Power Distribution System Improvement Using Automatic Power Theft Detection System

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Abstract— Distribution site play vital rule in power system. Third world countries like Pakistan facing issue of power theft, which results as huge power losses and make system inefficient. This work/project shows some common methods used by consumers for electricity theft and also presents an architectural distribution system for theft detection using microcontroller based smart energy meter. The Inspiration of this work is to detect illegal consumers, preserve and successfully utilize energy. As well as smart meter are designed to provide automatic readings/data. It will reduce the laborious task and financial expenditure by adopting the automatic meter reading instead of the manual meter reading process and bill data entry process.

The major reasons of electricity loss in distribution networks are non-technical losses. These losses are meter tempering system and poor energy metering system. Current work to design an Automatic Power Theft Detection System (APTDS) for distribution network that will give the solution to overcome these losses.

Index Terms— Theft detection, Automatic Power Theft Detection System (APTDS), meter tempering, smart energy metering, Kunda system, Pakistan water and power development authority (WAPDA).

1 Introduction

PAKISTAN has faced considerable energy crises since 1947 [1]. Financial progress is not achievable in the lack of appropriate national power reservoirs including electrical energy requires for domestic, farming and developed sector. Pakistan is an agricultural country and about 70% of the people are involved in agriculture [2].

To start work any project, the initial step is to study the project related literature and also literature of the project's equipments. The other important thing is to study a lot about the project from various sources e.g internet, books and discussing it with several professional personnel. The main thing in the literature review is to study about various methods of power thefts that consumers often attempts. After studying about different power theft methods now we have to study the methodologies that can stop these power thefts and compare it with our project. It gives a comprehensible direction and it makes our idea better as compared to the previous methods.

In the second step we have to study literature related to the different type of equipment and choose the equipment which is best and easily available.

Power losses are mostly separated in two primary parts.

- Technical losses
- Non-technical losses

Technical losses delivered because of the physical way of the electrical parts. Transformer losses, Line losses, Regulator losses, Skin impact losses, and so on are a portion of the known technical losses that are incorporated into the general framework's losses esteem. Technical losses, as the name portrays discusses the study of the operation [3].

Non-technical losses, dissimilar to the technical ones, exist in light of non-electrical reasons. The major non-technical losses known not utilities is through pilferage and meter reading blunder. Non-technical losses in influence frameworks that can't be anticipated or figured previously [3].The theft of these losses are likely brought on by power robbery, as opposed to alternate conceivable outcomes, for example, poor upkeep, and count and bookkeeping botches, however some influence frameworks may experience the ill effects of both. Hence this shows the clear image how much work to do to address the issue of power theft in electrical distribution network.

1.1 Problem Statement

Major factor concern with non-technical losses in electrical distribution system is power theft. Hence non-technical losses due to energy theft are inefficient metering at distribution system.

2 Literature Review

According to WAPDA act.1958 (Pakistan act NO.XXX3 1958), WAPDA was established [4]. WAPDA has been given the duties of preparing and monitoring projects to fulfill the challenges of energy requirement faced by the country and efficient management of water resources to deal with the water or irrigation of agricultural sector of the country.

Electrical energy is transferred to the areas where there electric power is needed. To transmit bulk power over long distances, it is efficient to transmit this power with voltages greater than at distribution side, which enhances the transmission efficiency, reducing the voltage drop, conductor size and the transmission line loss. The transmission lines transmit power from the generating side to required region. In order to improve the reliability of the system, transmission lines interconnect the grid stations. [5]

As Electricity is much more important for industries and household. Electrical equipment's turn out to be a primary part of human life and a life without electricity is unimaginable in this modern world [6]. Electrical energy is necessary for economic development. As the electrical energy demand increases, all steps are being taken to improve the electrical production capacity to carry out the necessities. Though, the major problem to the electricity organization is power loss.

- Line losses (technical losses).
- Thefts (non-technical losses).

Line losses comprise of losses, corona losses and reactive power loss in the transmission lines. These losses cannot be excluded but can be reduced to some level by suitable design of the transmission lines.

Power theft is an illegal method and power companies are losing billions of rupees in this version. The charging

Electricity can be stolen in several ways:

- Meter tampering i.e. cutting the neutral of the analog meter.
- Impeding the flux of analog meter with exterior magnets.
- Changing the phase and neutral wires can stop analog meters.
- Sloping can slow down Analog meters.
- Informal connection to the service line by passing the meter.

Consumers also steal electricity by bribing Linemen and meter readers.

3 Proposed Methodology

Following methodology is followed for completion of this project:

3.1 Analysis

In the starting phase of our project following data was required for design of the project:

- Functions of present metering systems.
- Previous solution and related problems.
- Statistical data of power theft and line losses.
- Shortcomings in the present metering system.

3.2 Proposed technique

To implement this system, the current through C.S 1 is total current of feeder line according to KCL the current entering in a node will be equal to sum of the current leaving that node. The current entering the node is I(t) and the current drawn by load 1 is I(1), the current drawn by load 2 is I(2) and the current drawn by Load 3 is I(3) and the current drawn by the illegal user is I(I) . The current I(1), I(2) and I(3) are the currents that are metered by the meters as these current passes through C.S 1, C.S2,C.S3 and C.S4. The current I(i) is the current that is not metered because there is no metering device between the feeder line and consumer. According to KCL

$I(t) = I(1) + I(2) + I(3) + I(i)$

When an illegal user is connected to feeder line it will draw current I(i) and this current is included to the total current of feeder as it is passes through C.S 1 and it is not included in the sum of load current because there is no metering device to metered the load of illegal user.

So when meter will compare the sum of load currents to total current of feeder .Total current is greater than the sum of load current then the following condition will not be satisfied.

$I(t) = I(1) + I(2) + I(3)$

Its mean there is a theft and message will be displayed on LCD "WARNING".

Whenever input power is passing from supplier to the receiver at that time if the total amount of power is not received by the receiver then there is possibility of stealing of energy.

$\sum Pin = \sum Pout$ No Power Theft

$\sum Pin \neq \sum Pout$ Power Theft

3.2 Flow chart

After analysis of the problems, flow charts had to be designed. These flow charts were designed and verified from the engineers working on the projects of automatic metering system.

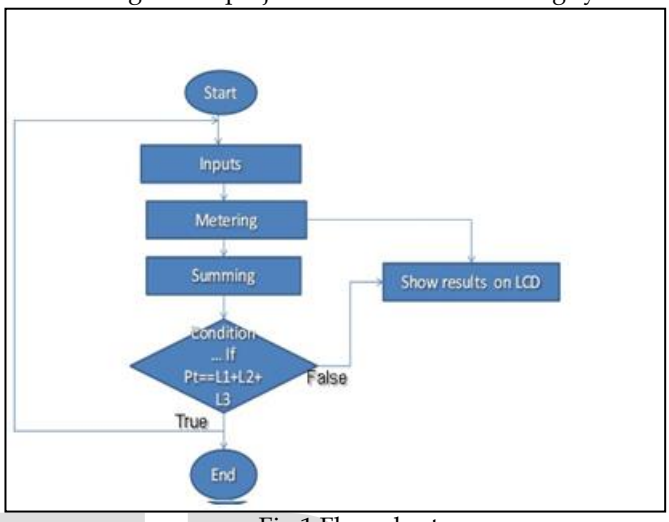

Fig.1 Flow chart

3.3 Simulations

For simulation the proteus 8.0 environment is used, while for coding the MPLAB XC 8 environment used. In initial step implementation of energy meter, and then final complete simulations.

In initial simulation the step down transformer and 20X4 LCD used, while in final of project current sensor IC and nokia LCD used to optimize cost of project.

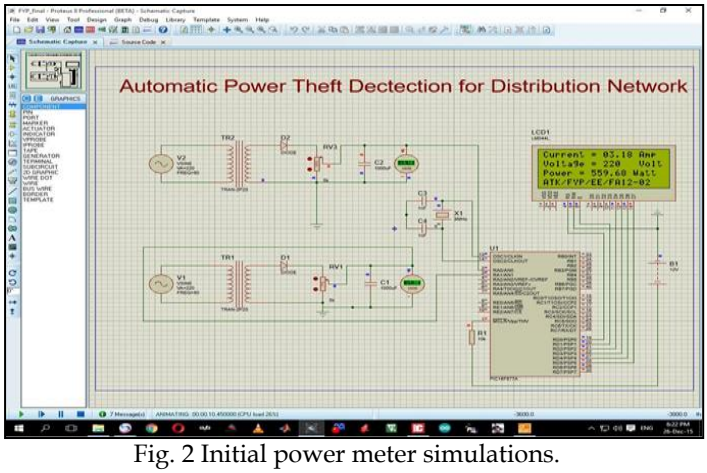

Fig. 2 Initial power meter simulations.

One of the consideration for the proposed work is that the proposed design must be cheap. For this many aspect studied, use of arduino board is avoided even they have many advantages such that coding, code burning, built-in libraries etc just because of cost. Same way the use of current transformer

and LCD is also avoided as explained earlier.

These aspects result promising in term of cost constraint, such that almost up to 25% the cost of final hardware of the system is reduced.

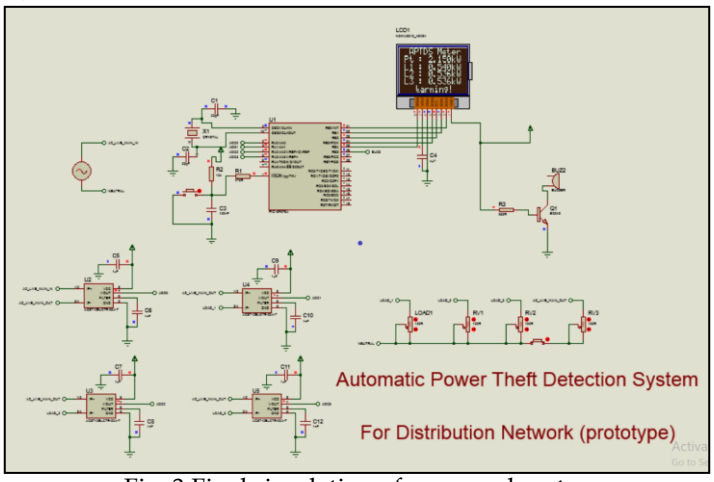

Fig. 3 Final simulation of proposed system.

3.4 Final prototype

For the final hardware of proposed system PCB was required, hence the PCB of the final simulations was sketched via proteus PCB layouts.

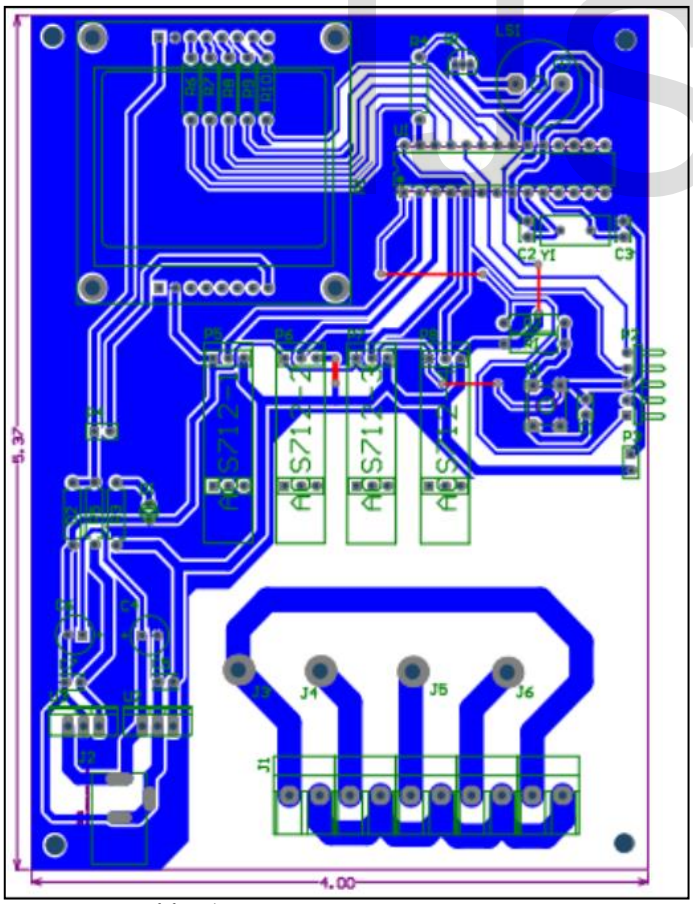

Fig. 5 PCB of final prototype.

Schematics help to understand the circuit as well as the components used in the proposed system. To design the proposed system following components and circuit are used;

- Interface circuit for current sensor (ACS712ELC-20A).
- Interface circuit designing for LCD (Nokia 3310 LCD).
- PIC microcontroller (PIC16F876A).
- LCD (Nokia 3310 LCD).
- Buzzer (Beep Type).
- Push switches.
- Voltage Regulator 7805.
- DB-9 connectors.
- Breadboards.
- Vero Boards.
- Crystal Oscillators (20 MHz).
- Resistors.
- Capacitors.
- Power Supply 9Volts.
- Printed Circuit Board (PCB).

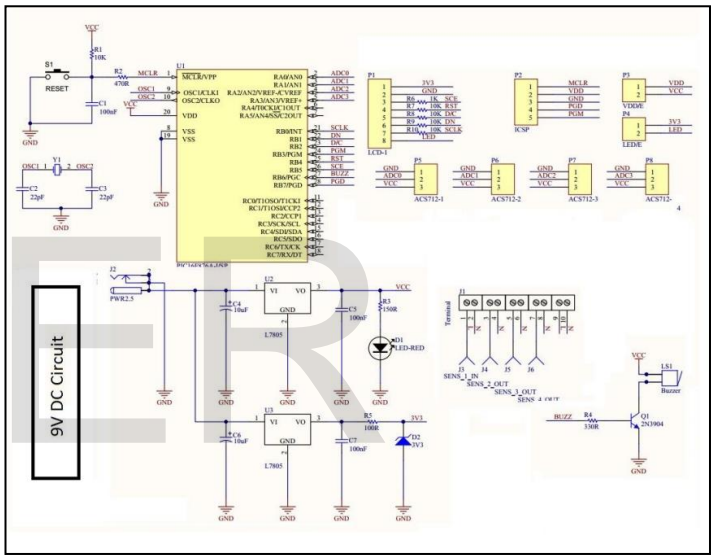

Fig. 6 Schematic diagram of proposed system prototype.

Final circuit board for prototype is follow;

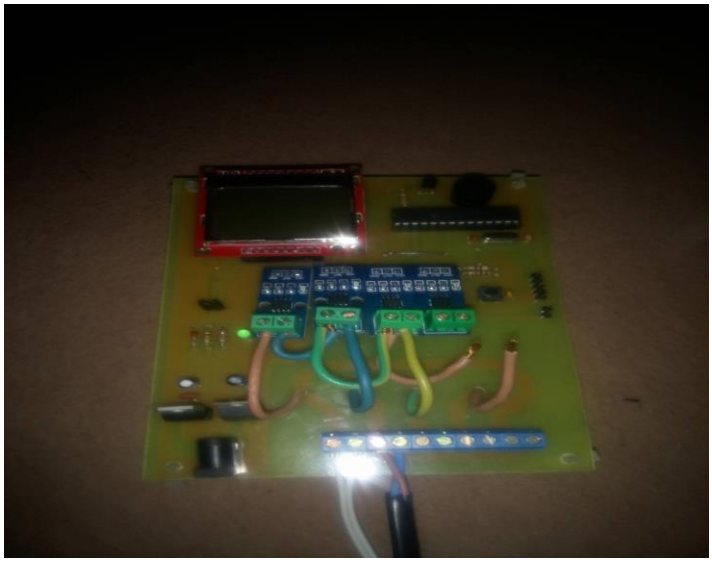

Fig. 7 Circuit board of prototype.

Final hardware we make prototype that we consider three loads

- Inductive load.
- Capacitive load.
- Resistive load.

All loads are consider to be a legal consumers, and one illegal load of resistive are connected, whole loads power are calculated and compare to with incoming power. Whenever illegal are not connected then incoming power from transformer is almost equal to legally consumer (considering tolerance up to frictional watts of powers), and whenever illegal consumer is connected then incoming power is more than legally consume power, so it will be detected and alarm will activate to inform concern authorities.

Fig. 8 Final prototype of APTDS.

4 Future recommendations

There is most likely about the potential advantages of mechanization. Prepaid Energy meter give off an impression of being the greatest inventive advancement of this decade and will get to be vital for all business sector administrators sooner rather than later.

The future meter can impart the client's information by means of Internet, E-mail, SMS, and so on straightforwardly as opposed to having the focal framework going about as a contact.

The future meter can be utilized for interest reason (animate the client to change his energy conduct) by presenting Multiple Tariff Meters having the office of Time Of Day observing and request side administration (direct control of family unit apparatuses, for example, clothes washer, or the aeration and cooling system).

Fault area and force robbery area finding additionally find effectively.

User`s point of interest can be made accessible by means of web and every client will have a remarkable ID where he can pick up data about his till-date utilization.

Tripping of those lines from control units where most power stolen by utilizing basic transfer rationale.

Smart camera likewise utilized over those dispersion line where power loss in robbery structure happen for the most part, which send online potage of line control units, and complete subtle element for security power gave of those criminals.

4 Conclusion/ Learning from project

The transformation of current proposed prototype to usable system will revolutionize the power system losses especially in distribution network side, such that huge amount of energy will be reserved as well as proper utilized.

- Professional project planning, scheduling, conducting and management.
- Personal time administration required to productively add to this sort of task.

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