Raspberry Pi-Based Smart Energy Meter Using Internet of Things with Artificial Intelligence

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Abstract: - There are numerous challenges with existing domestic energy meter reading systems, in constructions, narrow bandwidths, low rates, poor real-time, and slow two-way communications. This paper used an Automatic Meter Reading device with wireless technology to solve the problems. The proposed approach uses the Internet of Things (IoT) to communicate between the Electricity Board and the user section, allowing the customer's electricity usage and bill information to be transmitted. The customer receives information on bill amounts and payments through IoT. In the past decade, the Indian power sector accomplished a great deal in policy reforms, private sector participation in generation and transmission, and the development of new manufacturing technology and capabilities, still more to accomplish and obstacles to overcome for capitalization. Therefore, the private sectors are very active in investing in various parts of the value chain. Nevertheless, the majority engagement of private investors is taking place in the generation. This trend is driven by de-licensing of generation, fiscal incentives for large-scale capacity increases, and competitive buying of electricity. Accordingly, with the changes implemented in the industry, the structure of the market has been transformed from vertically integrated to competitive. The effectiveness of the market has been increased throughout time as a consequence of several rules and regulations that have had the intended effect. Mobility in the power market has risen, and so has the number of competitors; legislation has produced a competitive marketplace, which will in the future totally open the market in the power sector.

Key-Words: - Raspberry Pi, IOT, Artificial Intelligence, Embedded systems

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1 Introduction

Real-time applications and embedded systems Operating systems are only two of the many innovations that will help to make these ideas a reality. While a large number of people still relay on operating systems for real-time applications, these "eyes in the sky" will now have a more important effect on our daily lives. Embedded systems are pre-programmed and run according to the mission at hand. Instruction in operating systems, on the other hand, is design-oriented. These frameworks are essentially platform-agnostic [1]. Embedded devices are the unsung heroes of much of the technology uses today, whether it's a video game, a CD player, or a washing machine.

One wouldn't be able to connect to the internet via modem without an embedded device. Embedded technology is used in almost every vehicle that leaves the factory these days, in some form or another; most embedded systems in cars are robust in nature, since most of these systems are made up of a single chip. In these systems, there are no driver collisions or "systems busy" situations. Because of their small dimensions, they can comfortably fit under a car's hood. These systems can be used to incorporate features such as suspension adjustments based on road conditions and fuel octane material, as well as Antilock Braking Systems (ABS) [2] and protection systems. Embedded systems are computers that have been configured to perform a specific function instead of being a general-purpose machine capable of performing multiple tasks. Others require real-time performance for reasons such as safety and accessibility, whereas others may have very few to no performance standards, enabling the device hardware to be standardized to save money. Embedded systems are not always self-contained units. Many embedded systems are made up of small, computerized parts that are housed within a larger unit that serves a larger purpose. The Gibson Robot Gultar, for instance, has an embedded device for adjusting the strings, but the primary function of the Robot Gultar is to play music. Likewise, an embedded device in a car plays a specific role as a vehicle subsystem. Embedded systems, as opposed to general-purpose computers capable of performing multiple tasks, are developed to perform a single task. Others require real-time performance for reasons such as safety and accessibility, whereas others may have very few to no performance standards, enabling the device hardware to be simplified to save money [3].

The voyage of the Indian power industry began with tiny generators and small licensees, often restricted to one district in the pre-independence period, i.e. before 1947, operating under the Indian Electricity Act 1910. This was the beginning of the trip. Since India's independence, the Government of India (GOI) has placed a significant emphasis on the nation's electrical infrastructure, acknowledging the vital role that electricity plays in the country's continuing economic and social development. The Indian Supply Act of 1947 was passed into law just after independence was declared. State Energy Boards (SEB) was established in every state in accordance with the Indian Supply Act of 1947. These boards were given the responsibility of generating, transmitting, and distributing electricity within their respective states. Every single minor producing and distributing licensee that was already [4] in existence was consolidated under the appropriate SEBs. At the federal level, the Central Electricity Authority (CEA) was founded with the mission of coordinating and monitoring the operations of SEBs at the central level.

Electricity is on the concurrent list, which means that both the federal government and the state governments have authority over it. This is because Item 38 of List III of the Seventh Schedule of the Constitution of India placed it there. In actuality, what this has meant is that the Centre is in control of all affairs pertaining to relations between states and nations, as well as any instances in which ownership lies with the Centre. Everything that happens inside the state falls under the purview of the state government. In the beginning, electricity was considered a state affair, and there was very little involvement from the business sector. SEBs was crucial in the expansion of the country's power infrastructure and the quickening of economic activity throughout the nation. In a democratic society, the importance of electricity in political life has grown in tandem with the growing significance of electricity in the lives of individual individuals. Due to the fact that they are directly controlled by state governments, SEBs were unable to increase their retail prices at a rate that was proportional to the growing cost of goods, notably gasoline. As a direct consequence of this, SEBs and the state government began experiencing significant financial setbacks. SEBs [5] were likewise condemned for their inefficiency, non-accountability, and for all of the other reasons that can be ascribed to a failing public sector. This was done for the same reasons that an ailing public sector was faulted. This resulted in a slowdown in the construction of additional generating capacity as well as other expenditures in the industry that were intended to foster growth. On the other hand, the demand for electricity continued on growing due to factors such as a growth in population, economic activity, and an improvement in social life, and a transition in irrigation methods from one based on canals to one based on tube wells that draw ground water.

The Electricity Regulatory Commission Act of 1998 established regulatory commissions in order to insulate the industry from the potential for political involvement from the State Government and to ensure that the sector is governed by an independent professional organization. [6] Concurrently, the Government of India (GOI) began the process of liberalizing the economy and extended an invitation to private actors to participate in a number of different sectors, one of which was electricity, notably in the generating sector. Legal enforcements that were not favorable to the creation of a competitive environment was one of the factors that was cited for why there was a limited reaction from private companies to invest in generating. As a direct consequence of this, the Government of India (GOI) adopted a brand new Act known as the Electricity Act 2003 (EA) [7], which resulted in the repeal of the Indian Electricity Act 1910, the Electricity Supply Act 1947, and the Electricity Regulatory Commission Act 1998. The aim is that corporatization would attract private sector skill sets and improve the sector, the EA dissolved SEBs into generating, transmission, and distribution firms usually three to four distribution companies in a state [8]. The primary emphasis was placed on boosting production as the demand-to-supply imbalance reached nearly 20% on average in year 2001-2002. Generation was fully liberalized, and the need of obtaining CEA's techno-economic permission before constructing a thermal power plant was eliminated [9]. It was urged that businesses generate their own electricity, and such businesses were given permission to sell their power to other parties. Open access was made available to the customers.

The people were acknowledged to have a universal right to access to electricity. It was thought that the EA would bring about a revolutionary shift in the electricity industry and throw up the door to private investment in the sector [10]. The EA had various policies, rules, and regulations that were to be obeyed in order to fulfill its goals.

2 Problem Formulation

One of the key problems with present obsolete grid is to deal with reliability [11]. The grid becomes overwhelmed during peak periods or season. Smart grid meter was the main part of the project. We could save the vital resources by utilizing the intelligent grid program, if we acquire data requires human resources.

In this paper one of the unique technique used is Global System for Mobile Communications (GSM) feature which Leads smart [12] energy meter with the use of relay which can control the power supply for the load side, and it also improves less losses, billing difficulties are managed and voltage fluctuations, complications are also solved.

Its purpose is to build a device that could transmit the meter readings of the electrical meter in the local area to the nearest electrical meters accounting stations. In order to provide consumers with real time billing and reading, the analogue electric meter is interfaced with the digital circuits by utilizing the LCD-liquid crystal display [13]. Basically, there are dual sides, one end of the users and the other end of the servers. The meter could be prepaid or after payment that was fully observed and regulated via the servers' end of the particular region. For recharging the meter bill or checking balance for the prepayment meter, the customer shall be issued with pin codes.

Microcontroller and GSM module as well as IR [14] analogue meter are main elements of this research. This system revolves over the GSM modules with the GSM modules, which controls the whole functioning of the system with the GSM modules utilized to transfer wireless data.

When increased energy costs are detected, efficient energy usage becomes more important. A Wireless Energy Meter (WEM) can transmit data to a central server using Wireless Communication [15] in order to easily monitor and analyze the data using GSM.

3 Problem Solution

This meter's more sophisticated iteration had two separate pendulums, each of which featured a coil that was linked to the voltage being measured. Below the pendulums were two current coils, each winding in the opposite direction of the others. Therefore, the movement of one of the pendulums was slower than it would have been without the weight, while the other was quicker. The counting mechanism was driven by the difference in the times at which the oscillations occurred. Every minute, the roles of the two pendulums were switched around in order to correct for the initial disparity in the timeframes it took for each of the pendulums to complete an oscillation. The winding of the clock took place at the same moment. Because of the high cost of these meters and the fact that they had two clocks, they were eventually phased out in favor of motor meters. Although they were able to measure watt-hours and ampere-hours, pendulum meters were only suitable for use with direct current.

Fig. 1. Graphical system meter

During the course of this research work, an AMI infrastructure that is optimally suited for the conditions of India will be developed. This infrastructure will take into account the global experiences where AMI has been deployed in several discom, the current state of the Indian power sector, the upcoming policies of the Government of India, and the behaviour of Indian electricity customers. To this day, not a single utility company in India has deployed AMI. In the following text, we will present a short review of the existing technologies and uses of each of the four components of the AMI, as well as how we intend to construct them for the Indian electricity distribution system. The likely and anticipated results of the investigation will also be discussed with regard to each individual AMI component.

A. Smart Meter

Throughout the majority of the industry's existence, conventional electromechanical meters have been used in place of a cash register. At the home level, these metres only recorded the overall amount of energy that was used over a certain period of time, which was generally one month. The term "smart meter" refers to programmable devices made of solid state that are capable of performing a wide variety of additional duties, including the majority or all of the following:

- Billing and charging depending on time
- Information on consumption for both the client and the utility
    - Net metering
    - Notification of a loss of power (and its subsequent restoration)
    - Remote on/off and turn-on activities
    - Limiting the load in order to prevent "poor pay" or for demand response objectives
- Detection of tampering and energy theft Communication with other intelligent devices in the house Prepayment of energy monitoring of power quality Detection of tampering and energy theft.

B. Energy meter

The conventional mechanical energy meter was on the basis of "Magnetic Inductions" phenomenon. It has several toothed wheels and a revolving aluminum wheel called Free wheel. The Free wheel rotates in response to current flow, causing various wheels to spin as well. This would be transformed into corresponding measurements in the display. Mechanical faults and failure were normal since there are so many mechanical parts involved.

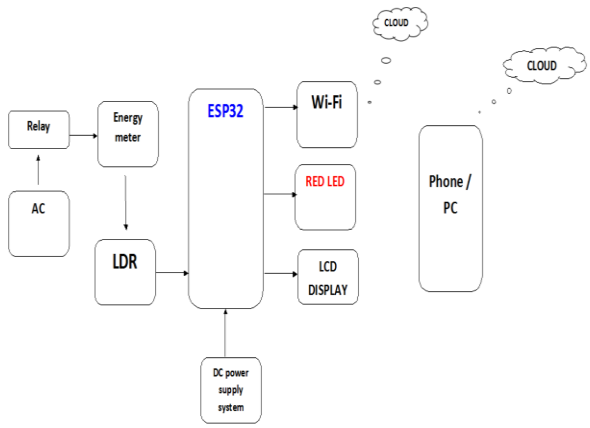

Fig.2. Raspberry Pi Based Smart Energy Meter

The Digital Micro Technology (DMT)-based Electronic Energy Meter has no moving parts. As a result, the EEM is referred to as a "Static Energy Meter." ASIC is a specially built IC that controls the precise functioning of EEM (Application Specified Integrated Circuit). Embedded System Technology is used to create ASICs for particular applications. ASICs like these are currently utilized in air conditioners, washing machines, digital cameras, and automobiles among other things. EEM also includes analogue circuits, a voltage transformer, and a current transformer, among other things, to “sample” currents and voltages. The 'input data' was compared to the 'references data' programmed (Voltages) and the output will eventually have a 'voltage rate.' The AD Converter (Analog Digital Converter) present at ASIC converts this Output into 'Digital Data.

Fig.3. Smart Meter Structure

The users should know their use of electricity. By analyzing each house at the end of each month, the work of human collection is prevented by the automatic generation of electricity bills. Tamper-proven power meters can prevent theft of electricity. The device errors can be easily detected.

- A basic energy meter, a WIFI, an Raspberry Pi Web portal, is part of the built energy meter. The energy meter blinking on the led light and the LDR Raspberry Pi records the number of times the LED blinks.
- The notification shall be sent if a notice is forwarded to the module by the electricity department or the user.
- It is needed to give a notice via WIFI how many units must be consumed when the main supply is automatically consumed through a relay circuit.
- The RED LED in the module is enabled when 90% of the devices are consumed.

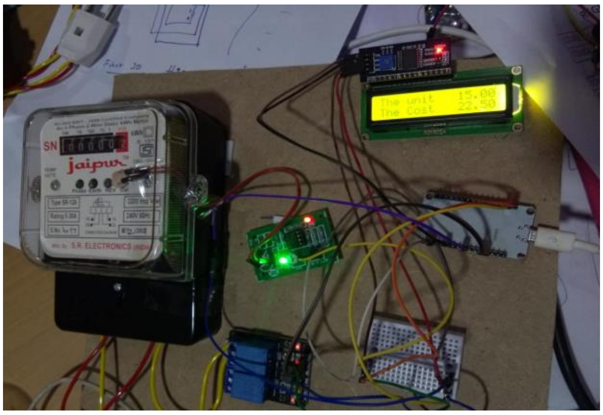

Fig.4. Circuit connection for smart energy meter

A. Outputs

Fig.5. Email Notifications

Fig.6. Unit and Cost displayed in smart phone.

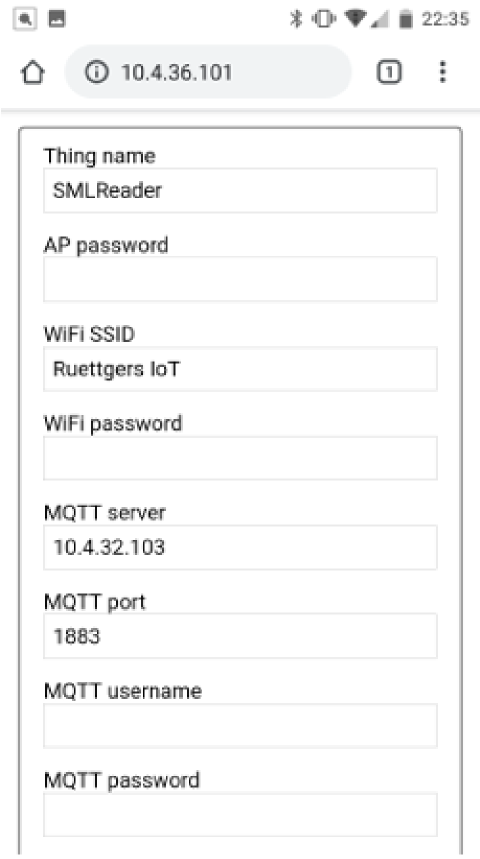

Fig.7. Output 1

Fig.9. Output 3

Fig.8. Output 2

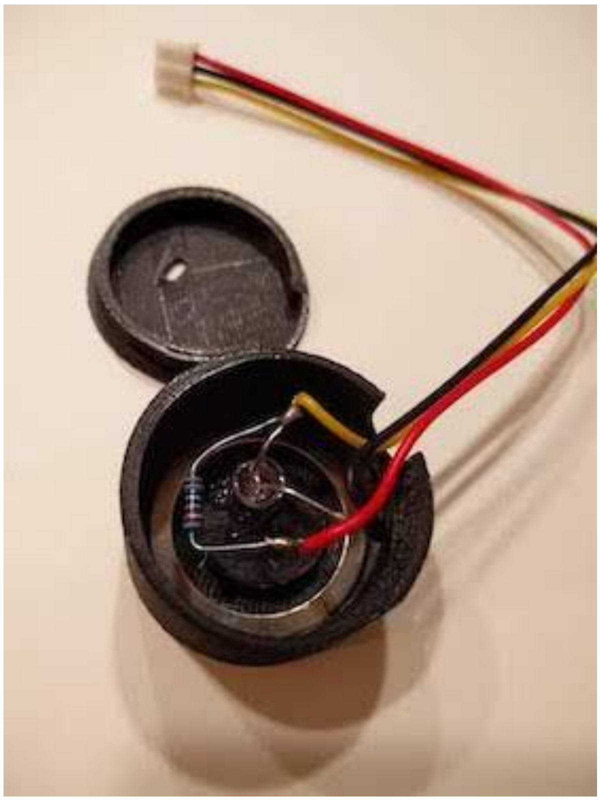

Fig.10. Output 4

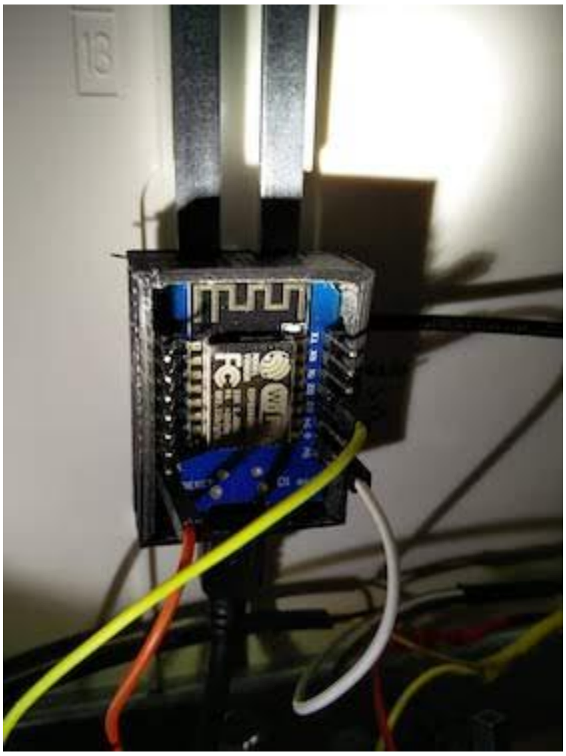

Fig.11. Output 5

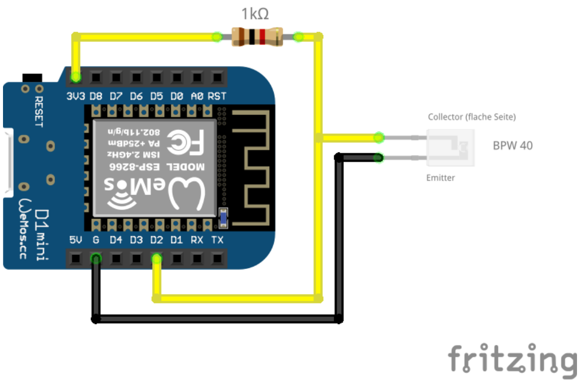

Fig.12. Output 6

Advanced Data Analytics: The MDM system need to be able to provide advanced data analytics in order to facilitate the identification of theft and tampering. It should make it possible to establish anomalous situations in a customizable manner based on current, voltage, power factor, and power quality profiles, and it should also offer an exception report in response to service requests made for surveillance operations.

Enable Additional AMI Apps While the utility is in the process of creating the MDM system; it should take into account additional applications that may easily utilize the same software platform without requiring a great deal of specific design. Other apps that take use of the MDM database platform must to be made accessible either as add-on modules or as an integrated component of a corporate MDM strategy. Typical uses of AMI include load curtailment and demand response, revenue protection and theft analysis, end-customer analysis and presentation, loss localization / electricity balancing, and more.

Electric utilities are becoming more and more aware of the growing need to include consumers in their day-to-day operations in order to more effectively control the demand on their systems and deliver value-added services. Home Area Networks (HAN) make it easier for customers to participate in utility decision-making by linking consumer premises with utility communication systems HAN, which are a part of the smart grid network, contribute to the development of demand response and demand side management. Opportunities in the field of renewable energy, such as rooftop photovoltaic systems, are also directly tied to the development of HAN and demand response. Because of this, it is only applicable to consumers in Category B. Architecture of the HAN would seem that there are two separate schools of thinking when it comes to the modifications of the HAN architecture4 that are associated with the utility. To begin, the utility company, which has historically managed the bulk of the electrical infrastructure, if not all of it, will be allowed to operate certain important appliances inside the house in order to better manage the grid.

4 Conclusion

This article introduced a new solution to energy meter tracking using Raspberry Pi, which interfaces with consumers to enable consumers to track their current bills or power consumption usage from anywhere using the cell phone. It has technologies that give energy meter readings and calculate the cost and will be sent to our android mobile through push-up notifications and also to Gmail. One need not wait until the month's end to know their electric charges, so this is totally user friendly for the customer.

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Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.