DSP based slide mode control for photovoltaic system

By

Asif Ali
Enrollment Number: 01-133182-017

Faiq Afzal
Enrollment Number: 01-133182-022

Muhammad Nosher
Enrollment Number: 01-133182-073

Supervised By

Sir Muneeb Yaqoob

Session 2018-22

A Report is submitted to the Department of Electrical Engineering,
Bahria University, Islamabad.
In partial fulfillment of requirement for the degree of BS(EE).

Certificate

We accept the work contained in this report as a confirmation to the required standard for the partial fulfillment of the degree of BS(EE).

______________________. ______________________

Head of Department Supervisor

______________________. ______________________

Internal Examiner External Examiner

Dedication

This thesis is dedicated to our parents who provided us with their support and encouragement and assured us that even the most difficult tasks at hand can be accomplished if performed one step at a time. We would also like to dedicate this thesis to our supervisor Sir Muneeb Yaqoob for his inspiration, his cooperation and his utmost patience with us.

Acknowledgments

First and foremost, we would like to thank Allah the most Beneficial, the most Merciful, to whom belongs all praise and on whom we depend for knowledge and guidance. He bestowed us with the patience and knowledge required to complete our project. Secondly, our sincere appreciation goes to our supervisor Sir Muneeb Yaqoob for his encouragement and guidance. This project would not have been possible if it weren't for his advice and assistance. His patience helped us along every step of our project. We would also like to acknowledge our all the instructor for his moral and technical support and his invaluable advice on the course of our project. .

Abstract

In today's world, without power we cannot even imagine a single day. To produce energy, we rely on fossil fuels such as gasoline, gas, coal, liquid petroleum gas etc. All these resources are available from limited resources so we will not be relying solely on them. There are also independent resources such as solar, wind, water and more. Today, engineers have made it their goal to come up with a solution to every problem that arises in life. The Energy crisis is one of the most prominent issues for everyone, there was a phase where load shedding was common as we went along, eliminating the need for energy with all the resources we get such as coal, oil, gas, liquid petroleum gas and so on. We also use natural resources to meet the energy needs of solar, wind, water, biomass and more. They all have their advantages and disadvantages but the most reliable among them is the sun. The sun is not dependent on any other factor, with the time of sunrise and sunset, which varies from region to region. Each region has a solar radiation of at least 8 hours and in Pakistan about 13 hours due to the geo static location of Pakistan near the equator. Our goal is to identify high energy production from the sun to complete our need and overcome adversity. Therefore, the report focuses on discussing solar energy and converting it into electricity from a photovoltaic cell using efficient technology and control. The main project theme revolves around the solar panel, DSP kit and continuous slide mode control with the basic purpose, functionality, and construction of these devices.

Contents

List of Figures

Chapter 1

Introduction

1.1 Project Background

In the present world, the most important thing to mankind is energy. Without energy we cannot imagine a single day. To produce energy, we are dependent on the fossil fuel such as petrol, gas, coal, liquid petroleum gas etc. All these resources are present in limited resources so we cannot permanently depend on them. There are also independent resources such as sun, wind, hydro etc. Nowadays, engineers have made it their sole purpose to come up with a solution to every dilemma faced in life. Energy crisis is one of the highlighted topics of everyone, there was phase when load shedding was so common as we are progressing, we are completing the need of energy through all the resource we got such coal, oil, gas, liquid petroleum gas and other. We are also utilizing the natural resource to complete the need of energy including sun, wind, hydro, biomass and other. All of them have their benefit as well as losses but the most reliable among them sun. Sun does not depend on another factor it has a rise time and sunset time which differ from region to region. Every region has at least 8-hour sun availability and in Pakistan, it is around about 13-hours due to Pakistan geo static location closer to the equator. Our aim is to target the maximum energy production from the sun to complete need and overcome the crisis. Hence, this report focus is to discuss solar energy which convert it into electrical energy from the photovoltaic cell using efficient technique and controller. The main body of the project circulate around the solar panel, DSP kit and slide mode control further we have basic purpose, working and construction of these apparatus..

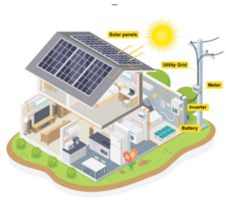

Figure 1.1: Solar energy model

1.2 Photovoltaic panel

The photovoltaic turn sun-light energy into electrical energy. A positive negative junction diode is used as the solar cell. PV is a form of photoelectric cell that changes its electrical properties. Solar panels are constructed from individual solar cells. An open circuit potential differential of roughly 0.50 to 0.60 volts can be produced by a one-unit conventional silicon solar cell connection [1]. This may not seem like much, but these solar cells are quite little. As a result, massive amounts of renewable energy can be produced when integrated onto a large solar panel.

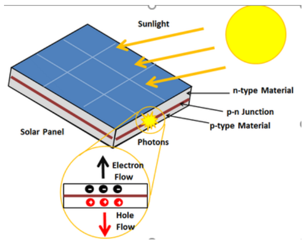

Figure 1.2: Photovoltaic cell model

A very thin semiconductor layer of positive type and negative type-based semiconductor. These electrodes do not reach the thin layer of similarly, newly created holes on the p-type side of the joint cannot continue to cross with the same blocking force [3]. A photovoltaic is the name for this voltage.

A little stream will flow through the joint if we put a low resistance load to it. The materials used in the production of photovoltaic cell are silicon, (GaAs, CdTe, CuInSe2) reason for which they use that they have a band gap of 1.5ev, they have high visual acuity, great electrical flexibility. Photovoltaic cells are economical, do not produce pollution, low maintenance charges and easy access to immature materials. The drawback of a photovoltaic cell is that hot weather can affect its performance and it is not working properly which is what we have aimed on our project.

1.3 Digital Signal Processor

Digital signal processor is a dedicated micro-processor chip, own design specified to digital signal processing operations. DSPs are made up of integrated MOS chips. Dedicated DSPs are more efficient, thus more suitable for mobile devices such as cell phones due to power usage issue. DSPs often use special memory structures that can download multiple data or instructions at once.

According to standard purpose processor standards, DSP command sets are often very uncommon; while conventional sets command occur frequently in DSP calculations. we are Using the TMS320C6713 DSP kit, it is an expensive development platform designed to accelerate the development of an accurate supported application. it is a true plug and play system. The DSP kit contains a 3.5mm audio output line, 2M flash and 16 MB port connector, 5V world power, connector Analog interface for data conversion, IDE studio code maker.

Figure 1.3: Digital signal processing kit

1.4 Slide mode controller

On a computer and mainly in computer hardware, the controller is a chip, expansion card, or standalone device that connects to the nearest compatible device. This may be a link between two devices components (for example a memory controller that controls access to computer memory) or a controller on an external device that controls the operation (and communication) of that device. There are different types of controllers like as PID controller, current mode controller, voltage mode controller, V.V con- troller, hysteresis controller, SMC and more. Slide mode (SM) controls switch back and forth between the two control rules as a regional vector function. As a result of these changes in sliding conditions occur beneficial advantages of control in relation to the variable parameter of the plant. What is bad is the change in the high frequency of the control element, which when switching of equipment leads to more wear and tear. SM control provides a flexible approach to the indirect environment of power source switch converters.SM was originally designed for successive plants where later indirect plants were added. We will only consider line control loops, as these systems allow us to determine the essential bases for controlling the slide situation.

1.5 Boost-Converter Model

A boost converter is a Direct current to Direct Current power converter that boosts voltage while lowering current from the input to the output charger. To reduce voltage ripple, capacitors are commonly used in the filters close to the converter's output and the supply side filter. The booster converter can be powered by any appropriate DC source, including batteries, solar panels, filters, and DC generators. The process of converting one DC voltage to another is known as DC conversion to DC.

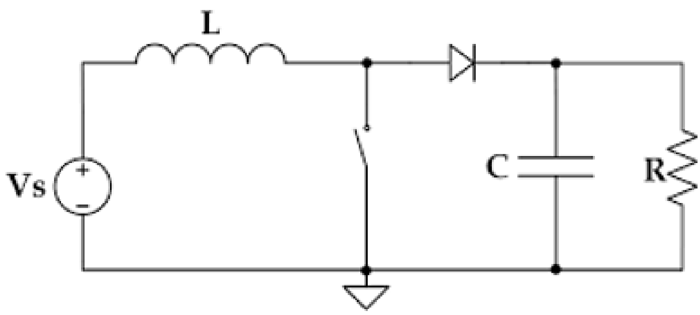

Figure 1.4: Ideal boost converter circuit

Chapter 2

Literature Review

2.1 Literature review

The innovation that has been going on for many years has been created at a rapid pace, this result having innovative systems that work and make human presence more secure. In particular, the energy industry aims to meet global energy needs. Mainly the energy development fields that have created the most development are in the energy sector by providing free and affordable energy to full fill the load requirement. As in the recent past, the energy sector has developed exponentially. There is a separate published research paper that highlights the importance of DSP as a controller over another controller such as the aurdiono. We also learn different techniques and experiment with software and conclude with the result that the SMC method is better than the PID of the most common controller. We also receive MPPT and apply Climbing Behavior over distraction and monitoring. In addition we will discuss various research papers working on related projects where we get our first impression of the project implementation.

Because of the unpredictability of weather conditions, the DC output voltage provided by solar PV systems is not balanced.Despite the presence of several control modes in conjunction with Buck-Boost converters in the study, converting an uncontrolled DC source to a constant voltage remains a difficult process. The voltage mode control, on the other hand, is simple to operate but has a long response time and poor dependability and stability. Furthermore, the PID approaches' overshoot has a significant impact on the converter's output voltage. SMC, among the different control measures outlined above, attracts major regulatory attention due to its following.Strong capacity to block out undesired input. Gives you a somewhat more steady state inaccuracy. It has been discovered that it is better suited for indirect systems than PID controls. In the sliding mode mode, it may give stability. SMC with Buck-Boost converter, on the other hand, has been regarded as a good solution for getting DC power supply managed from an uncontrolled supply, although negotiating productivity owing to quick switching is a stressful issue. Due to the quick change of SMC, poor control precision, heat loss, machine loss, and other issues arise. As a result, researchers are increasingly interested in conversational reduction tactics in order to develop effective SMC-based controls. Several research projects have been done to reduce high-level SMC discussion and performance.In order to reduce friction, two control modes, PID and SMC, were initially merged and employed for significant distortions. In addition, combining PI and SMC controls to reduce conversions, static error, and high shot created by PI-based control and SMC is advised. In addition, two non-negotiable SMCs are designed to keep the engine operating in the correct position and control the current super capacitor at reference values. Although the legal framework of SMC control is highly recommended in many studies, only software acquisition is tracked to evaluate control performance. Simulation studies alone cannot assess controller performance since changeable environmental numbers can alter accuracy.

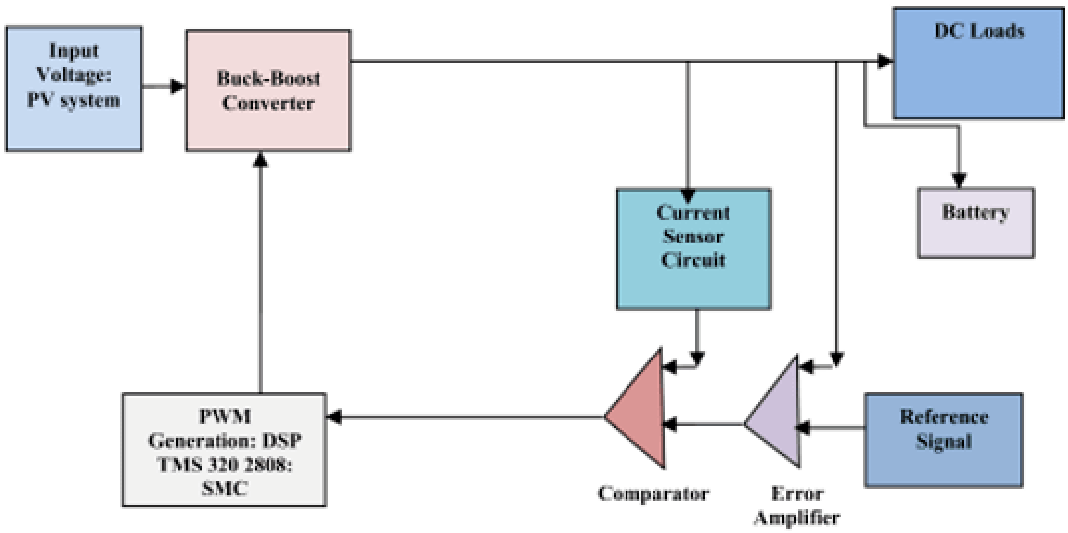

Figure 2.1: Block diagram of project

The exponential reaching law provides the least amount of chattering in the quickest amount of time.This technique is also chatter-free because the velocity at which the system trajectory will strike the switching surface is modest. Furthermore, the exponential reaching law's output deviation is only 0.16 percent. In addition, in the exponential reaching law, the initial control voltage is the lowest.

2.2 Methodology

Photovoltaic (PV) generating is one of the most promising renewable energy sources currently available. PV generating is favoured over other renewable energy sources due to its environmental and economic benefits, as it is clean, durable, and requires little tweaking. PV cells convert solar energy into electricity to generate electricity.

The operating point of the system is I-V PV curves for the same members as the load, where the same PV members are directly connected to the load. Calculating these parameters is sometimes quite expensive, and the PV system model's needed parameters are not well understood. As a result, MPPT continues to look for MPP. Using various properties of solar panels and MPPT placement, multiple continuing MPPT search algorithms have been presented.

2.3 Basic Principle of PV Cell

The positive-negative junction diode, P-V cells have formed between the negative-type and positive-type regions. When sun fall PV cell, the energy is converted energy. Inside the semiconductor, transmission light is input to by forcing free electrons to jump from a low-energy to a high-energy state. When a P-V cell is turned on, light in all directions produces a large number of electron capture pairs, which is why the positive-negative junction is short and I flows.

2.4 PV array Characteristics

Characteristics hold by PV cell can be modelled using a single-circuit electrical circuit. An equation can be used to create a mathematical model of a photovoltaic cell. The fundamental figure in semiconductor theory is that

$$I = Ipv, cell - Id \tag{2.1}$$

$$I_d = I_(o, cell) expa(qv/akt) - 1 \tag{2.2}$$

$$I = (Ipv, cell - Id) - (I_(o, cell) expa(qv/akt) - 1) \quad (2.3)$$

statistically describes the I-V feature of the Ideal photovoltaic cell provided by ' q 'charge -electron [1.60217646 * 1019C], k is fixed [1.3806503 * 1023J / K], 'T' Figure 1 depicts an excellent PV cell's comparable cycle. Because system

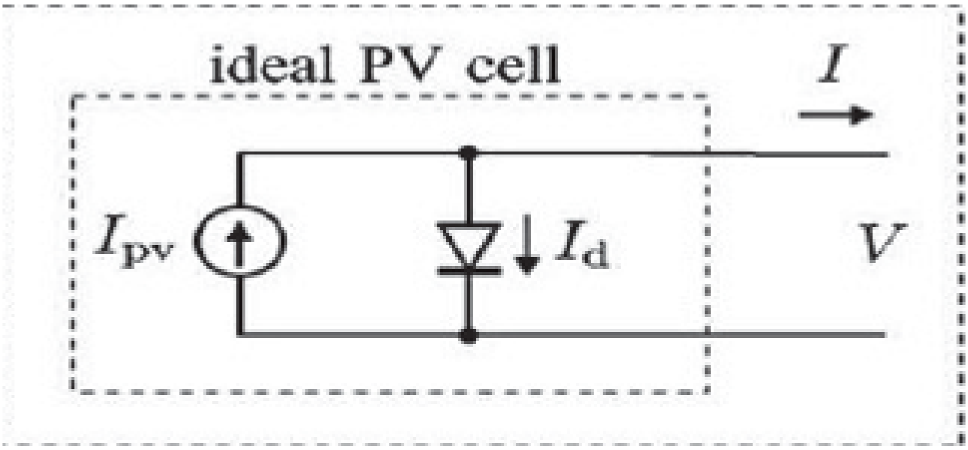

Figure 2.2: Equivalent circuit of ideal PV system

are made up of too many P-V, observing the characteristics at the PV array's terminals necessitates the addition of extra parameters (as illustrated in Figure 2) to the basic equation:

$$I = I_(pv) - I_(o)[expa(v + R/vz_a) - 1](v + R/vz_a) \quad (2.4)$$

ohms law relationship for MPPT in the system.

IC algorithm can be easily identified by the following flow chart shown in the figure

The various parameters of the PV array are determined and selected. Because the 'Io' is strongly temperature sensitive, the 'Io' simulation circuit contains, which are electric current and I coefficients, respectively. The methods listed be-

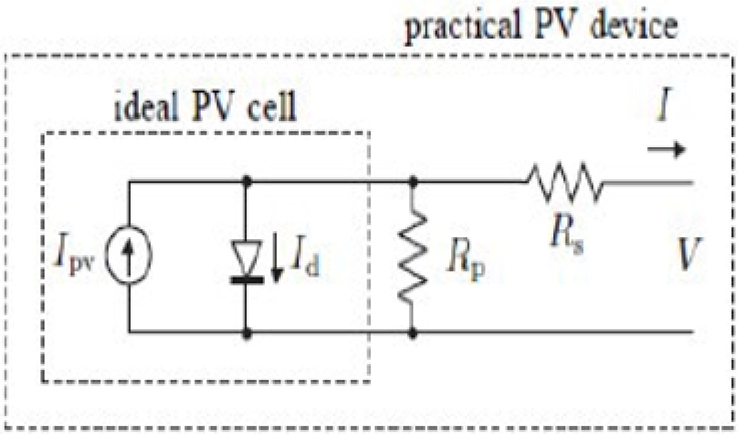

Figure 2.3: practicle PV device

low are some of the most commonly utilised MPPT approaches in various PV systems, including space satellites, solar vehicles, and solar water plants, among others. Solar technology is tested and approved. Among the many parameters of comparing different strategies, the algorithm process is one of the best mathematical methods used based on factors such as, the flexible controls involved and the type of control strategies, rotation and cost-effectiveness and so on.

2.5 Evaluation

For a multitude of causes,general economic growth, and industrial growth, the current worldwide need for energy has been gradually increasing. Throughout history, fossil fuels have been used to meet a variety of energy needs. As a result, achieving great efficiency in PV systems is critical. This is accomplished through full power which entails keeping the system functioning in the workplace even when the power output is quite high.

It works by disrupting control volatility on a regular basis and comparing rapid PV power before and after the disturbance. The sample interval (Ta) P and O were chosen to generate reference voltage (Vref) due of their ease of use.

The PID controller is based on a PV system line close to a specific working

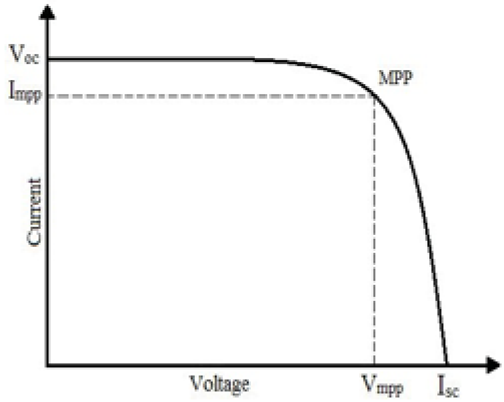

Figure 2.4: ohm's law relationship for MPPT

area, such as MPPT in low ambient light, such as the Index. As a result, non-line controls that do not rely on linear models must be designed to assure uniform operation over the working range.

2.6 Response-Using PID Controller

Using a typical PID Controller to compare the planned SMC controller's results. A typical Perturb and Observe MPPT code identified with a 1 V amplitude of Perturb and Observe interference. The voltage of a common controller is being monitored.

For the maximum in 5 milliseconds. Trace tracking error is common when there are strong waves and oscillation. For the identical PV components, the power output and reference power curve are shown. It should be emphasised that MPPT is accomplished in 5 milliseconds with a typical PID control; however, the controller effectively traces the reference but displays big values.. A zoomed view is provided with electrical and power curves to detect relative conductor.

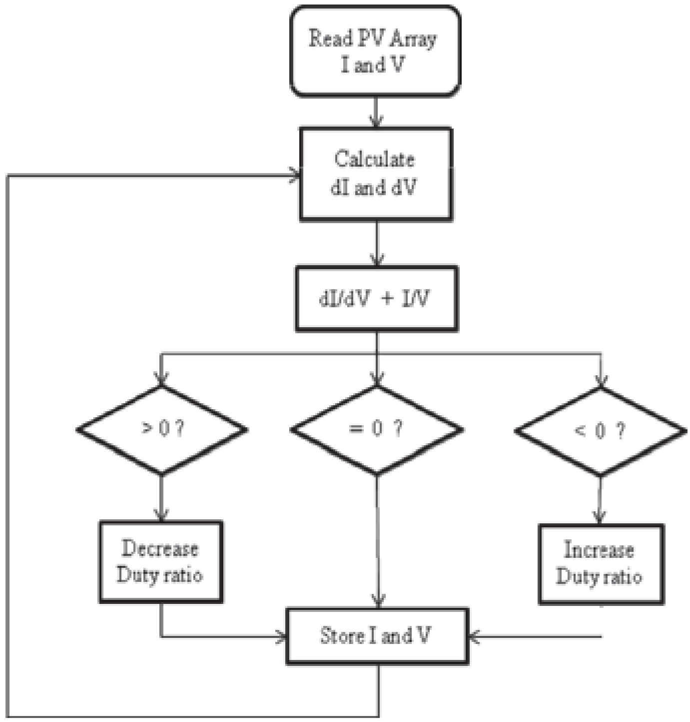

Figure 2.5: Incremental Conductance Algorithms

2.7 Response Using the SMC

The MPPT output based on Perturb and Observe is an electrical reference that the controller must track. The controller is used to for PO system, and to verify that the tracing error is close to zero using the proposed controller's required operation. When the proposed control is used, the system's efficiency improves dramatically. The results obtained with the sophisticated SMC controller are PID, both high and visible, rather than ripples and overshoot.

2.8 Comparative Analysis

The suggested SMC controller was compared to others. The suggested controller's curve voltage is compared to the reference signal and the voltage signal of the

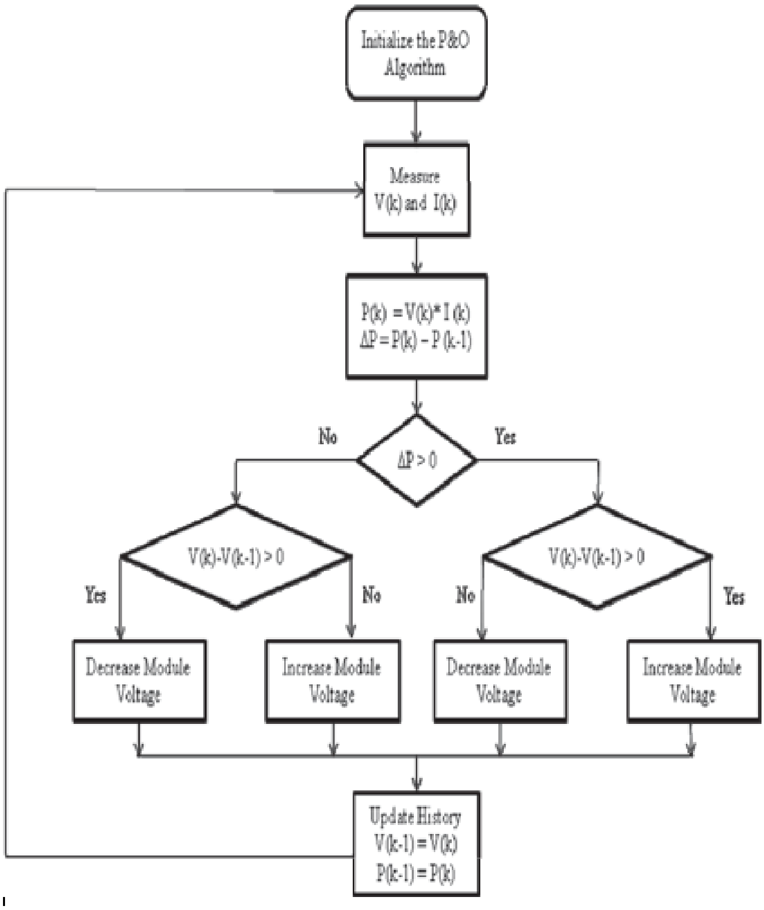

Figure 2.6: perturb and observe

standard controller. Both controls properly track the reference, and the PID controller's behaviour may be controlled to a high degree. Similarly, it emphasises the suggested control panel power's comparison to reference signal intensity and regular control power. M-P-P-T track by S-M-C control, which has nearly no ripples in contact with the reference signal, as opposed to the PID control, which has bigger ripples in contact with the reference signal.

The algorithm process is one of the best mathematical approaches for comparing multiple strategies based on characteristics such as the flexible controls involved and the type of control schemes, rotation and cost-effectiveness, and so on. An algorithm for comparing perturb and viewing, as well as Ascending Behavior, with

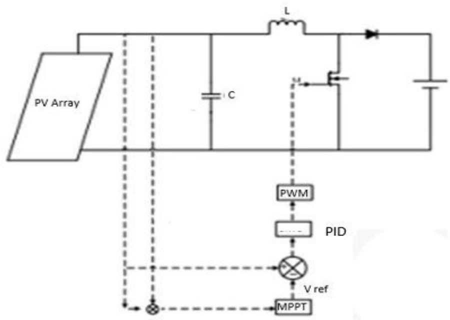

Figure 2.7: Block Diagram using PID

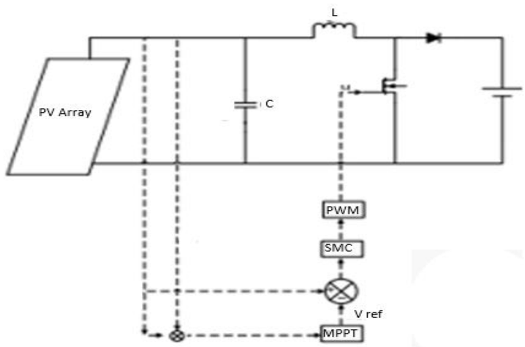

Figure 2.8: Block Diagram using SMC

a 70W photovoltaic panel model, has been created in this study. This concept is utilised in algorithms that track exceptionally high scores. MPPT algorithms that cause problems, as well as surveillance and incremental behaviours, are discussed and shown. Ascending habits have been shown to outperform disruption and the viewing algorithm. These algorithms boost a photovoltaic system's power and stability while also increasing the efficiency of the dc-dc conversion system.

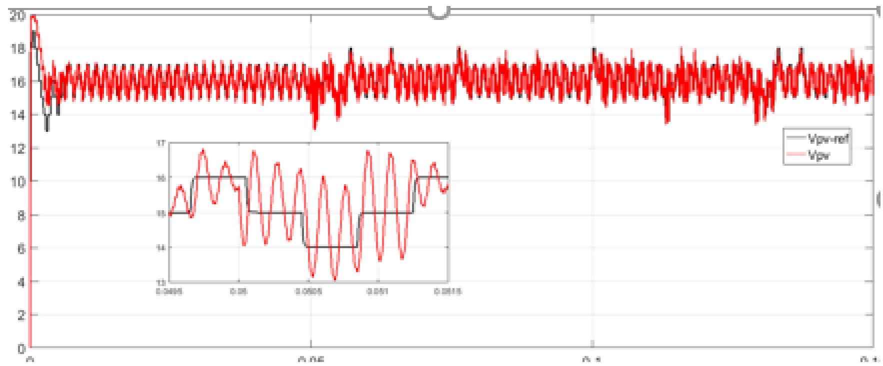

Figure 2.9: Profile of the panel voltage

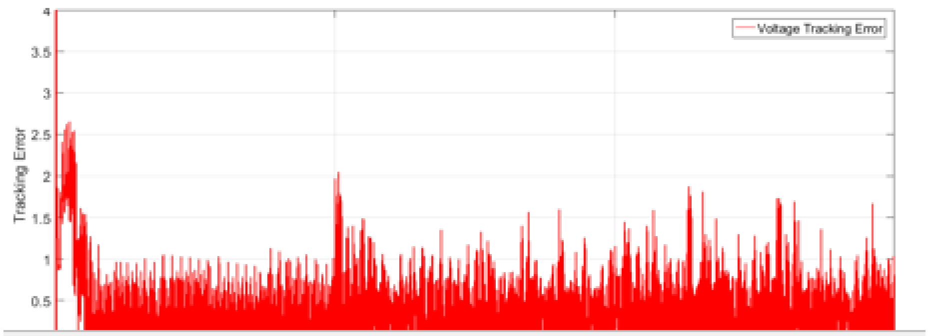

Figure 2.10: tracking response of the Proposed controller

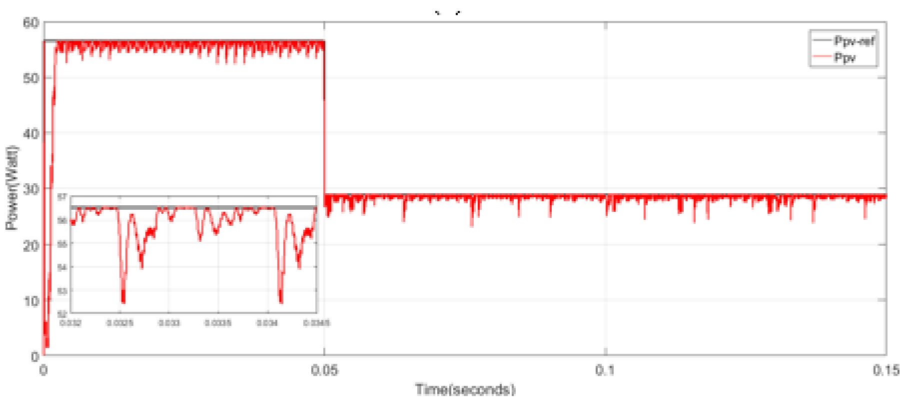

Figure 2.11: profile of the PV power extraction

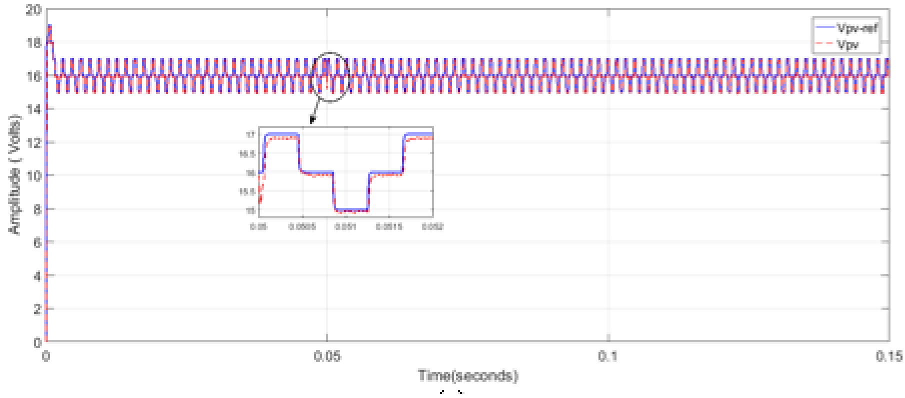

Figure 2.12: Profile of the PV panel voltage

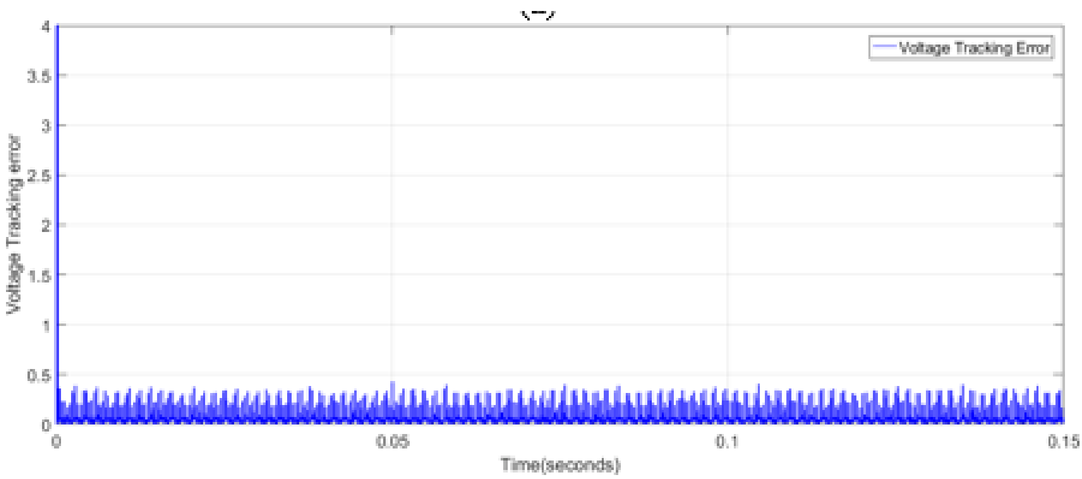

Figure 2.13: Tracking response of the proposed controller

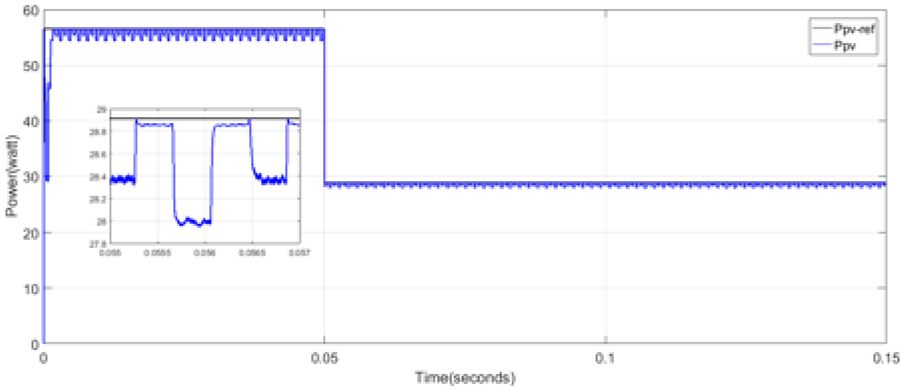

Figure 2.14: profile of power extraction

Table 1. Performance characteristics of the conventional PID and the proposed SMC controller.

Controller	Over/Undershoot (%)	Settling Time (s)	Power Losses (Watt)
PID	2.61	5 ms	3
SMC	0.6	0.3 ms	0.68

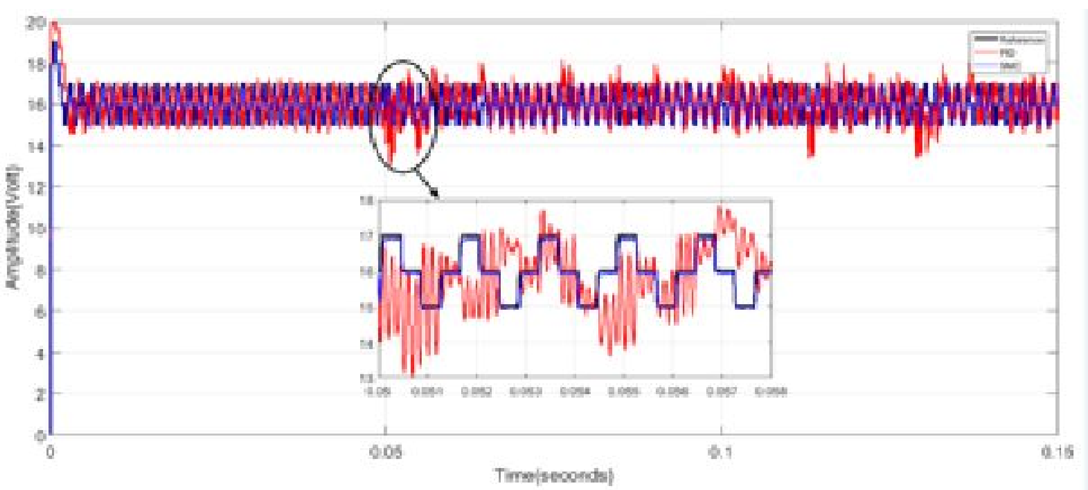

Figure 2.15: Reference, $P_{ID}andS_{MC}P-Vvoltagecurve$

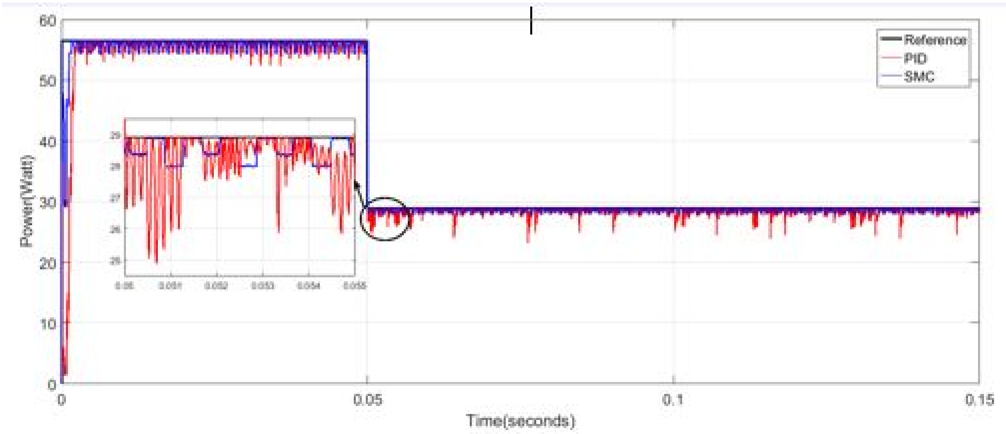

Figure 2.16: Reference PID and SMC PV power curve.

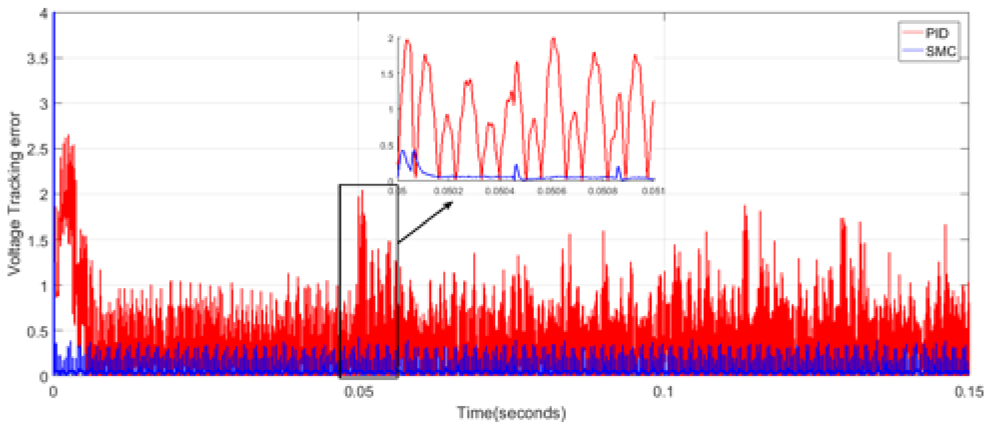

Figure 2.17: Error tracking

Chapter 3

Requirement Specifications

3.1 Existing System

Solar panels are very commonly used in our daily lives. Solar panels are used in our homes, offices, schools, factories etc. it produce electrical energy to meet the load demand but still work in a simple way to convert solar energy into electricity. There was no flexibility in the solar panels.

The existing systems are designed in such a way that they are placed on the rising side of the sun and remain intact until sunset. Without the direct effect on them. It has been observed that in the summer at 40 degrees Celsius or above the solar panels collapse causing the system to slow down. The existing systems are easy to have a solar panel with a battery for charging and the inverter converts a DC charged battery into AC for charging.

Solar panels have remained the same since the decade using the same method. We lack a efficient system that can turn the solar system smart enough to understand what elements are beneficial to it in order to make the most efficient energy. We have to design system that can make the solar panel smart enough to understand the limitations that can give us effective power in the system. As we know that at temperature of 25-degree Celsius is the most appropriate temperature for the operation of the solar panel to get efficient output

3.2 Proposed System

Hardware model of the proposed system, SMC is implemented using hardware components. Buck-Boost converter, with parameters will be designed on PCB. Regulatory rules are made with help of MATLAB Simulink.The TMS320F6713 is available for all Digital Signal Processing and is ready to apply the regulations. However, a microcontroller-based or a hardware-based controller may not work efficiently in real time. Most computer problems are beyond the microcontroller's capabilities. For hardware-based controllers, changes in control algorithms necessitate modifying the complete control loop. The DSP TMS320F6713 processor is used to implement the control rules. Configuring, modifying, and coordinating processors is a difficult undertaking that requires expert skills..

3.3 System Requirement

3.3.1 System Modeling

The TMS320F6713 is available for all DSPs and is ready to apply the regulations. DSP perform all the action in real time and take the input of P-V system and output given to battery. Most computer problems are beyond the microcontroller's capabilities. For hardware-based controllers, changes in control algorithms necessitate modifying the complete control loop. The DSP TMS320F6713 processor is used to implement the control rules. Configuring, modifying, and coordinating processors is a difficult undertaking that requires professional skills. An IC

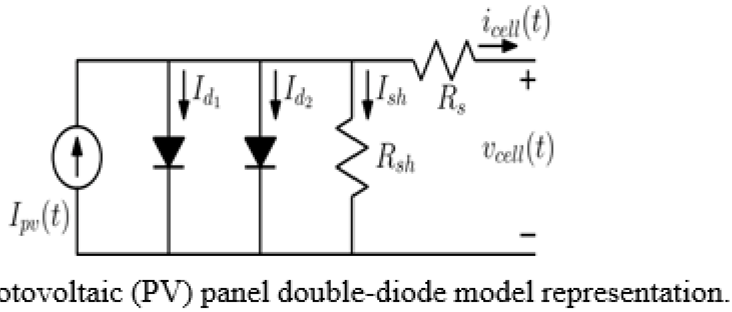

Figure 3.1: Photovoltaic PV panel double diode model representatio

algorithm, which is the most extensively used MPP tracing method, is utilised to harvest the highest available power from the solar panel. After monitoring the panel's power, the IC generates a Vref reference voltage. If that power is greater than previous power, the reference voltage rises by the same fraction, if not, it traces it again.

3.3.2 Controller Formulation

Closed loop system is used to track the M-P-P-T of the P-V. MPPT algorithm can be written as:

$$X_d = [X_d \qquad X_d]^T = [V_p v - ref \qquad V_p v - ref]^T \tag{3.1}$$

The tracing-error defined:

$$\begin{vmatrix} e_1 = X_1 - X_d \\ e2 = e_1 \\ e_2 = x_2 - x_d \\ e2 = x_2 - x_d \end{vmatrix}$$

$$u = u_e q + u_s \tag{3.2}$$

$$u_e q = h(X,t)^- 1[x_{df}(X,t) - J(X,t) - c1e2] \tag{3.3}$$

$$u_s = -h(X,t)^- 1[K_s(sgn)(s)] \tag{3.4}$$

the signum function, defined as:

$$sgn(s) = \begin{cases} +1 & if \quad s < 0 \\ 0 & if \quad s = 0 \\ -1 & if \quad s < o \end{cases}$$

Controller law

The SMC-MPPT algorithm is divided among two steps: • In the first step, the Incremental Conductance algorithm determines Vref's reference voltage when the system reaches its maximum power. These procedures gurantees that the system functions properly. A search. MPP: Increased Behavior (IC) To find MPP voltage Vref, the Increasing Behavior (IC) approach is utilised.

dPpv dVpv = Ipv +Vpv dIpv dVpv

In the case When the power slope equal to 0, i.e., dIpv dVpv =- Ipv Vpv , the photovoltaic system is at the highest power point.

Therefore, the update law for Vre f is given by the following rules

Vre f(k) = Vre f(k 1) +V , f or dIpv dVpv ¿ Ipv Vpv

Vre f(k) = Vre f(k 1)V , f or dIpv dVpv ¡ Ipv Vpv

Thus, the problem is changed to control PV array voltage Vpv to follow the reference of high voltage Vre f which is the role of the old sliding mode and the Adaptive sliding mode.

– Power Rate Reaching Law

Power rate reaching is fluctuation in the real time. The Power rate reaching law is:

$$S_i = -K_i[S_i]^{\alpha} sgn(S_i)$$

where $sgn(S_i) = [sgn(S_1), ------, sgn(S_m)]^T$ and $k_i = diag[K_{1,} ----, K_m]$

$$K_i > 0; 0 < \alpha < I; T_i = \frac{1}{(1-\alpha)K_i} S_{io}(1-\alpha)$$

Furthermore, the phrase [Si] ensures chatter-free functioning through quick reach. As a result, this law reduces sliding motion, indicating the controller's resilience. The power rate reaching law, the following formula is utilized:

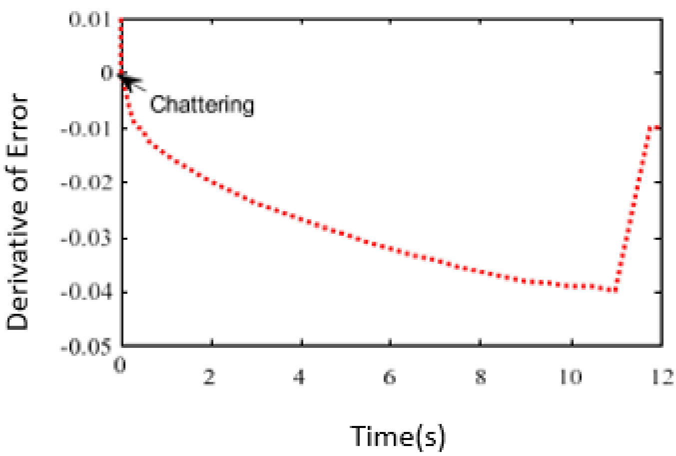

Figure 3.2: Variation of derivative of error

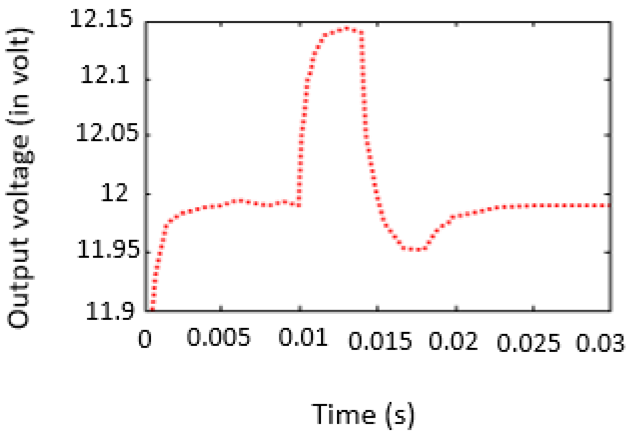

Figure 3.3: peak variation derivative error

The level of efficiency of law implementation is determined by measuring the variability of the error with respect to which it emanates. In addition, the output voltage fluctuations with the provided input and load switching. The outgoing voltage initially has a slight deviation but remains stable at 0.02s. Conversation exists and gradually reaches a point of equilibrium. Here, the output is 0.139 V .

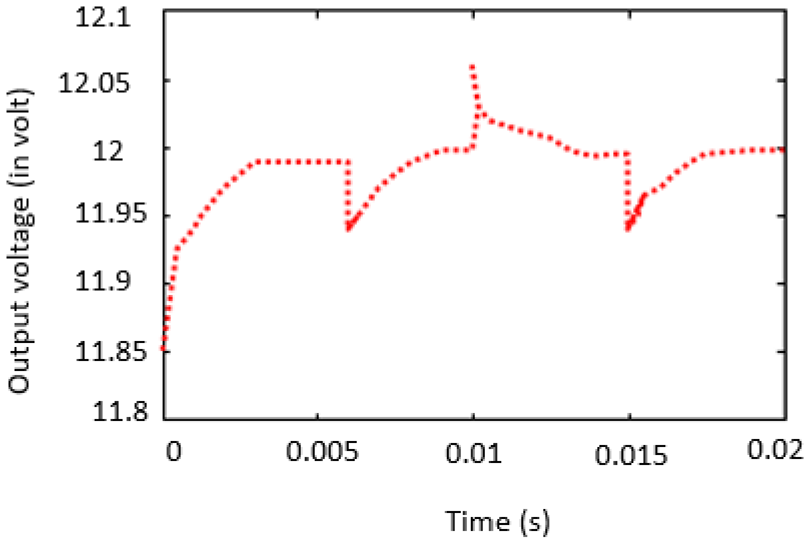

Figure 3.4: Variation in output with time

Exponential Reaching Law To obtain faster time and energy, the worth of K must be increased, but the level of control of the input control must also be improved. As a result, another strategy has been offered to address this issue, namely, power reaching law. The exponential reaching law is provided:

$$s = -esig \tag{3.5}$$

$$s = -etanh \tag{3.6}$$

$$\sum_{n=1}^{n} |x_i| k > 0, \Phi > Osig(X, a, Q) = (1 + e^{-aX+Q})^{-1} \tag{3.7}$$

$$ifa = 1, Q = 0sign(x) = 2sign(X, 1, 0) - 1 = 1 - e^{-x}/1 + e^{-x} \tag{3.8}$$

$$ifa = 2, Q = tanh(x) = sign(2X) - 1 = e^{x} - e^{-x}/e^{x} + e^{-x} \tag{3.9}$$

Some of the features of exponential reaching laws are contained in reaching laws, hence this sub-section is omitted. Control voltage variations through-

$$S= \frac{K}{N(s)} * \operatorname{sgn}(s) \quad K > 0$$

$$S=\delta o + (1 - \delta o)e^{-a|s|p}$$

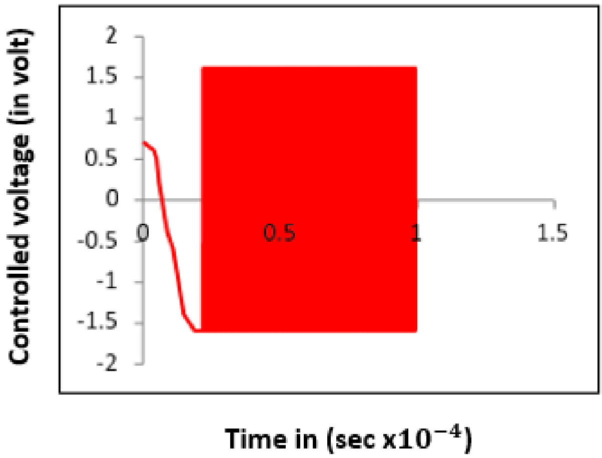

Figure 3.5: change in output voltage with time

out time. Variation in output voltage over time. Maximum overshoot does not exist, as can be seen. The result voltage change over time is shown.

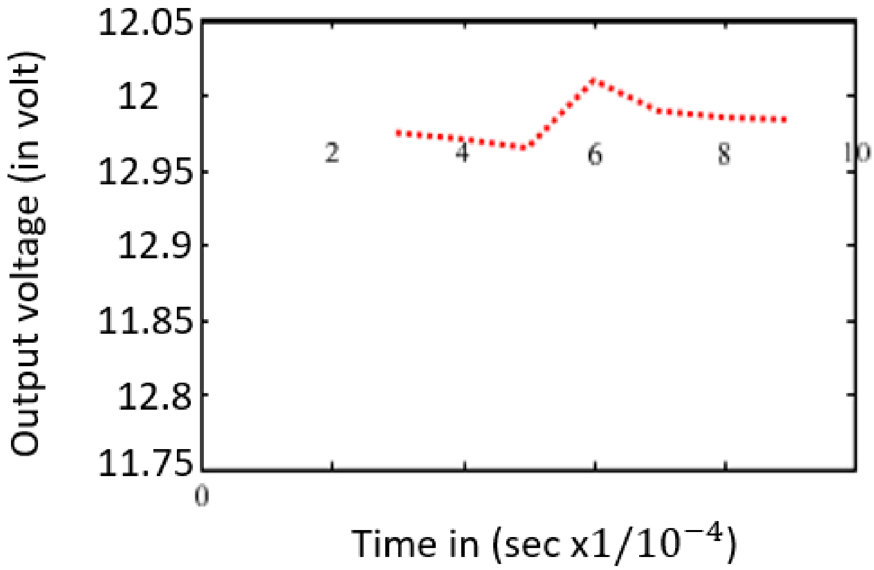

Figure 3.6: Output voltage variation with time

Chapter 4

System Design

4.1 System Architecture

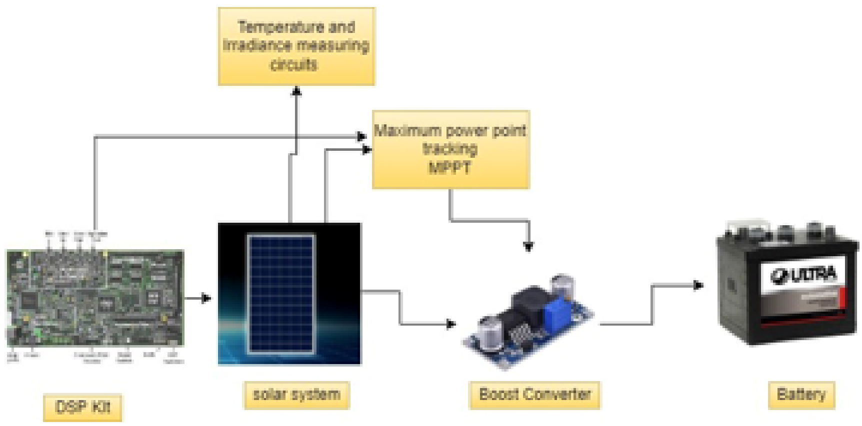

Figure 4.1: Block Diagram of system

This is our proposed version of our Final year project we have plan to use four solar panel in the model to take temperature and radiance on every solar panel. It will be beneficial while taking output on different input. There are many different programming kit such as raspberry pie, Arduino and DSP. We are using DSP kit because it is an industrial device which is very much common in industry level. DSP kit will be program in such a way that it will take input at the temperature of 25 degree Celsius because it is the most efficient temperature for the solar system to provide highest output. We have also to figure out the MPPT point through which we are up to correct input. For that purpose, we are using slide mode controller under the incremental conductance technique. input voltage will go under the boost converter to be boosted to around 24 volt and store in the battery for the load

.

4.2 Design Constraints

In a comprehensive solar PV system, both monocrystalline and polycrystalline solar panels work in the same way, and the science behind them is simple: they collect energy from the sun and convert it to electricity. Both are constructed of silicon, which is a heavy, sturdy material that is utilised in solar panels. Monocrystalline and polycrystalline solar panels are available from a variety of manufacturers. Both monocrystalline and polycrystalline solar panels are viable options for your home, but there are several key distinctions to be aware of before making your final decision. The type of silicon solar cell used in both technologies is the key difference: Monocrystalline solar panels have single crystal silicon cells, whereas polycrystalline solar panels have multiple crystal silicon cells. they use: monocrystalline solar panels with single crystal silicon cells, while polycrystalline solar panels with solar cells are composed of multiple pieces of molten silicon together.

Why polycrystalline panels should not be ruled out Despite the fact that monocrystalline panels perform well, polycrystalline panels may make sense in some situations. Despite the fact that they perform far better than monocrystalline panels, if you have a workplace tone, this may not be a significant concern. Installing extra polycrystalline panels in your location to suit your energy needs may save you money due to their low cost. Poly loses their efficency through increase in temperature.Furthermore, technology is continuously evolving, and polycrystalline solar panels are now being created.

4.2.1 Controlling kit

4.2.2 Raspberry pi

The Raspberry Pi is a latest tool but expensive and require the basic learning of language.

4.2.3 Arduino

Arduino is a hardware and software startup that is cheap and commonly used in school task.

4.2.4 DSP kit

DSP is professional tool mostly used for tech industrial purpose for controlling the system.

4.3 Controllers

4.3.1 PID

PID controller is a loop control module widely used in industrial control systems and other applications. necessitating ongoing control modifications The PID controller continues to calculate the error number as the difference between the desired setting and the approximate process variation , and utilises correction based on measurement, complete, and derivative terms (specified as P, I, and D, respectively). When it comes to assets, PID adjusts the control function automatically and precisely.

4.3.2 SMC

Slide mode controller (SMC) is an indirect approach in control systems that modifies the indirect system flexibility by employing a non-continuous control signal . that causes the system to "slide" closer. the opposite part of the system's typical behaviour. The law governing state reaction is not a linear function of time. Instead, depending on the present location in the region, it can flip from one continuous structure to another. Slide mode control is thus a versatile structure control tool.

4.4 Controller technique

P and O

When the voltage increases, the p and o controller changes the potential difference from the range by a tiny amount and measures the power; when the power increases.

4.4.1 IC

The controller calculate the effect of the power shift by quantifying the increased current and voltage variation. This approach involves more computation on the controller, but it is faster than PO at tracing changes. The output power remains constant. It calculates the voltage fluctuations signal relative to the voltage (dP / dV) using the rising conductance (dI / dV) of a solar array. MPP is incorporated into increased behaviour by comparing increasing behaviour.

4.5 Design Methodology

This is our proposed model for the Final Annual project "Slide mode control based on DSP photovoltaic cell" in which we plan to use four solar panels in the model to take the temperature and brightness across all solar panels. It will be useful when extracting output for different inputs. There is a different editing kit like raspberry pie Arduino and DSP. We use the DSP kit because it is the most common industrial tool at industry level. The DSP kit will be a system in such a way that it will absorb inputs at temperatures of 25 degrees Celsius because it is the most efficient temperature so that the solar system provides the highest output. We should also find the MPPT point we are on to adjust the input. For that purpose, we use the slide mode control under the steering mode. After that the input voltage will go under the boost converter to amplify up to about 24 volts and save the battery for charging.

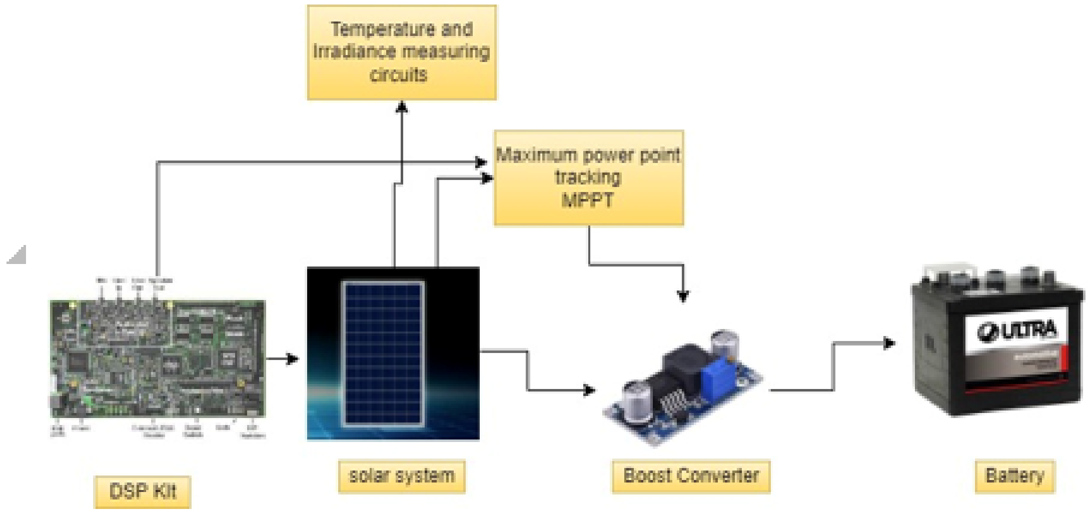

Figure 4.2: Block diagram

4.6 High Level Design

Conceptual or Logical:

Monotype Solar cell:

Monocrystalline solar panels are widely considered to be a significant solar product. Monocrystalline panels' key advantages are their high efficiency and high quality. Silicon is formed into bars and then sliced into wafers to manufacture monocrystalline solar cells for solar panels.

Polycrystalline Solar cell Polycrystalline PV have less effect than monocrystalline PV, but they have the advantage of being less expensive and temperature sensitive.

4.6.1 Process

This is our proposed block diagram of the Final Annual project "Slide mode control based on DSP photovoltaic cell" in which we plan to use four solar panels in the model to capture the temperature and irradiance of all solar panels.

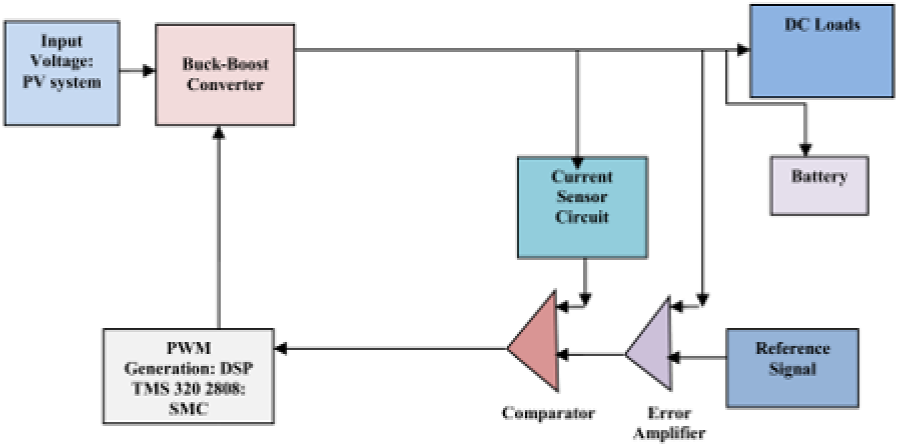

Figure 4.3: flow chart diagram

4.6.2 Physical

4.6.3 DSP KIT

DSP kit has high signal processing speed. It also has high accuracy.we use DSP kit because its reconfiguration is very easy as compare to others controllers. It also offer various interfacing types like UART,12c etc. we can also easily implement the mathematical equations by using c language.

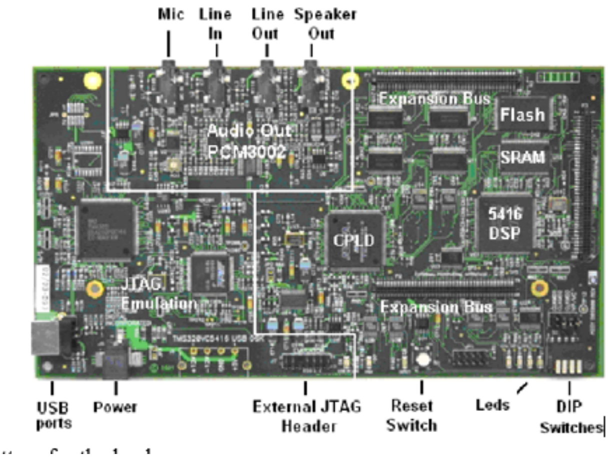

Figure 4.4: DSP kit

4.6.4 Battery

In our project we use two batteries of 12 volts. we connect them in series to convert them into 24 volts. As we are taking inputs 12 volts from the pv and we give these 12 volts to our boost converter. Our Boost converter will step up the DC voltage to 24 volts and charge our batteries. After that we run two type of load one is DC load and the other is AC load. we give our 12 volts battery input to the inverter that will convert them to the 220v Ac and our enlight our bulb.

Figure 4.5: Battery

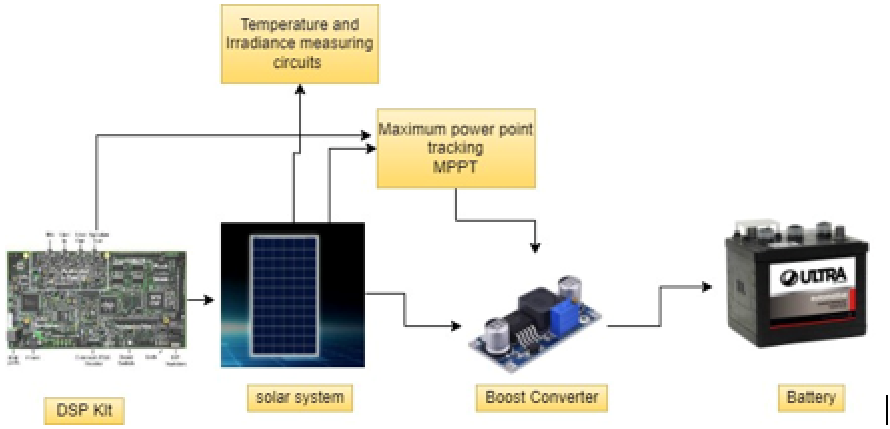

Figure 4.6: Architecture Design

4.7 Low Level Design

The proposed model for the Final Annual project "Slide mode control based on DSP photovoltaic cell" in which we plan to use four solar panels in the model to capture the temperature and brightness of all solar panels. It will be useful when extracting output for different inputs. There is a different editing kit like raspberry pie Arduino and DSP. We use the DSP kit because it is the most common industrial tool at industry level. The DSP kit will be a system in such a way that it will absorb inputs at temperatures of 25 degrees Celsius because it is the most efficient temperature so that the solar system provides the highest output. We should also find the MPPT point we are on to adjust the input. For that purpose, we use the slide mode control under the sliding mode. After that the input voltage will go under the boost converter to amplify up to about 24 volts and save the battery for charging.

4.8 Simulink Design

Simulation of incremental conductance

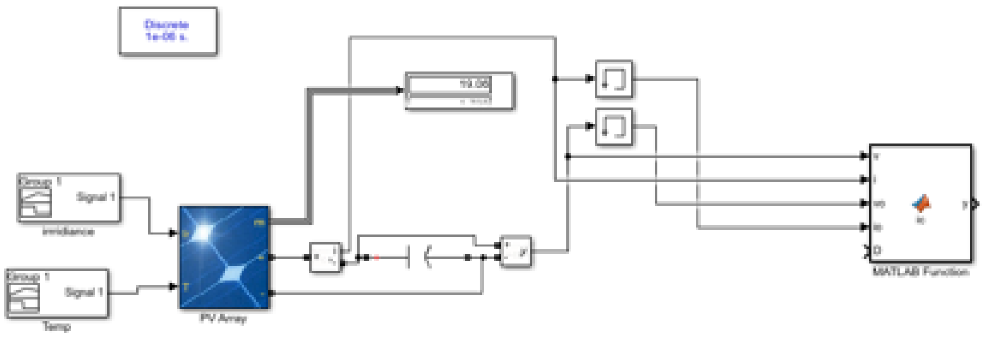

Figure 4.7: MPPT Technique

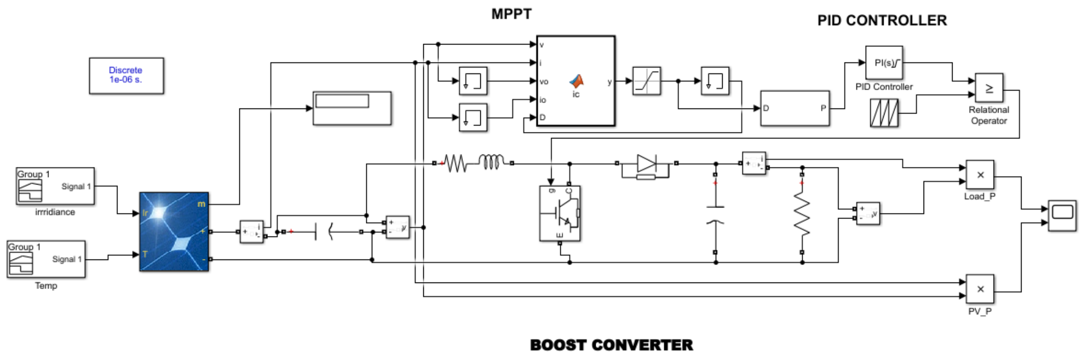

Figure 4.8: circuit with PID controller

Output of PI Controller

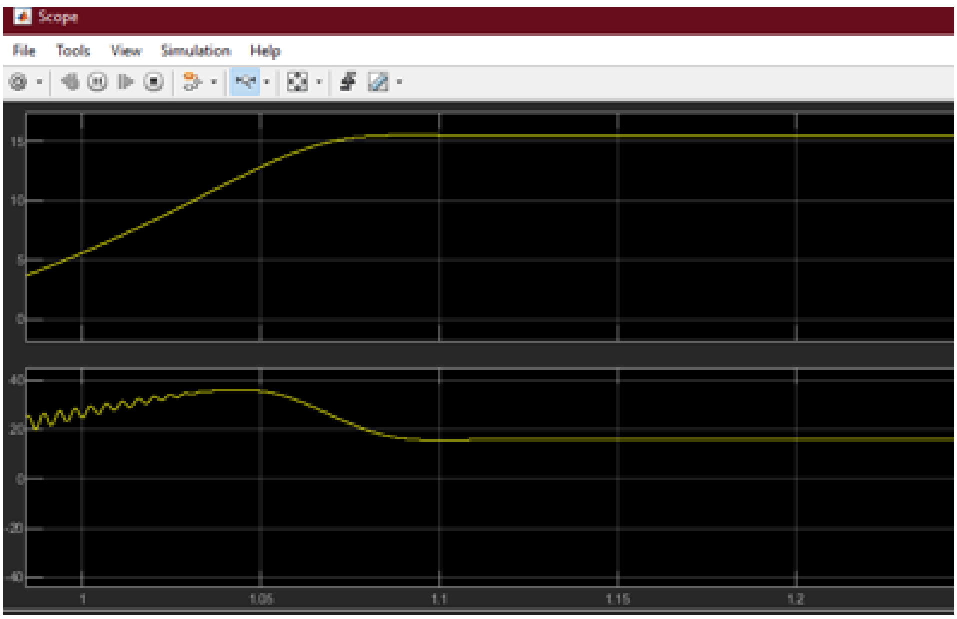

Figure 4.9: Output using PID Controller

Simulation of SMC Controller

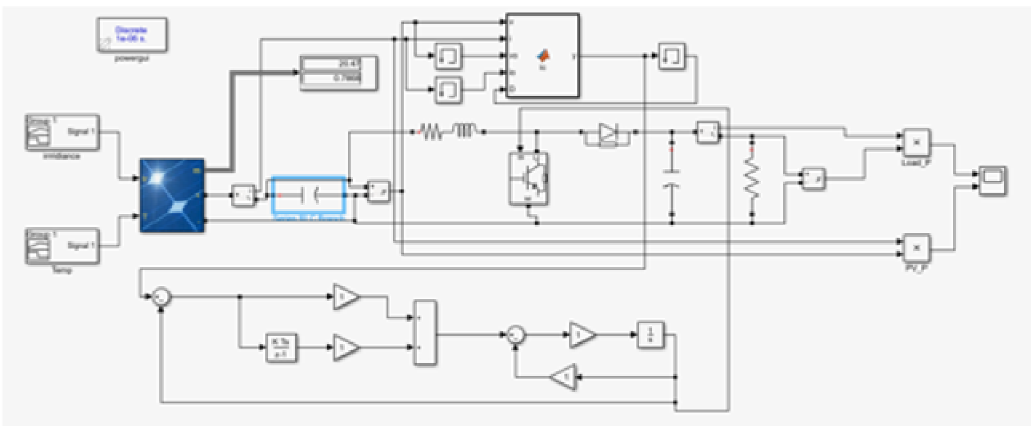

Figure 4.10: circuit using SMC

Output of SMC

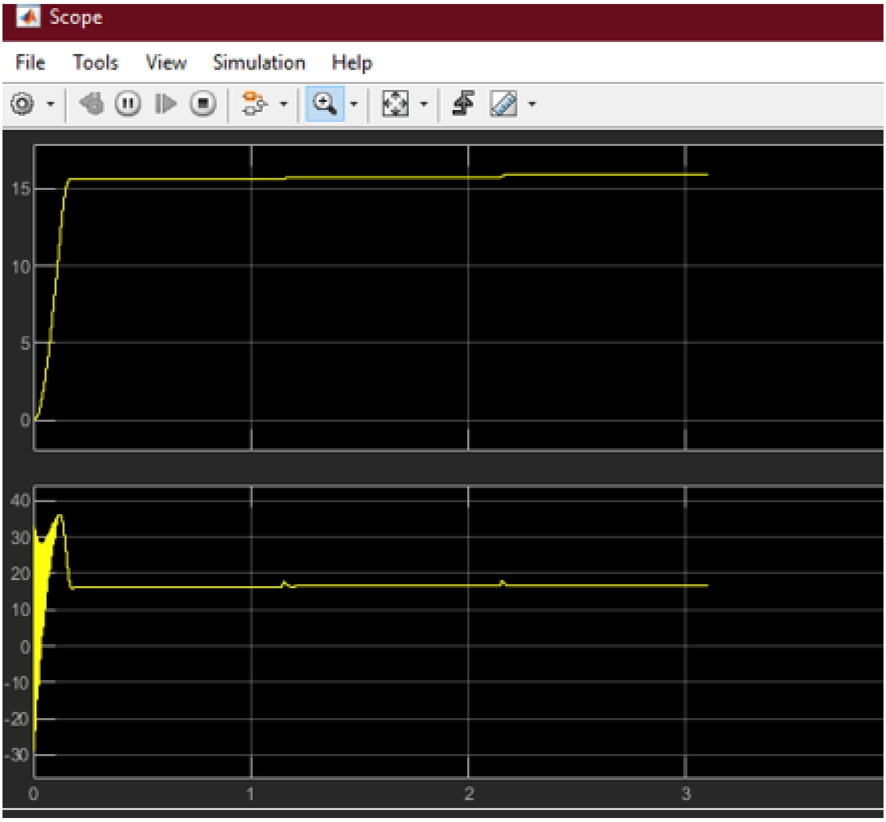

Figure 4.11: Output using SMC

Chapter 5

System Implementation

To take things to the real world we must be more realistic, and we must face all the challenges and uncertainties to achieve our goal. When we design, we have natural elements that affect our effect. The sun is not always reliable and may vary in time and weather, so we should do a test to prepare for our project. We have selected the DSP kit over the rest of the controllers due to its high-speed testing and processing. We have chosen a monocrystalline solar panel over a polycrystalline solar panel by studying all the features and completing our goal with different techniques will be discussed.

5.1 system Architecture

our block diagram is:

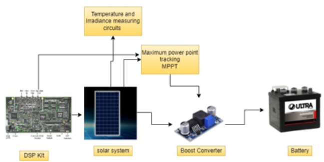

Figure 5.1: Block diagram

Our DSP kit is programmed in such a way to detect the most efficient temperature which we study from the literature review it is 25 degrees Celsius for that purpose we have designed a code to program the DSP kit.

5.1.1 TRACKING SOURCE CODE

```
include ¡AT89XS1.H¿
include ¡my.h¿
define ldr1 P1 0
define Idr2 P1 1
bit fl = 0;
bit 12 =
char temp = 2;
void clock(void)
P2 0 = 0:
delay(500);
P2 0 = 1:
delay(2000):
void clock(void)
P2 1 = 0:
delay (500):
P2 1= 1;
delay(2000):
void main( void)
delay (5000);
search again:
if(ldr] == 0)
temp = 1;
f1 = 1;
else if(ldr2 == 0)
temp = 2;
f2=1:

else
goto search again;
while(1)
```

```
if((ldr] == 0) (f1 ==0))
if(temp == 2)

clock0;
temp = 1;
f1=1:
2 = 0:
if((ldr2
==0)  (12 == 0))
if (temp==1)

Cclock();
temp =2;
f1=0:
f2=1:
```

This is a generic code our objective is to program the DSP kit in such a way that it will take specific inputs from the solar system.

After programming and connecting the DSP kit, we must check the temperature on the solar panel. For that, we have used a specific temperature sensor to record the temperature on every panel to differentiate between the working on desired input temperature and undesired input temperature. We have used 4 panels to monitor the temperature on each solar panel and to view the temperature we have to use an LCD.

Figure 5.2: “Project name display on LCD display

Figure 5.3: Irradiance display on LCD display”

5.1.2 Tools and Technology Used

- DSP Kit
- Programming in C++
- Temperature sensors
- MPPt approach through IC
- LCD display unit
- Battery
- Solar panel
- Boost converter
- Solar frame

Figure 5.4: Temperature display on LCD display

- Buck converter

Figure 5.5: Battery volt and input voltage display on LCD display

5.2 Development Environment/Languages Used

Flow chart model for the project include DSP kit which has been coded according to our objective.

5.2.1 Codes

Tracking Source code for MPPT

include ¡AT89XS1.H¿

xxxviii

include ¡my.h¿

define ldr1 P1 0

define Idr2 P1 1

bit fl = 0;

bit 12 = 0;

char temp = 2;

void clock(void)

Figure 5.6: Complete Project hardware model

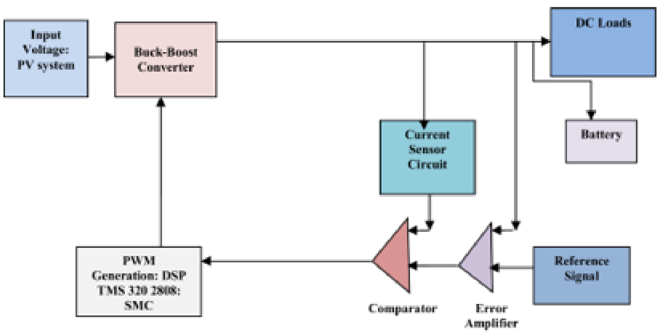

Figure 5.7: Flow chart model for project

P2 0 = 0:

delay(500);

P2 0 = 1:

delay(2000):

void clock(void)

P2 1 = 0:

delay (500):

P2 1= 1;

delay(2000):

```
void main( void)
delay (5000);
search again:
if(ldr] == 0)
temp = 1;
f1 = 1;
else if(ldr2 == 0)
temp = 2;
f2=1:
else
goto search again;
while(1)
if((ldr] == 0) (f1 ==0))
if(temp == 2)
xxxix
clock0;
temp = 1;
f1=1:
2 = 0:
if((ldr2==0) (12 == 0))
if (temp==1)
Cclock();
temp =2;
f1=0:
f2=1:
```

When the DSP kit detect the MPPT point through IC method We move to our next step to give instruction to the Solar panel to take input from specific range

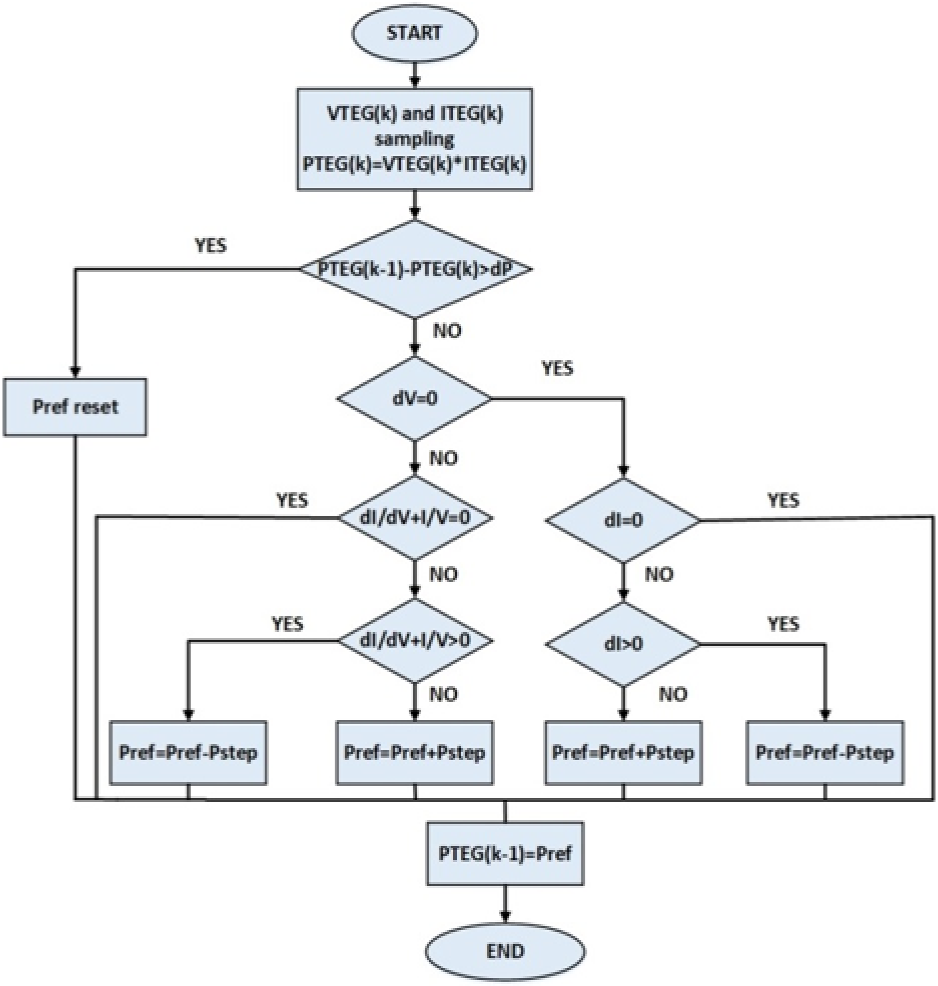

Figure 5.8: MPPT through IC method

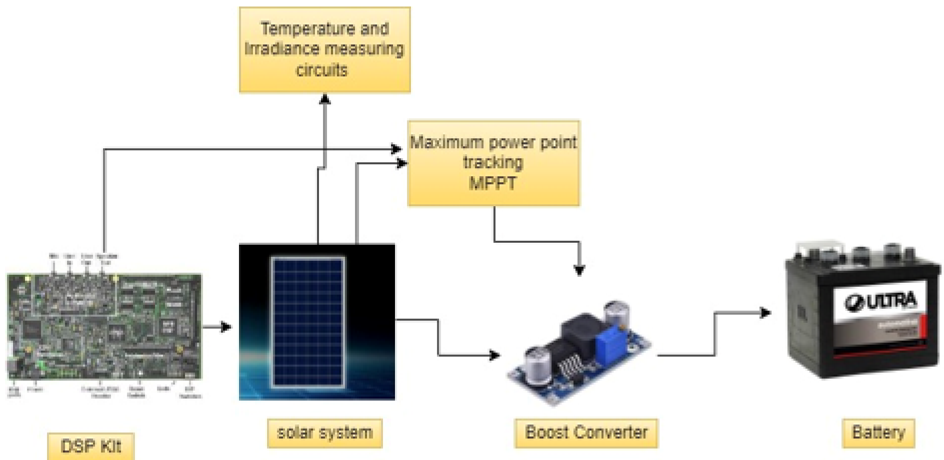

Figure 5.9: Project Design

Chapter 6

System Testing and Evaluation

Because the DSP outperforms smaller controls mathematically, all the available rules are applied to the DSP in real time for the proposed conversion in this study. As an SMC, the intended DSP was employed.
The suggested model's performance is determined by a series of tests. The proposed prototype approach uses multiple regulatory rules to decide the extent of the discussion.
Similarly, the various parameters, such as, K, ε, load variability, control power, access time, and output power output, are limited by the proposed computer model of the various control rules programmed.
In terms of test results, control rules can be highlighted asfollowing points:

1)A clear access law allows for a minimum chat in a short amount of time. As a result, the suggested DSP-based SMC is designed with a legal framework for transparent access to give a smooth response while maintaining durability and dependability.
2) The worth of 'k,' as determined by a limited rate law, the law's level of access power, and the flexible sigmoid access law, is extremely high while the degree of exposure to law is extremely low. As a result, the suggested DSP-based SMC is designed in the form of a clear access legislation, which enables a fast access time with no settling time. A tiny amount of speed with the system trajectory will also arrive at the changing point, making this path similar to a free conversation..
3) Furthermore, with the given access rule, the output variance is only 0.16 percent, demonstrating constant voltage at the converter's output terminals.
4) Except for the stated access law, all control rules get important time adjustment values. As a result, the explicit access law accelerates the dynamic response of a planned system.
5) At the very least, the first control voltage is found in the clear access rule.

Project was tested for a day to note its output and working while considering all the environmental factors. The result is explain below:

Time (1Hour Avg)	Temperature	Irradiance	Output
7am	18 degrees Celsius	230m/W^2	0.2V
10am	25 degrees Celsius	530m/W^2	1.8V
12pm	32 degrees Celsius	830m/W^2	1.2V
2pm	35 degrees Celsius	730m/W^2	1V
4pm	25 degrees Celsius	510m/W^2	1.7V
6pm	27 degrees Celsius	280m/W^2	1.7V
8pm	20 degrees Celsius	100m/W^2	0.5V

Figure 6.1: Recorded Data from the working of PV System

At the end of the day, we have concluded the working of the project was efficient at the range of temperature 23-27 degree Celsius giving us the maximum output from the source. By programming the DSP kit around this range, it can give us the efficient energy which is required.

Chapter 7

Conclusion

After our research, literature review and experimentation we have find the DSP kit preprocessing faster than other controllers including aurdino and raspberry pi. DSP kit is one of the industrial common program devices used. We have explored different code for programming of DSP and use different technique of coding and design efficient working code for MPPT tracking under Incremental technique. We have explored the polycrystalline and mono crystalline solar panel. Learn their specification and study its Pros and Cons. At the end we have charge the battery as well as directly provide to the load. changing irradiance levels and simulation effects compared to the old PID control. .By calculating and looking at the project we conclude that almost 30 percent is effective against the conventional PV photovoltaic PID control system which is basically a mistake in the current system that falling to 40 degrees Celsius or high temperatures reduces the efficiency of the photovoltaic system. We have designed our Final Year Project in such a way that it can become a power supply project for those who want to be independent by generating their energy. Our prototype was tested and yielded to about 2kWh per day which is enough room for a large series of solar sets that can provide full power in the house. It is a one-time investment that can recoup the electricity costs for 8 years and last a year longer.

Chapter 8

References

- https://www.solar-electric.com/mppt-solar-charge-controllers.html

- Jump up" $ASurveyofMaximumPPTtechniquesofPVSystems-IEEEXplore"(PDF).Retr$
  1
  $D.P.Hohm, M.E.Ropp, \backslash ComparativeStudyofMaximumPowerPointTracking$
  $AlgorithmsUsinganExperimental, Programmable, MaximumPowerPointTrackingTestB$
  $7803-5772-8/00, IEEE, 2000, 1699-1702.$

- N. Pongratananukul and T. Kasparis, "Tool for Automated Simulation of Solar Arrays Using General- Purpose Simulators," in IEEE
  Conference Proceedings, (0-7803-8502-0/04), 2004,10 - 14.

- Trishan Esram, and Patrick L. Chapman, Comparison of Photovoltaic Array Maximum PowerPointTracking Techniques," IEEE Transactions on Energy Conversion, 22 (2), 2007, 439-449.

- Hairul Nissah Zainudin, Saad Mekhilef, Comparison Study of Maximum Power Point Tracker Techniques for PV Systems," Proc. 14th International Middle East Power Systems Conference (MEPCON"10), Cairo University, Egypt, 2010, 750-755

- Chaibi, Y.; Salhi, M.; El-Jouni, A. Sliding mode controllers for standalone PV systems: Modeling and approach of control. Int. J. Photoenergy 2019, 2019, 5092078. [CrossRef]

- Alba-Flores, R.; Lucien, D.; Kirkland, T.; Snowden, L.; Herrin, D. Design and Performance Analysis of three Photovoltaic Systems to Improve Solar Energy Collection. In Proceedings of the IEEE SoutheastCon, St. Petersburg, FL, USA, 19–22 April 2018; pp. 1–4.

- Metry, M.; Shadmand, M.B.; Balog, R.S.; Abu-Rub, H. MPPT of Photovoltaic Systems Using Sensorless Current-Based Model Predictive Control. IEEE Trans. Ind. Appl. 2017, 53, 1157–1167. [CrossRef]

- de Brito, M.A.G.; Galotto, L.; Sampaio, L.P.; Melo, G.D.; Canesin, C.A. Evaluation of the main MPPT techniques for photovoltaic applications. IEEE Trans. Ind. Electron. 2013, 60, 1156–1167. [CrossRef]

- Sera, D.; Mathe, L.; Kerekes, T.; Spataru, S.V.; Teodorescu, R. On the perturb-and-observe and incremental conductance mppt methods for PV systems. IEEE J. Photovolt. 2013, 3, 1070–1078. [CrossRef]

- Subramanya Bhat H. N. Nagaraja DSP Based Sliding Mode Control for Photovoltaic SystemAccepted: 14 January 2021 / Published online: 24 January 2021 © The Author(s), under exclusive licence to Springer Science+Business Media, LLC part of Springer Nature 2021

- Ni, Y., Xu, J. (2008). Global sliding mode controller for buck converter based on reaching law. In proceeding of 2008 International Conference on Communications, Circuits and Systems, Fujian, pp. 1319–1323.

- Gokasan, M., Bogosyan, S., Goering, D. J. (2006). Sliding mode based powertrain control for efciency improvement in series hybrid-electric vehicles. IEEE Transactions on Power Electronics, 21(3), 779–790

- Song, Z., Hou, J., Hofmann, H., Li, J., Ouyang, M. (2017). Sliding-mode and Lyapunov function-based control for battery/supercapacitor hybrid energy storage system used in electric vehicles. Energy, 122(1), 601–612.

- Azib, T., Talj, R., Bethoux, O., Marchand, C. (2010). Sliding mode control and simulation of a hybrid fuel-cell ultracapacitor power system. In Proceeding of 2010

IEEE International Symposium on Industrial Electronics, Bari, pp. 3425–3430

- ajanna, G. S., Nagaraj, H. N. (2013). Comparison between sigmoid variable reaching law and exponential reaching law for sliding mode controlled DC-DC buck converter. In Proceeding of 2013 international conference on power, energy and control (ICPEC), Sri Rangalatchum Dindigul, pp. 316-319.

- Al, K.; Khan, L.; Khan, Q.; Ullah, S.; Ahmad, S.; Mumtaz, S.; Karam, F.W.; Naghmas. Robust Integral Backstepping Based Nonlinear MPPT Control for a PV System. Energies 2019, 12, 3180.

- Sera, D.; Mathe, L.; Kerekes, T.; Spataru, S.V.; Teodorescu, R. On the perturb-and-observe and incremental conductance mppt methods for PV systems. IEEE J. Photovolt. 2013, 3, 1070–1078.

- de Brito, M.A.G.; Galotto, L.; Sampaio, L.P.; Melo, G.D.; Canesin, C.A. Evaluation of the main MPPT techniques for photovoltaic applications. IEEE Trans. Ind. Electron. 2013, 60, 1156–1167.