oil temperature to control overload or maintain load security.

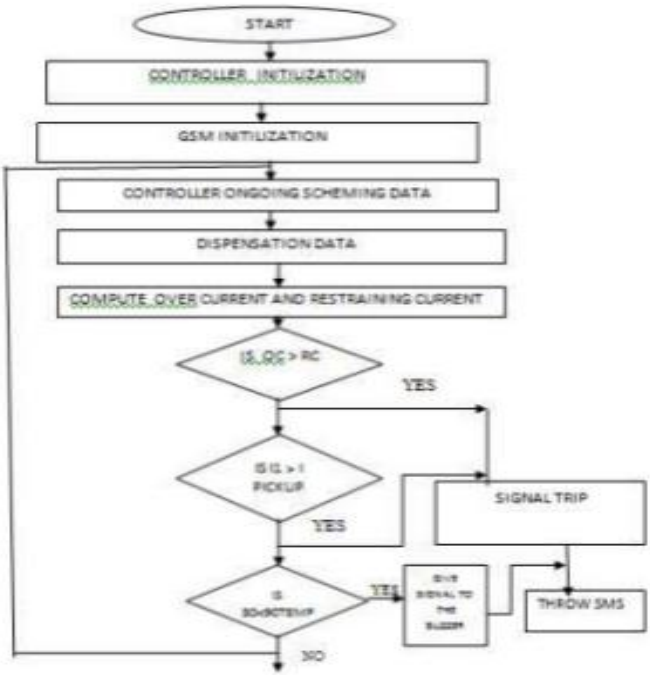

Figure 1: Represented that the Algorithm Flow Chart [4]**.**

Encoding is possible to separate into two parts.

- Together with mandatory executable files

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- Computing global variables

Simulation Process

Using technology named as PROTEUS, the process of reprogramming reproduction was finished. The produced curriculum is defective in ATMEGA16 disfigurement in PROTEUS software. We will also use PORT A, B, C, and D, the four seaports of ATMEGA16. PORT A (PA0, PA1, PA2) serves as the A/D converter's multiplexed analogue inputs. The transmission is second-hand for LCD display through PORT B. The output industrial powerhouse for the anxiety signal is PORT C (PC4). For digital signals, PORT D (PD0, PD1) is worn, and PD7 is worn as the output industrial powerhouse for the journey signal. One LM35 output, two variable voltage sources, one on or after the main sides of the transformer, the other at the start of the secondary side, and these exports are guaranteed to go to PA0, PA1, and PA2, respectively [5]. The LCD connected to PORT B displays:

- High ambient temperature,
- Using a digital signal value in place of the main side currently and secondary side current in that sequence on PA1 and PA2,
- In commission current (I1 - I2), also referred to as the percentage of difference in current flowing from the transformer's side to side.
- PORT D served as the outputting entrecote for the preventive power supply. Relay is connected to pin PD7 from the NPN transistor's base to its outputs.

The NPN transistor designates as no resistance flow of electrons and ordinarily closes relay flatter when ATMEGA-16 push signal to this pin. A LED is connected to the typically closed half of the relay in reproduction to ensuring that the curriculum is followed. For concern that LED would glowing ember due to a defective specification.

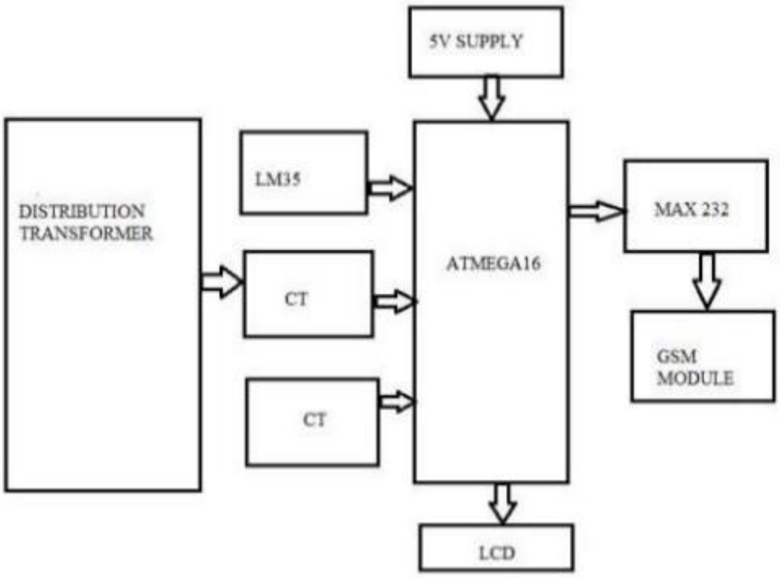

Figure 2: Represented that the Block Diagram of Transformer Monitoring System [1]**.**

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CHAPTER 11

INTRODUCTION TO SMART VENDING MACHINE

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Several information technology-based strategies are being used to increase drug adherence. The methods we discovered via our survey may be divided into three categories: sensor-based intake monitors, electronic medicine dispensers, and application-level medication reminders. UbiMeds, Wedjat, and MyMediHealth are a few instances of application-level medication-reminding methods. PDAs and smartphones, for example, are mobile devices that can run these apps. They provide software platforms for setting up medication schedules and notify users when and what kind of medicine is due following the chosen schedule. They are quite inexpensive and help stop overdosing and underdoing [1]–[3].

Utilizing sensors, sensor-based intake-tracking techniques monitor and evaluate the user's pharmaceutical habits. A typical example of this kind of technique, the Smart Drawer, uses an RFID tag and reader. Additionally, some systems include computer vision-based motion detection technology. These techniques have the benefit of being able to determine if the user is truly taking the prescription [4]–[6].

The use of electronic drug dispensers is also thought to significantly increase medication adherence. Through the lockout of the medicine-administration tray, the dispensing of pharmaceuticals following the preset medication schedule, and the pharmaceutical time alarm, they avoid overdosing, missing, and underdosing. A communicable medicine dispenser has been suggested recently, even though early medicines dispensers were created as independent versions that could not connect with other equipment. These dispensers gather a patient's drug status and send it to a server for monitoring, where medical professionals may review it. Similar to conventional dispensers, the medication monitoring system discussed in this work transmits medication status to a remote monitoring server.

The ability to remotely regulate drug dispensers sets the proposed medication monitoring system in this research apart from others. The dispenser's medicine schedule is set up remotely, and system settings, software, and faults are handled remotely rather than by patients. The Web-Based Enterprise Management standard (WBEM) of the Distributed Management Task Force (DMTF), the Simple Network Management Protocol (SNMP) of the Internet Engineering Task Force (IETF), and OMA DM are examples of remote device-management techniques that improve device reliability and reduce user annoyance. The most popular of these techniques, OMA DM, is the worldwide de facto standard for managing mobile devices. Studies are being conducted in several domains to use OMA DM. Early research often concentrated on managing mobile devices, while more recent work has concentrated on managing and debugging software faults, networks, managing vehicles, etc. It is uncommon to use OMA DM to manage personal health devices, nevertheless.

Given that most people who use medicine dispensers are older people, managing their dispensers and configuring various settings might be challenging for them. A pharmaceutical dispenser's accuracy is also strongly related to the user's health, and mistakes with one might have catastrophic results. Therefore, it is essential to do a significant study on the dependable maintenance of drug dispensers. It has become more necessary for those who need supervised medical care to discover ways to minimise their medical care expenditures as the price of in-home medical care grows. As a result, many people who need to take several doses of medicine at specified times have started using tools like automated pill dispensers to reduce their need for an in-home nurse regularly. These dispensers provide an in-home healthcare professional the ability to control a patient's drug regimen without having to continually monitor the patient. These dispensers often include automated pill distribution at predetermined intervals, audio alerts, and a link to the phone line or the internet enabling the medical professional to monitor the patient's progress. The design and execution of the project will use off-the-shelf technologies to create the pill dispenser. Instead, the objective is to create a device that offers the same fundamental capability but at a significantly lower cost.

The goal of this project is to create a monitoring system and medication reminder to make sure you take the appropriate medications in the right amounts at the right times. To provide a simple rest system so that tablets may be taken on time. To remind users to take their medication at the appointed time. To provide information by display and warnings via buzzer. People who are unwell or elderly must take medicine because of their conditions. They often get prescriptions for a variety of medications, each of which must be taken in a different dose. 25% of older people use four or more prescription medications daily. Patients must remember when they are meant to take these drugs at the proper times. 50% of all medicines purchased are mistakenly taken, and 55% of older people don't follow their drug schedules. Age and illness can weaken a person's senses, and those on medicine frequently experience forgetfulness, loss of focus, and hearing or vision impairment. Therefore, helping seniors and those with diabetes is our major goal. We all know that doctor will prescribe extra pills for diabetes patients, and they must take these tablets on schedule. If they miss a dose, they may experience a variety of health problems. So, we are creating this prototype to avoid this.

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CHAPTER 12

MEDICATION DISPENSING TRAY

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They suggest a highly saleable and remotely controllable smart drug dispenser. They built the dispenser with an expandable hardware design for scalability and inserted an agent application in it for remote management. When the user hits the dispense button at the moment the real-time clock reaches the specified medication time, the predefined medicine is delivered from the medication dispensing tray (MDT). Each patient's medicine is kept in an MDT in the proposed dispenser. One smart drug dispenser typically holds only one MDT, however, the dispenser may be expanded to hold several MDTs to accommodate many users. The suggested dispenser sends the system settings and medicine status to the monitoring server for remote administration. A particular event, such as a prescription shortage, memory overload, software bug, or non-adherence, is sent right away. Through the agent software that is put in the dispenser, all of these activities are carried out automatically and without the involvement of patients. The suggested dispenser runs normally and effectively carries out management tasks from the medicine monitoring server, according to installation and verification results [1]–[3].

As the prevalence of chronic illnesses rises, medication nonadherence is becoming a significant public health concern. Dispensers for medications are often suggested to increase patient adherence. Known as a particularly effective tool for increasing medication adherence, a prescription dispenser is a gadget that administers medicine to the patient following predefined schedules. Nevertheless, there is some space for advancement concerning the present drug dispensers. The majority of current drug dispensers have a poor degree of scalability and are intended to handle only one user. Therefore, allocating one drug dispenser to each patient would raise the expense of running the business. A pharmaceutical dispenser should be preset with the proper drug regimen and system parameters. However, the majority of current drug dispensers demand that customers manually establish the schedule and parameters. Mistyping results in annoyance and blunders. A mistake with a drug dispenser might be deadly. However, remote device management features are not available on any of the current drug dispensers. As a result, users are required to operate their drug dispensers alone [3]–[5].

They have suggested the smart medicine dispenser in this article to address the issues with current medication dispensers, such as their lack of expandability, inconvenience, poor dependability, and ineffective communication. Comparing the suggested dispenser to current drug dispensers, there are three benefits. Multiple users may utilise a single dispenser since the antidepressant trays can be connected successively to create a high degree of scalability. Distant management techniques are developed and put into practise to obtain a high level of remote manageability, lower management expenses, and decrease management efforts. These techniques make it easier to update the medicine schedule set up in the smart dispenser. Medical personnel and system administrators may also remotely control system settings, embedded applications, and operational faults. The suggested dispenser runs normally and effectively

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carries out management tasks from the medicine monitoring server, according to installation and verification results.

Geriatric patients depend on their prescriptions to maintain their health, but complicated medication regimens may result in errors like skipping doses, taking the wrong dosage, or taking the drug at the wrong time. These errors may result in unneeded trips to the doctor or hospital, illnesses, or even fatalities. Therefore, it is necessary to create a medicine dispensing device that may aid geriatrics in taking their medications on time. By doing this, unanticipated hospital or doctor visits due to inappropriate pharmaceutical usage would be avoided. This essay suggests a concept for a smart gadget that delivers drugs following the recommended timetable.

People nowadays tend to forget to take their medications according to the recommended time since they are occupied. Because of this, elderly people are being forced into unneeded hospitalisation. Therefore, a system or gadget has to be created so that it can distribute the pills right now. Since older people are the intended users of the technology, it must be simple to use, portable, safe to use, and lightweight. They used the well-known Engineering Design Approach, in which many phases were taken to accomplish certain features, to construct a functioning prototype. They outlined many characteristics of the gadget before actually putting the prototype into practise. They gathered input from several patients and discovered that this equipment is desperately needed in the medical industry. They began to work based on the comments made by the patients and their qualities, and eventually, they were successful in creating a smart pill dispenser system. In this work, several processes for designing the aforementioned gadget utilising the engineering design technique are explained. The reader should be well-versed in the electronics that drive stepper motors as well as various Atmega 328P microcontroller interface strategies.

The main concept that must be addressed to tackle the aforementioned issue is the creation of a self-pill dispensing mechanism that does not need human interaction. This project takes use of the idea of a compartment moving in a circular, stepwise pattern while holding pills. Stepper motors are used to move the compartment in steps. The gadget has a built-in alerting feature that uses a buzzer and an LED to signal when it's time to take medicine. This describes a medicine vending machine based on IR Standard touch technology as the input to select various medical facilities like First Aid facilities, ambulance facilities, and direct calling facilities via GSM, dynamic GPS, smart card facilities, and restocking medicine alerts. Singh proposed a touch screen-based automated medical vending machine. The visual basic software that is being utilised was built so that the patient would be serviced when they choose a certain institution.

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CHAPTER 13

DESIGN OF ANY TIME MEDICINE VENDING MACHINE

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The Scientific method of the product involves various fundamental phases. An Arduino board, one LCD, a GSM module, an RTC module, two servo motors, and a buzzer are all components of an automatic medication vending machine. Arduino IDE and embedded C are needed for this project's software needs. In addition to a text editor for writing code, a message area, a text terminal, a toolbar with buttons for frequently used operations, and several menus, the Arduino Integrated Development Environment (IDE), sometimes known as the Arduino Software, is also available. To upload programmes and interact with them, it connects to the Arduino hardware. The C Standards Committee created Embedded C as a collection of language improvements for the Programming languages to solve concerns of commonality across C extensions for various embedded devices. For embedded C programming to enable improved microprocessor functionality, nonstandard additions to the C language are often needed. The language most often used by embedded programmers to create embedded systems is probably embedded C [1]–[3].

A microcontroller based on the ATmega328P is the Arduino Uno board. This microcontroller is utilised because processors, which use 8-bit and 16-bit data instead of 32-bit and 64-bit data, are easier to operate. Having 23 programmable I/O lines and 32k bytes of embedded self-programmable flash programme memory, it is immediately useful without the need for extra computer components. Code-efficient and 10 times quicker than traditional microcontrollers because of the direct connection of all 31 registers to the arithmetic logic unit (ALU).

A single-packed module called an RTC module contains an oscillator circuit, a master clock, and an RTC IC. You don't need to create the oscillator circuit and alter the frequency yourself. Data for seconds, minutes, hours, days, dates, months, and years are tracked by the RTC. Additionally, it automatically makes adjustments for leap years and years with less than 31 days. The clock may run in either a 24 or a 12-hour style with AM/PM hours. Knowing how to get the current date and time depends on the project.

A device that employs GSM mobile telephone technology to provide wireless data connectivity to a network is known as a GSM modem or GSM module. Mobile phones and other devices that connect with wireless phone networks utilise GSM modems. To identify their device to the network, they need SIMs. This module may send text SMS data to a host server after receiving serial data from radiation detection systems like survey metres and area monitors [4]–[6].

A servomotor, often known as a servo motor, is a simple induction engine that is controlled by servomechanism. If a motor is used as a controlled device and is connected to a servomechanism, it is referred to as a DC Servo Motor. The controlled motor is referred to as an AC Servo Motor if AC drives it. Small and effective servo motors are essential for use in

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applications needing precise position control. A pulse-width modulator, also known as a signal or data, controls the servo motor (PWM). To regulate the direction of motion, servo motors are also often employed in remote-controlled toy automobiles. They are also extensively used as the motor that moves the tray of a CD or DVD player. In addition to these, there are many more servo motor uses that we see every day.

A liquid crystal display (LCD) is an electronic display that works by changing the electric voltage applied to a hydrophobic membrane crystal to alter its optical characteristics. Although there are many alternative display kinds and configurations on the market, including 82, 81, 161, and 102, the LCD 162 is often utilised in gadgets. Portable electronic games, viewfinders for digital cameras and camcorders, video projection systems, electronic billboards, computer displays, and flat-panel TVs are all typical applications for LCDs.

A SIM800A GSM module, PCB Mountable 3V Active Electromagnetic Buzzer, DS3231 Real Time Clock, LCD16*2 Parallel LCD Display that offers an easy and affordable alternative for adding a 162 Black on RGB Liquid Crystal Display, We are utilising a Tower pro MG90S Mini Digital Servo keypad, which has 4 rows and 3 columns. Implementing the suggested technique is included in the methodology of this project design, along with a few other fundamental phases. An Arduino board, one LCD, a GSM module, an RTC module, and two servo motors are all components of the anytime medication vending machine. The hardware components must be set up as the first significant step. Through the Arduino IDE, embedded C code is created and stored in the microcontroller. The Arduino board is provided with a power source. The alarm buzzer will sound at the predetermined time since the time has already been established. The button is pushed using the keypad, and when it is pressed, the microcontroller receives information. The corresponding servo motor is driven by the microcontroller. The medication is delivered via a 180° rotation provided by the servo motor. If the medication is given out simultaneously, a message will be transmitted through the GSM module to the designated individual. To transmit messages, a sim card must be put into the GSM module. After that, the consumer may pick up the medication from the retailer.

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CHAPTER 14

IMPLEMENTATION OF MEDICINE VENDING

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Servo motors are used in the prototype to dispense the medications. A variety of hardware elements are used to construct the anytime medication vending machine prototype. The following is an explanation of each component's specific role.

Microcontroller

The key component of the anytime medication vending machine is the microcontroller. It is in charge of carrying out all of the orders and activities of the medication vending machine. The microcontroller is chosen to provide the machine with the capability it needs without costing extra money for extra capabilities. The microcontroller's fundamental needs are a few input/output ports for connecting to the keyboard, communication unit, motor, and ringer [1]–[3].

The Arduino Uno is a free and open-source microcontroller board built on the Microchip ATmega328P microprocessor. A variety of expansion boards (shields) and other circuits may be interfaced with the board's sets of digital and analogue input/output (I/O) pins. A low-cost, adaptable, and simple-to-use programmable microcontroller board called Arduino UNO is available for use in a wide range of electrical applications. Other Arduino boards can interact with this board. Relays, LEDs, servos, and motors may be controlled as output by Arduino shields and Raspberry Pi boards.

An ATmega328-based microcontroller is used in the Arduino Uno board. It contains a 16 MHz ceramic resonator, an ICSP header, a USB port, 6 analogue inputs, a power connector, and a reset button in addition to 14 digital input/output pins, 6 of which may be used as PWM outputs. This includes all the necessary microcontroller support. They just need to be linked to a computer via a USB connection, an AC-to-DC converter, or a battery to begin going. Unlike all previous boards, the Arduino Uno Board does not have an FTDI USB-to-serial driver chip. The Atmega16U2 (Atmega8U2 up to version R2), which is programmed as a USB-to-serial converter, is included in it [4]–[6].

RTC Module

A real-time clock module called the DS3231 RTC uses the DS3231 IC. A very accurate and reasonably priced RTC with an I2C interface is the DS3231 IC. It employs a crystal and an inbuilt temperature-compensated crystal oscillator (TCXO), which makes it exceptionally precise. The DS3231 features a backup battery installed at the rear of the module so that time may be kept track of even if the primary power supply is disconnected. When required, the chip changes between the primary and backup forms of energy automatically.

Data for seconds, minutes, hours, days, dates, months, and years are tracked by the RTC. Additionally, it automatically makes adjustments for leap years and months with less than 31 days. The clock may run in either a 24 or a 12-hour style (with AM/PM hours). Additionally, two time-of-day alarms may be programmed and a square-wave output.

RTC is short for real-time clock. RTC modules are essentially TIME and DATE remembrance systems with a battery configuration that keeps the module operating in the face of human power. As a result, the TIME and DATE are current. Therefore, anytime we want, we may get the correct TIME and DATE from the RTC module. The DS3231 has six terminals, however, only four of them must be used. Thus, we generally have four pins. These four pins are accessible on the other side of the identical-named module.

Features of RTC MODULE

RTC counts milliseconds, minutes, hours, and years with an accuracy of +2ppm to -2ppm for temperatures between 0°C and +40°C and +3.5ppm to -3.5ppm for temperatures between -40°C and +85°C. Low power consumption, automatic power failure battery switch circuitry, register for ageing trim, a programmable square wave output, a 400 kHz I2C interface, and a CR2032 battery backup with a two- to three-year life

LCD Display

There are several uses for LCD (Liquid Crystal Display) screens, which are electrical display modules. A 16x2 LCD is a very fundamental module that is often included in many different devices and circuits. With a 16x2 LCD, 2 lines can each show 16 characters. Each character on this LCD is presented using a 5x7 pixel matrix. The 224 distinct letters and symbols may be shown on the 16 x 2 intelligent alphanumeric dot matrix display. The Command and Data register on this LCD are its two registers.

Various instructions sent to the display are stored in the command register. Data for display is kept in a data register. Data that make up the desired picture are placed in the data registers as part of the control process for the display, and instructions are subsequently placed in the instruction register. You don't need to know the low-level commands since Liquid Crystal Library simplifies this for you in your Arduino project. By altering the potentiometer that is linked across the VEE pin, the contrast of the display may be changed.

The LCD 162 is a kind of electronic display that shows information and messages. As the name implies, it has 16 Columns and 2 Rows, allowing it to show 32 letters (16 x 2), each of which is made up of 5 x 8 (40) Pixel Dots. Therefore, 32 x 40 or 1280 pixels may be used to compute the total number of pixels in this LCD. The majority of 16 X2 displays rely on multi-segment LEDs. There are many alternative display kinds and configurations on the market, including 82, 81, 161, and 102. However, the LCD 162 is widely utilised in gadgets, DIY circuits, and electrical projects because of its lower cost, programmability, and ease of access.

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CHAPTER 15

GPRS MODULE

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GSM, which stands for "global system for mobile communication," is a kind of mobile modem (GSM). Bell Laboratories created the GSM concept in 1970. In the whole globe, it is a widely utilised mobile communication system. GSM is an open, digital cellular technology that uses the 850MHz, 900MHz, 1800MHz, and 1900MHz unlicensed spectrum to provide mobile voice and data services. The time division multiple access (TDMA) approach was used to establish the GSM technology as a digital system for communication. The data is first reduced and digitalized by a GSM before being sent across a channel with two distinct streams of client data, each in its own specific time slot. The digital system may transmit data at speeds ranging from 64 kbps to 120 Mbps [1], [2].

A GSM system uses macro, micro, pico, and umbrella cells, among other cell sizes. Depending on the implementation domain, each cell is unique. In a GSM network, there are five distinct cell sizes: macro, micro, pico, and umbrella cells. Each cell has a different coverage area depending on the implementation environment. The time division multiple access (TDMA) technology works by allocating several time slots on the same frequency to each user. It can handle data rates of 64kbps to 120Mbps and is highly adaptable to voice communication and data transfer. The SIM800A modem features an RS232 interface and a SIM800A GSM chip, making it simple to connect to a computer or laptop through the USB to Serial adapter or a microcontroller via the RS232 to TTL converter. The right COM port must be identified from the USB to the Serial Adapter's Device Manager after the SIM800A modem has been connected via the USB to RS232 connection [3]–[5].

A specialised Short Messaging Service (SMS) worldwide System for Mobile communication (GSM) module is created for wireless radiation monitoring (SMS). This module may send text SMS data to a host server after receiving serial data from radiation monitoring devices like survey metres and area monitors. A full GSM/GPRS/Bluetooth development board called the SIM800A GSM 100% compatible with Sim 900A Modem may be used to provide voice SMS and Data transfer features to embedded system applications. The SIM800 supports quad-band MHz technology and uses less power to transmit voice, SMS, and data. equipped with Bluetooth.

Specifications:

- 12V DC is the operating voltage.
- Comparability of Sim Cards
- Use only 16k and 32k cards; 64k and 128k cards do not support the SIM800 module.
- The sophisticated features:
- MHz Quad-Band

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- GPRS multi-slot class; SIM900A compatibility; built-in Bluetooth; embedded AT; TTS, Record; embedded AT.
- IC package for an on-board Buck converter power regulator

BUSSER

A buzzer or beeper is a mechanical, electromechanical, or piezoelectric audio signalling device (piezo for short). Buzzers and beepers are often used as alarm clocks, timers, train horns, and to validate human input such a mouse click or keyboard. A beeper or buzzer, for example, might be electromechanical, piezoelectric, or mechanical in design. The signal is converted from audio to speech as its primary purpose. It is often powered by DC voltage and is utilized in timers, alarm clocks, printers, computers, and other electronic equipment. It may produce a variety of sounds, including alarm, music, bell, and siren, according on the varied designs.

This is a 3V active electromagnetic buzzer that may be mounted on a small PCB. Including Audio Alert in your electrical designs is a terrific idea. It employs a coil element to produce an audible tone and runs on a 3V supply.

Specifications:

External Material: Plastic; Color: Black; Input Voltage (Max.): 3V; Resistance: 30; Resonance Frequency: 2048 Hz; Sound Pressure (dB(A)/10cm) min.: 80; Body Size: 12 x 9.5mm; Pin Pitch: 6mm. A matrix qwerty keyboard is a tiny, portable input device for user inputs, which microcontrollers then process. This is present in many everyday items, including calculators, digital locks, gas pumps, and do-it-yourself projects. Membrane keypads are one of the varieties; they are smaller and may be pasted on top of your new thinking.

The majority of embedded system applications call for keypads to accept user inputs, particularly when the application calls for additional keys. In order to provide more inputs to the user with fewer I/O pins, matrix keypads are replacing traditional push buttons thanks to their straightforward design and straightforward interface technique. Keypads are crucial components of the important microprocessor- and microcontroller-based projects and machinery because they serve as Human Machine Interfaces (HMI). In many different application areas, including digital circuits, telephone communications, calculators, ATMs, and others, a matrix keypad is the most widely used input device. A matrix is made up of many pushbuttons or switches that are organised in rows and columns. Depending on the purpose, these keypads come in different configurations including 3x4 and 4x4.

The usage of a matrix keypad has the benefit of allowing the programmer to utilise fewer pins overall. 16 push button switches are linked to four rows and four columns in a 44 matrix keypad. Although it may seem that 16 pins are required to link the microcontroller to the matrix keypad, 8 pins on a microcontroller port may really accommodate 16 inputs for the keypad interface. Depending on the needs of the application, all 8 lines may be linked to the same port or to other ports. Actually, by reserving the additional 8 bits of the port, a microcontroller's 8 port pins are enough for a 44 keypad interface utilising the row & column matrix connection approach.

Each keypad's buttons are organised in rows and columns. We are utilising a keypad with four rows and three columns. Each key has a switch below it. Each switch in the row is linked to the others. The Arduino must be linked to each row and each column. There are a total of 7 pins that we will connect. The row and columns pins that are detected to the button are how Arduino determines which button on the keypad is being pushed.

i. All of the row pins are LOW and all of the column pins are HIGH if no buttons are touched.
ii. The button's column pin is pushed LOW when a button is pressed.
iii. The row must still be known by the Arduino even if it knows which column the button is in.
iv. This is accomplished by turning all of the rows to HIGH while simultaneously reading the pins on the columns to determine which column is HIGH.
v. The Arduino has located the row that is linked to the button when the column pin is HIGH.

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