IEEEP

NEW HORIZONS

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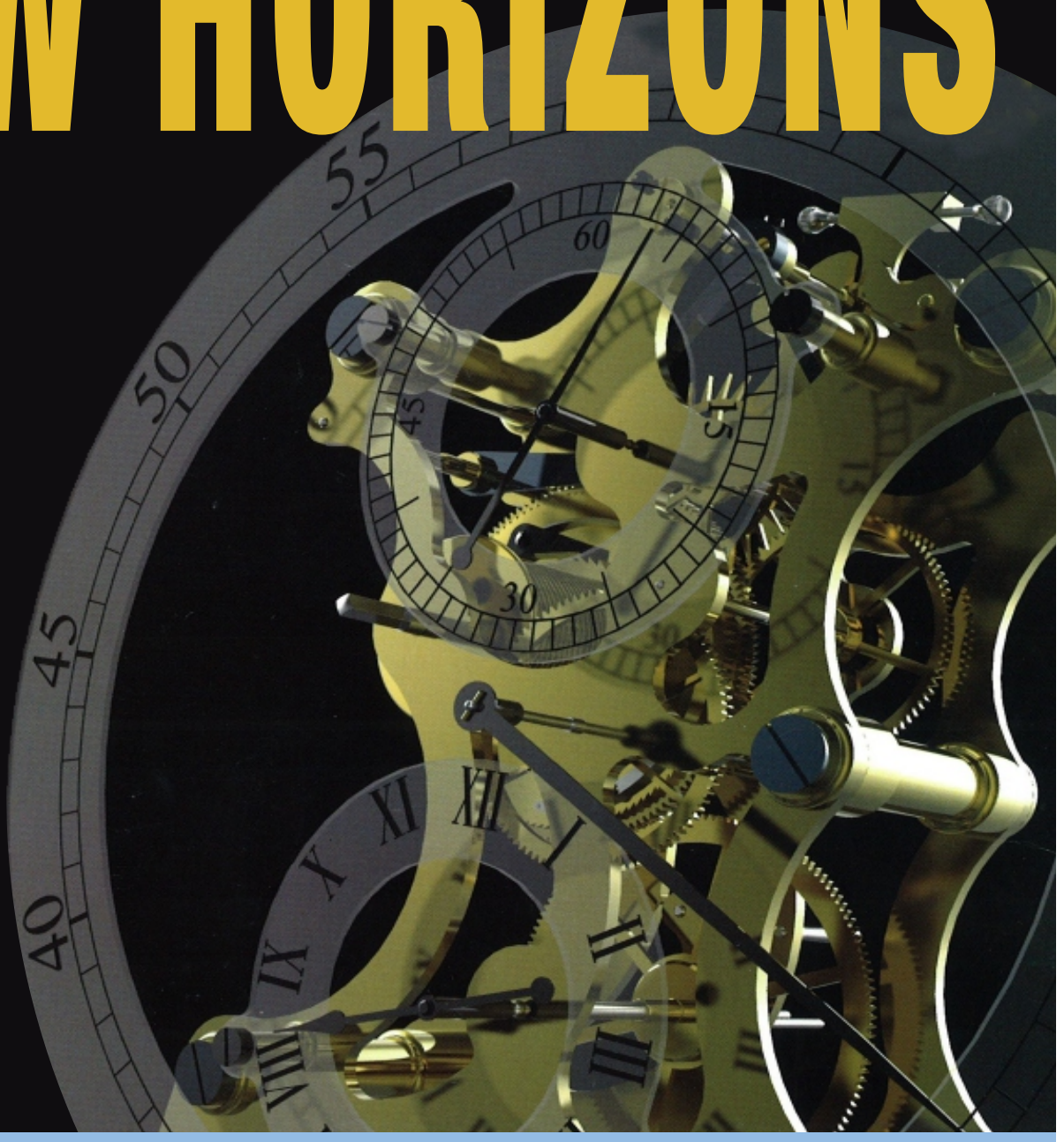


IEEEP

Journal of The Institution of Electrical and Electronics Engineers Pakistan

News!!

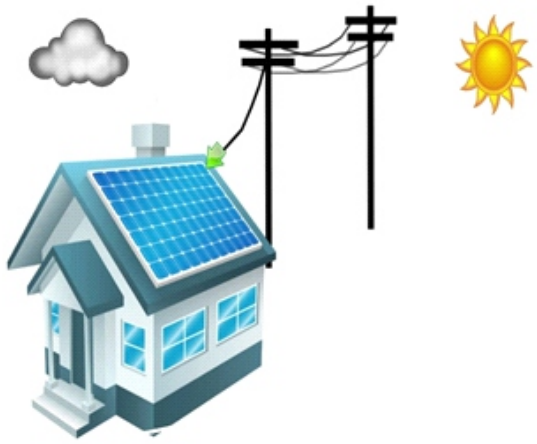
IEEEP has been recognized by HEC in category 'Z'

Do you know what Net Metering is????

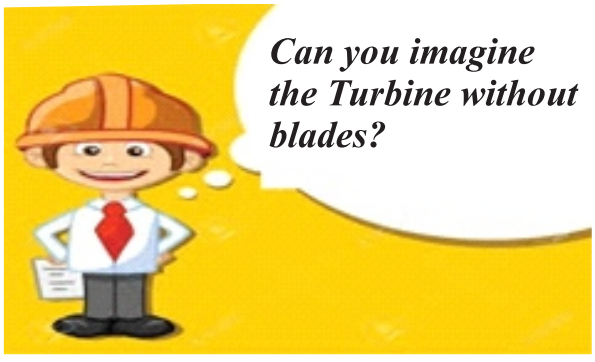
Net metering is a utility resource usage and payment scheme in which a customer who generates their own power is compensated monetarily.

How does it work?

In a net metering program, the electric company allows a customer's meter to actually run backwards if the electricity a customer generates is more than they are consuming. At the end of the billing period, the customer only pays for their net consumption, the amount of resources consumed minus the amount of resources generated.



Reverse metering using Renewable energy source



Yeah!!!
Its Vortex Bladeless turbine…

Working Principle?

If you put any object in the path of the wind, it will create an undulating vortex behind the barrier. The turbine takes advantage of this vortex.

What is it made of?

The cone-shaped vortex turbine is made of carbon fiber and fiberglass with the motor at the bottom instead of the top (like traditional turbines).

How does it work?

When wind passes one of the cylindrical turbines, it shears off the downwind side of the cylinder in a spinning whirlpool or vortex. That vortex then exerts force on the cylinder, causing it to vibrate. The kinetic energy of the oscillating cylinder is converted to electricity through a linear generator similar to those used to harness wave energy.

How is it better than the traditional turbines (with blades)?

Vortex's lightweight cylinder design has no gears or bearings. Unlike the common propeller-type wind turbine, where big area is swept by the blades, it just has a pole.

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Disseminate Technical Knowledge

Conserve Electricity

CONTENTS

Editorial

IEEEP brings to you another volume of "New Horizon" continuing its core mission of dissemination of knowledge and providing learning opportunities to engineering community. As the primary goal of IEEEP's research journal is to maintain high quality publications, it has been tried to bring together the latest research based articles in present volume.

During year of World War II engineering system became highly complex and the requirement for the human factors consideration became a necessity resulting in introduction to robotics. Now it has become the essential part of the industrial area. Two articles relating to robots highly efficient performance in pharmaceutical industry and Anti-bug mechanismare being presented in current issue.

As smart meter is about to replace conventional gas and electricity meters helping people meet some of the long term challenges they face in ensuring affordable, secure and sustainable energy supply,IEEEP comes with an innovative idea to control the smart meters using power line carrier communication.

Another paper studying the maximum efficient ways to improve solar power generation is part of the research journal. Also included the paper describing limitations caused by inter-Cell interference in the performance of relay networks.

We encourage the engineers from all over the world to send us quality papers for our forthcoming journal.

Chief Editor-IEEEP

Anti-Bug Robot using Spray Mechanism and Obstacle evading Expertise

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UET Lahore, Research Scholar, UET Lahore

Abstract:

In this research paper, anti-bug wheeled robotics is introduced with the help of spray shower having advanced obstacle avoiding technology. Movement of robot is controlled with the help of gear motors. Gear motors allow it to move in the forward direction and spray anti-bug liquid in anticipated region over a wide range through shower. It is capable of spraying the anti-bug liquid contained in a tank, on the ground surface as well as on the walls. While moving in the forward direction, if it detects any hurdle in its path, sensors sense it and take appropriate action against it. Firstly, it moves a step back and then it changes its direction according to the hurdle's direction.

KEYWORDS—anti-bug spray, wheeled robot, Gear motors, automatic spraying machine.

I Introduction

Today, biosphere robotics is an amiable technology. It is also rapidly rising and stimulating field. Over a long time, several practices have been developed for its up gradation. Robots are making substantial influence on modern life in several areas. These areas include manufacturing industry, transport sector, healthcare for disables, astronomy and ocean exploration [1].The fundamental requirement for every autonomous mobile robot is the capability to avoid obstacle that allows mobile robots to move with no collision in unmodified environments [2]. DATMO (Detection and Tracking of Moving Objects) problem has been widely under study for numerous decades [3]. Since 1960s, the latest trend for automation has been to use industrial robot extensively along with computer aided design (CAD) systems, and computer aided manufacturing (CAM) systems [4]. Although, the advancement in the robotics market has slowed down in comparison with the early 1980's [5].

The proposed paper is related to autonomous robotics. It is about an anti-bug wheeled robot having capability to spray the insect assassin liquid improper manners and also covers very extensive region. It is especially designed for dengue spray because dengue virus is becoming a more serious issue in the world especially in Pakistan. It contains a large liquid tank to store excessive quantity of the liquid. Capacity of the tank is about 20 liters so that the process is continued for a long period of time. A shower is mounted over the tank to spray the liquid. A pump is used for pumping the liquid from tank to the shower with a reasonable pressure. Pump is placed into the tank which is connected to the shower with the help of a plastic pipe. It sprays over the ground surface as well as on walls of any construction and covers the proper altitude of the walls.

Robot carries sufficient intelligence mechanism as it changes its direction on its own. To develop a robot capable of passing through corridors and diverse terrain, the volume and weight of robot must be minimized [6]. Photocells and phototransistors are predominantly responsive in the infrared region, hence they are ideal allies for infrared LED and laser diode sources [7]. IR transmitter transmits IR signal uninterruptedly. When robot faces the obstacle, reflected IR light is sensed by the IR receiver diode. Robot has two IR sensors, one on the left and other on the right side. When it detects any obstacle in its way, sensors sense the obstacle and send the signal to microcontroller which takes right action. When robot looks any obstacle, primarily it moves a step back then action is performed by microcontroller according to the direction of obstacle by following way

- When hurdle is in front of robot, both sensors sense the reflected signal so that left motor moves in the forward direction and right motor moves in the reverse direction and as a result robot will move to the right.
- When obstacle is on the right side, right sensor sense the reflected signal so that right motor moves in the forward direction and left motor moves in the reverse direction so robot will move to the left.
- If barrier is on the left side, left sensor sense the reflected signal so that left motor moves in the forward direction and right motor moves in the reverse direction and robot will again move to the left.

Block Diagram

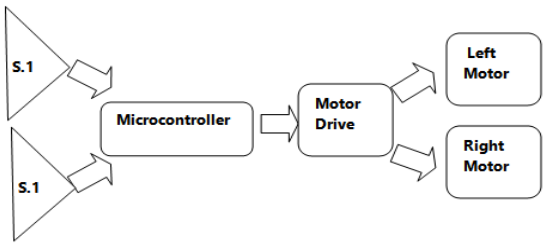

Figure 1: Block Diagram of Robot

There are two types of design for Robot:

- Circuit Design
- Mechanical Design

II. Circuit Design

This comprises of three main parts

A. Spray Part

B. Sensor Part

C. Governor Board

A. SPRAY PART

This part controls spray mechanism having different sub-part like liquid tank, shower, pump.

1) Liquid Tank: It is a large liquid tank to store excessive quantity of the liquid. Capacity of the tank is about 20 litters so that the process remains continue for a long period of time.

2) Shower: It is used to sprays the anti-bug liquid by rotating through the excessive pressure of pump and also covers long range of outward surface.

3) Pump: It forces the liquid with reasonable pressure towards the shower and a plastic pipe is used as a connector between them.

Figure 2:Spray Part of Robot

B. Sensor Part

Two IR senor circuits are used, one on the left and other on the right side. Each circuit has a pair of IR transmitter and receiver.

1) IR Transmitter: It continuously transmits IR signal through the complete process.

2) IR Receiver: IR receiver diode senses the reflected IR signal from any obstacle and send signal to the microcontroller for further process.

Sensor Part Diagram

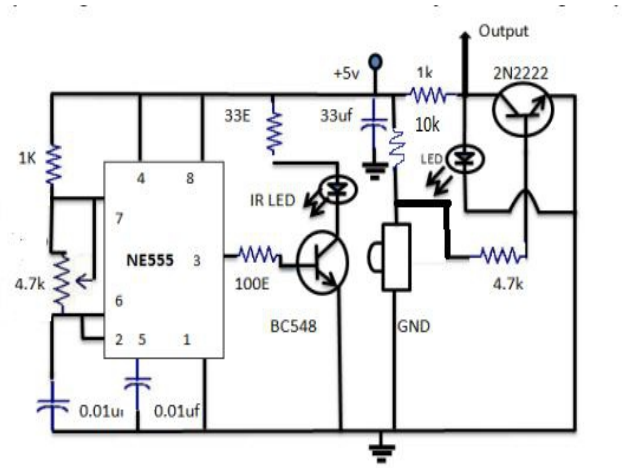

Figure 3(a):Sensor Circuit of Robot

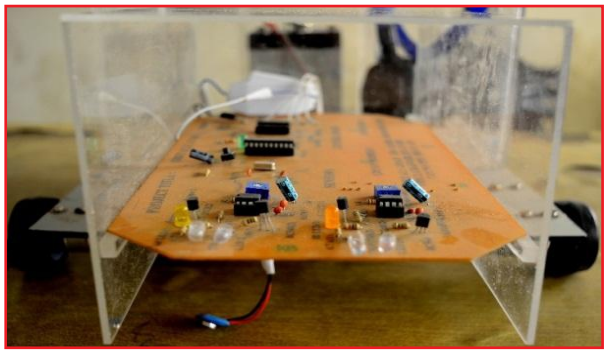

Figure 3(b): Sensor Circuit of Robot

C. Governor Board

It is the main part of robot. All Actions of robot are controlled by this part that consists of microcontroller of Atmel 89C2051 and the driver L293D.

Atmel 89C2051: This microcontroller enjoys special significance in the whole 8051 family of microcontrollers. It is ideal choice for making low cost mini projects. A simple 5V battery is sufficient to provide power to this controller and any 8051 programmer can be used to easily transfer hex file in the ROM of this microcontroller. It belongs to the 8-bit class of microcontrollers. Due to its inexpensive and easy availability, this is ideal for embedded applications. [8].

1) L293D: In order to rotate motors in both directions, an interface is required between microcontroller and motors. This driver interface is provided by H-bridge 16-pin IC [9]. It is a motor drive IC which drives motors according to microcontroller's instructions.

Sensors send the signal to microcontroller Atmel 89C2051, microcontroller sends command to L293D drive to start, stop or reverse the direction of the motors according to the program.

Circuit Diagram of Governor Board

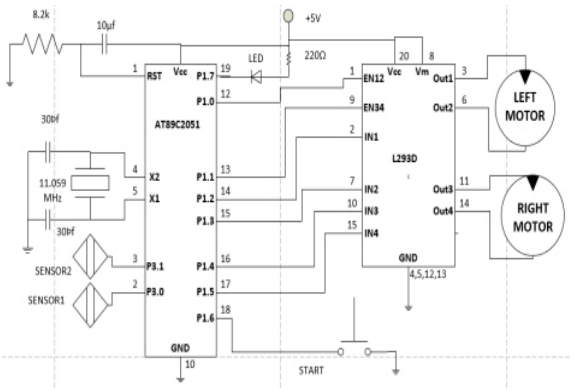

Figure 4: Governor Board of Robot

III. Mechanical Design

Mechanical design contains two DC gear motors. Two wheels are used, one for left side and other for right side. One freewheeling ball is also used which provide supports to the robot to rotate freely. Robot also has a body cover.

Design of Robot

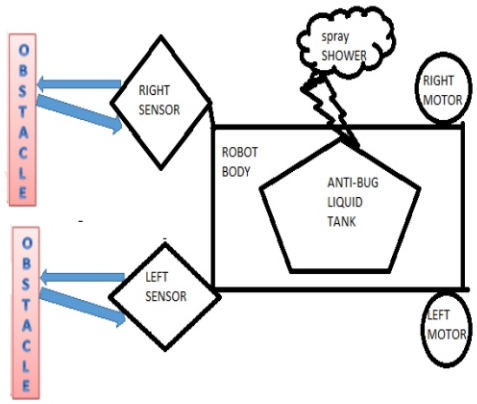

Figure 5: Descriptive Drawing of Robot

IV. Software Framwork

Algorithm and flow chart are shown as

A. Algorithm

- Start
- Initialize the input port (P3) and output port (P1)
- Set bit 1.0 and 1.1
- Set bit 3.0 and 3.1
- Set bit 1.2 & 1.4 and Reset 1.3 & 1.5
- Read data from port 3.
- When both bits receive no signal, Move in forward direction.
- When port 3.1 receives the signal, reverse the direction for specific time and then change the direction towards right and repeat step 5 & 6.
- When port 3.0 receives signal, reverse the direction for specific time and then change the direction towards left and repeat step 5 & 6.
- If port 3.0 and 3.1 both receive signal, reverse the direction for specific time and then change the direction towards right and repeat step 5 & 6.

B. Flow Chart

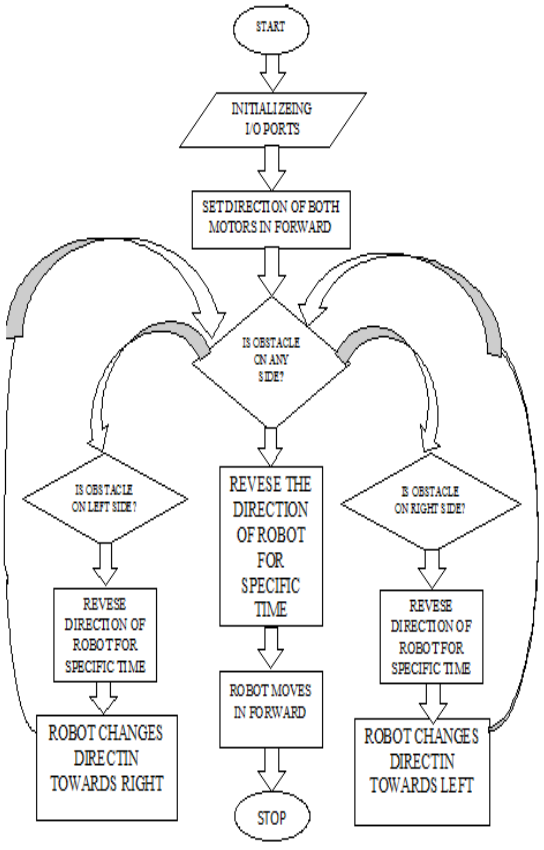

Figure 6: Flow Chart for Software

V. RESULTS

By pressing the start button, robot starts moving forward and spray anti-insect liquid around and also on its above surface. When a wall comes in front of it, robot continues its spray process on the wall by changing its direction in well-defined manners. It moves in the direction opposite to obstacle. This robot is an intelligent autonomous device. When bit 1.0 & 1.1 are set then robot moves in forward direction and by setting3.0& 3.1 robot changes its direction towards left and right respectively. It changes its direction according to obstacle coming in front of robot.

Diagram of Ready Robot

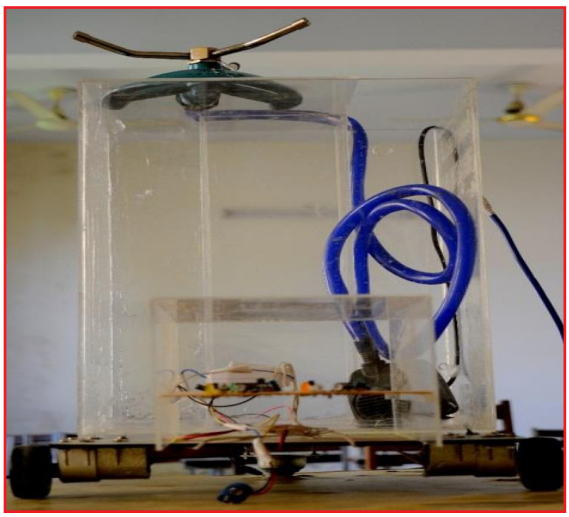

Figure 7: Robot is Ready

VI. APPLICATIONS

Robot is used to supply the water to the crops at large scale. We extend the application of these techniques to the coordinated motion of several mobile robots, and to the avoidance of two manipulators [10]. A Multi-robot system is developed to collectively perform a desired assignment in diverse applications [11-12]. Autonomous robot can be utilized to drive a vehicle in populated urban roads and accident free traffic control can be achieved. [13]. People with disability can be served by wheelchairs equipped with autonomous robots and proper navigation can be achieved [14]. The robotic wheelchair can also be utilized to serve the elderly patients unable to walk with ease. In this way health care facilities can be improved [15]. This technology is also used in various applications such as vacuum cleaner, path tracking and in mines.

VII. CONCLUSION

It is an intelligent autonomous robot having an ability to spray anti-bug liquid in various desired regions with sufficient amount of liquid carrying capability .Wide range of liquids can be sprayed for different insects in industries, homes and places which are the no go areas for human beings. By using sensors, gear motors and control circuit having unique functionality, it also has ability to avoid obstacles in its way in suitable manners. In future, weight lifting ability of robot can be increased by using more powerful motors, spray region can be enlarged by using more influential pump and sensing rang can also be increased.

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*****

QUOTATIONS

- The best preparation for tomorrow is doing your best today.

  H. Jackson Brown, Jr
- The best and most beautiful things in the world cannot be seen or even touched - they must be felt with the heart.

  Helen Keller
- What we think, we become.

  Buddha
- Change your thoughts and you change your world.

  Norman Vincent Peale
- Try to be a rainbow in someone's cloud.

  Maya Angelou
- It is during our darkest moments that we must focus to see the light.

  Aristotle Onassis
- Perfection is not attainable, but if we chase perfection we can catch excellence.

  Vince Lombardi
- Let us sacrifice our today so that our children can have a better tomorrow.

  A. P. J. Abdul Kalam
- We can't help everyone, but everyone can help someone.

  Ronald Reagan
- From a small seed a mighty trunk may grow.

  Aeschylus
- Memories of our lives, of our works and our deeds will continue in others.

  Rosa Parks
- It is never too late to be what you might have been.

  George Eliot
- No matter what people tell you, words and ideas can change the world.

  Robin Williams
- The power of imagination makes us infinite.

  John Muir
- Shoot for the moon and if you miss you will still be among the stars.

  Les Brown
- Quality is not an act, it is a habit.

  Aristotle

Solar Power Generation along with the Efficiency Improvement of Solar Panels, Automatic Solar Tracking and Remote Monitoring

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Abstract

This paper proposes the combination of different efficiency improvement techniques which enhance the output in multi directions. Experiments were performed to work out for such possible approaches that is MPPT(maximum power point tracking) , solar tracking (dual axis) and use of convex lens on solar panel. The effectiveness of the proposed method is that it increased the output of up to 17.4% . Along with that remote monitoring system also have been inducted that is GSM based to monitor and control the different features of the system remotely. As experiment is performed on the following two features to control them remotely. First is Battery status check (low, medium and high) and second is switching on/off the working load. Therefore this proposed scheme of combining different techniques on a single system will overall maximize the system output and make it more suitable to work in different environments efficiently.

I. Introduction

Sun is a major source of energy. The earth obtains 174 pentawatt (PW) of the incoming solar energy at the upper atmosphere. Approximately one third (Approx. 30%) of it is reflected back to the space while the rest is absorbed by the clouds, oceans and land masses [7]. A portion of it is utilized for the photosynthesis process which is critical for the provisions of life on Earth. Man has tried to utilize this infinite source of energy in the best possible way and has been able to harness only a negligible or a minute fraction of this energy till today[8].

The broad categories of the large scale applications of the solar energy include the heating and cooling of residential / commercial buildings, in agriculture & horticulture and solar power generation etc.

A solar cell is a photovoltaic device which converts the light energy into the electrical energy. When the sunlight falls on the material surface, the electrons present in the valence bands of the metallic atom absorb energy and hence become excited. These excited electrons jump to the conduction band and become free. When these free electrons are attracted towards the positive electrode, the current flows and hence the light energy gets converted to the electrical energy[6].

Experiments were performed in five separate parts. In first part without applying any technique of power increasing simple operation is performed . In the second part solar tracking scheme was implemented to maximize the solar panel output by tracking the sun movement. In the third part the effect on the power conversion efficiency of solar panel by experimenting it with convex lens was studied. In the fourth part MPPT solar charge controller was designed whereas in the fifth part GSM based Monitoring system was designed to control certain features of this solar system remotely.

II. Simple Measurement without Applying any Power Output Increasing Technique

The Electrical Characteristics of the panel that is used as follows:

- Maximum Power = 100W
- V_o (Nominal) = 12V
- Voltage at P_{max} = 17.5V
- Current at P_{max} = 5.71A
- Current Short Circuit (I_{sc}) = 6.17A
- Voltage Open Circuit (V_{oc}) = 21.6V
- Power Tolerance = ± 3%
- STC Irradiance = 1000V/m^2
- Maximum System Voltage = 1000V

III .Solar Tracking System

A solar tracker is used for orienting day light on photovoltaic array. The position and movement of sun varies seasons and the time of day a s the sun movies across the sky [3]. Solar powered equipment works at their best when pointed towards the sun. So, a tracker can increase the effectiveness of such equipment over any position. Tracker can be implemented in various ways depending upon the feasibility and sensitivity of the components used.

The tracking scheme implemented was a simple one using the LDR sensors, voltage comparators and H-Bridge to run the dc motor. LDRs were oriented on the panel as shown in figure 1.

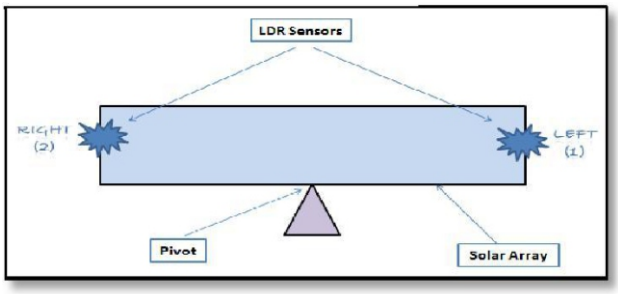


Figure 1

The sun tracking algorithm show n in figure 2

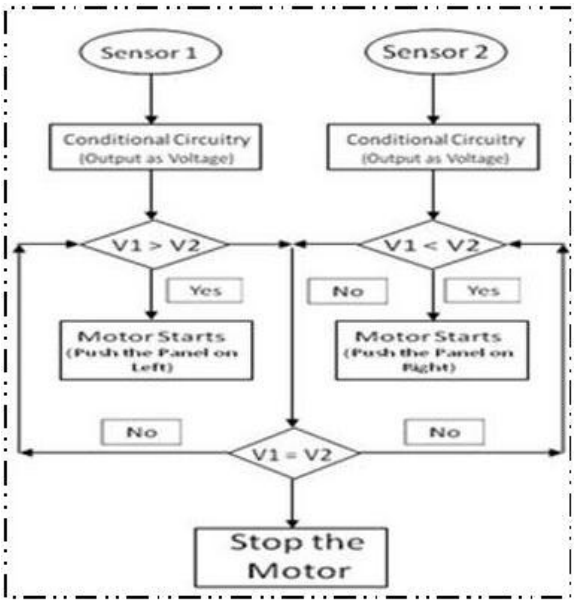


Figure 2

After tracking the movement of sun during the whole day, the panel will be facing the westward direction. i.e. the sunset direction. On the next day sun will have to rise from the eastward direction. So there must be some sort of logic system which will play its role in reverting the position of the panel back to the eastward direction in order to initiate the tracking cycle on the next day. A simple relay logic circuit was implemented to perform this resetting task automatically when the sun is about to set in the evening [3,4].

This designed tracking system was tested thoroughly and carefully and the behavior of system is summarized in table 2.

Status of LDRs	Status of Motor
LDR 1 is Illuminated more Than LDR 2	Motor is Running Anticlockwise
LDR 2 is Illuminated more than LDR 1	Motor is Running Clockwise
Both LDRs illuminated to Same Light	Motor is Stopped
Both LDRs are exposed to Darkness	Motor is Stopped

Table 1

The Reset system worked in a way that in the evening when the sun sets, the tracker will be in a position that it will activate the limit switch which will perform the reverting process.

The behavior of reset system is summarized in table 2.

Status of Limit Switches	Status of Motor
If Motor is Running Clockwise	
Limit Switch RESET is Pressed and Released	Motor is Continuously Running in the Clockwise Direction (In this situation Motor will not follow the outputs of LDRs)
Limit Switch SET is Pressed and Released	The Motor will start following the outputs of LDRs
If Motor is Running Anticlockwise	
Limit Switch RESET is Pressed and Released	Motor Changes its Direction and Runs in the Clockwise Direction (In this Situation Motor will not follow the outputs of LDRs)
Limit Switch SET is Pressed and Released	The Motor will start following the output of LDRs

Table 2

Result by using the solar tracking system

Month	Average power per day
January	333.47 wh
February	374.60 wh
March	366.20 wh
April	353.60 wh
May	315.20wh
June	281 wh
July	264 wh
August	269.8 wh
September	314.8 wh
October	313.4 wh
November	338 wh
December	341.12 wh

Table 3

MPPT or Maximum Power Point Tracking is an algorithm that is included in charge controllers used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' . which varies with solar radiation, ambient temperature and solar cell temperature [3].

The major principle of MPPT is to harness maximum power from PV module by operating them at the most efficient voltage (maximum power point). MPPT checks output of PV module, compares it to battery voltage then fixes what is the best power that PV module can produce to charge the battery and converts it to the best voltage to get maximum current into battery. It can also supply power to a DC load, which is connected directly to the battery [2].

The Perturb & Observe (P&O) is the most common approach adopted today because of its ease in implementation. It works sporadically by incrementing and decrementing the voltage of Photovoltaic Array [2,3]. The change in the Power drawn can then be observed. If the voltage shifts of PV array results in increase in the output Power then it continues to shift in the same direction. On the other hand, if the power decreases, the voltage shifting is in the opposite direction. This algorithm is shown in figure 3.

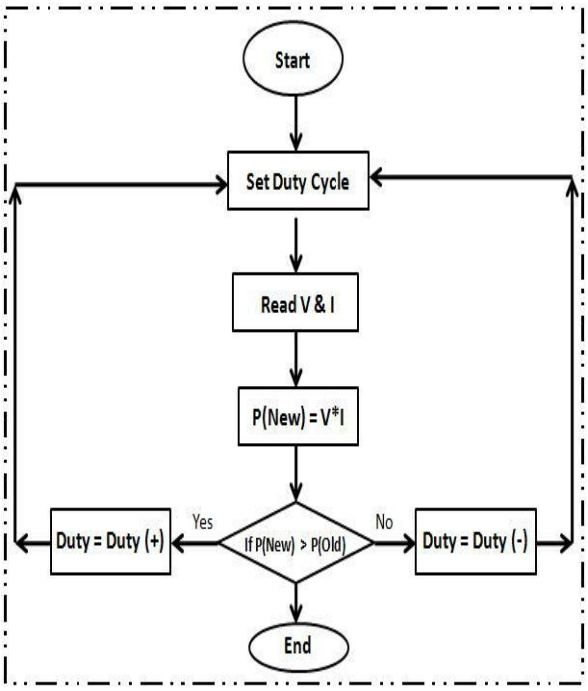
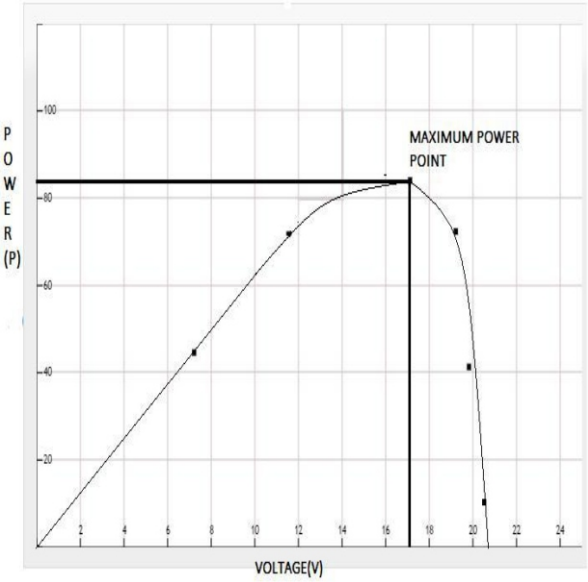


Figure 3

The solar panel used in this experimentation has the following specifications.



P-V CHARACTERSTICS OF SOLAR PANEL

Figure 4

Results by using the MPPT(maximum power point tracking).

Month	Average power per day
January	346.25 wh
February	390.76 wh
March	381.19 wh
April	368.23 wh
May	330.13 wh
June	294.2 wh
July	279.2 wh
August	284.7 wh
September	330.3 wh
October	327.4 wh
November	350.2 wh
December	355.30 wh

Table 4

It is clear from the above curve that there exists a point where there is maximum power. This point needs to be tracked in order to harness the maximum power from solar panels operating in any system.

V. Using Convex Lens with Solar Arry

The Convex Lens works on the principle of physics by converging the light rays falling on it at a point "F" which is a distance (Focal Length) from a point "O" on the radius of curvature of the lens. From the scientific inference, it is concluded that when a convex lens with more surface area than that of proposed photovoltaic array is placed at some distance over this array, it converges the falling light rays on the solar panel [5] thus by increasing the working power conversion efficiency of these solar arrays

- Jan = 4.81 kWh/m²/Day
- Feb = 5.19 kWh/m²/Day
- Mar = 5.05 kWh/m²/Day
- Apr = 4.84 kWh/m²/Day
- May = 4.34 kWh/m²/Day
- Jun = 3.98 kWh/m²/Day
- Jul = 3.54 kWh/m²/Day
- Aug = 3.63 kWh/m²/Day
- Sep = 4.46 kWh/m²/Day
- Oct = 4.49 kWh/m²/Day
- Nov = 4.72 kWh/m²/Day
- Dec = 4.68 kWh/m²/Day

So, the experiments were performed and the Power is calculated while using and without using the convex lens with our panel and the collected results are as follows:

*A. **Power calculated without convex lens.***

The average power per day was calculated as mentioned below

Month	Average power per day
January	320.65 wh
February	360.25 wh
March	352.12 wh
April	340 wh
May	303.2 wh
June	270.2 wh
July	253.2 wh
August	259.40 wh
September	302.7 wh
October	301.7 wh
November	325 wh
December	328 wh

Table 5

*B. **Power calculated with convex lens.***

The average power per day calculated with convex lens is as follows:

Month	Average power per day
January	336.68 wh
February	378.66 wh
March	369.72 wh
April	357 wh
May	318.35 wh
June	283.75 wh
July	265.85 wh
August	272.85 wh
September	317.8 wh
October	316.125 wh
November	341.25 wh
December	344.63 wh

Table 6

VI. Comparison Between Applied Techniques and their Effect on Output.

The comparison graph between simple, automatic solar tracking, MPPT(maximum power point tracking) ,convex lens and the combination of all these are presented below in a graph.

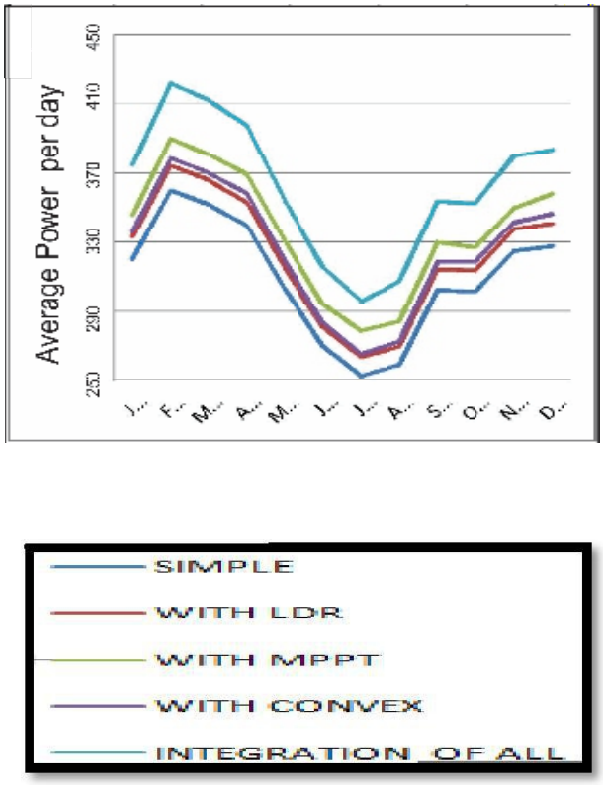


Figure 5

TECNIQUE	AST (B)	MPPT (C)	CONVEX (D)
AVERAGE POWER PER MONTH	291.5 Wh	302.7 Wh	294.3 Wh
OVERALL INCREASE IN OUTPUT	4.05+8.06 +5.03=17.4%		SIMPLE (A) 280.1 Wh
COMPARISON	MPPT > CONVEX > AST		

From the data we acquired that through different techniques we can increase the output of the pannel overall increase is about 17.4%.

VII . GSM Based Remote Monitoring System

The GSM based remote monitoring system was aimed to control certain features of the solar system remotely. These features can be more complex but as initial work, we selected the two features . The first is to check the status of the battery working in the system whether low, medium or high and second is to switch on or switch off the load workin on this system [4] Following tables summarize the implemented system and the collected results while testing

S.No.	Text Message Sent to GSM	Reply Received on Mobile
When Battery is Full		
1.	BATSTATUS?	System Battery Normal
When Battery is Medium		
2.	BATSTATUS?	System Battery is Medium
When Battery is Low		
3.	BATSTATUS	System Battery is Low
Switching On / Off Relays		
4.	S1ON	Switch 1 is Turned On
5.	S1OFF	Switch 1 is Turned Off
6.	S2ON	Switch 2 is Turned On
7.	S2OFF	Switch 2 is Turned Off
8.	S3ON	Switch 3 is Turned On
9.	S3OFF	Switch 3 is Turned Off

Table 8

In case of switching, the switching of relay was also observed through its switching sound practically.

VIII. Conclusion

This paper presented the basic concept of integrating different output enhancement techniques along with a new technique namely (distributed convex lens) method .Previously a single convex lens is used but in this experiment a piece wise distribution lenses are used smaller in size fixed on plastic transparent sheet which is mounted on the panel. Experiments has been carried out which shows that amalgamation of these techniques will increase the output in all weather conditions

Along with that GSM technique is applied to check the status of the system through cell phone (battery level and switching) which help the user to operate the system remotely. Therefore this proposed integrating and monitoring technique is very favorable to increase the output of panel rather than the use of individual techniques.

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QUOTATIONS

- The secret of getting ahead is getting started.

  Mark Twain

- What you do today can improve all your tomorrow.

  Ralph Marston

- It's always too early to quit.

  Norman Vincent Peale

- Things do not happen. Things are made to happen.

  John F. Kennedy

- Act as if what you do makes a difference. It does.

  William James

- The most effective way to do it, is to do it.

  Amelia Earhart

- Well done is better than well said.

  Benjamin Franklin

- The people who influence you are the people who believe in you.

  Henry Drummond

- To be a good loser is to learn how to win.

  Carl Sandburg

- Don't fight the problem, decide it.

  George C. Marshall

- If you want to conquer fear, don't sit home and think about it. Go out and get busy.

  Dale Carnegie

- Pursue one great decisive aim with force and determination.

  Carl von Clausewitz

ID Based Smart Energy Meter Using Power Line Carrier Communication

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Abstract

This paper illustrates an economical way to control energy meters using Power Line Carrier Communication (PLCC) and is controlled by the grid station. An ideal energy meter which is prepaid, have the ability of auto reading, and on load management. All users are restricted to use the limited load let's say 500 watts. Buzzer goes on and meter will shut down if user exceeds restricted load. On decreasing the load meter will restart. Energy meter will be shut down if user runs out of unit.

Key words— Power Line Carrier Communication (PLCC), Smart Energy Meter, Power Line Communication (PLC), ID Based Smart Energy Meter, PLC Module, KQ330 Module, Auto Meter Reading, Power Transmission Lines (PTL).

I. Introduction

Electric power system constitute the fundamental infrastructure of the society. Power system consist of machines that generate and consume electric power.

Power systems have lot of issues that needs to be solved with appropriate solution. One of the big issue that we addressed in this research paper is power theft and reducing the cost of metering.

This issue has solution in making a control mechanism which cannot be cheated and have the feature of auto reading and load management, and is controllable by the grid station.

II. Survey of Related Work

Using the electrical power line to send information is not a new idea. Sweden has been using its electrical power grids for telephone communication for many years. Further, electrical power lines have been used throughout the world for low frequency communication by electrical power industry for simple control function, using protocol such as X10 Home Automation. These proprietary protocol are low speed and are solely used for controlling consumer system, such as light, appliances or simple electronics.[1] We have used power lines to control energy meter from the grid station. Reception and transmission of data is carried out by using KQ330 [2] module which is interfaced with the microcontroller so that commands can be executed.

III. Research Question and Problem Statement

Our research question is that how can we control energy meters from centralized control unit using power line communication and its impact on our energy system. The main problem is that the old metering system can easily be tempered and sometime the human metering has reading draw backs.

IV. Problem Solution

Meter reading problem are solved. Water And Power Development Authority (WAPDA) Pakistan can improve its economy.

Implementing this system time, money and electricity can be saved. No extra wiring is required with best signal security.

We can access energy meter by using ID based communication and thus controlling from the control station using PLCC.

PLCC means transmission of data on Power Lines. This is done by sending data at zero crossing of the power signal by using 125KHZ carrier signal and ASK modulation.

V. Methodology

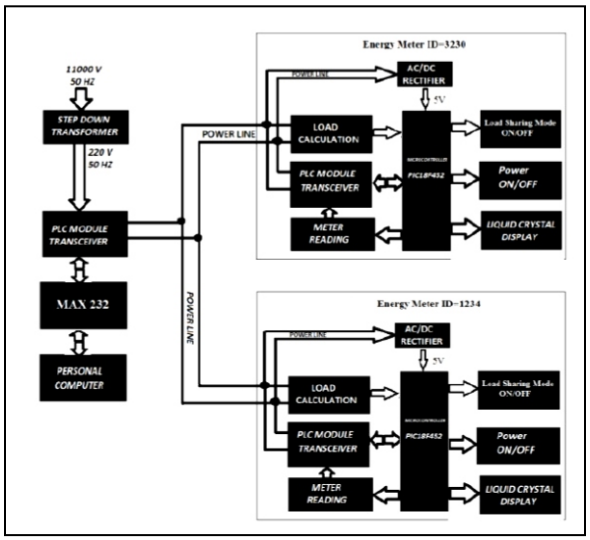

Fig 1.Block Diagram of ID Based Smart Energy Meter Using PLC

A. Controlling Energy Meter

Low voltage data received from the PC is impressed upon the high voltage using PLCC module. To stop high voltage flow into the control station coupling circuit is used. The modulated signal travels in the power lines until it encounters a demodulator via a coupler. The demodulated data is then analyzed by the

microcontroller and the appropriate command is sent. The Energy Meter Microcontroller is programmed in c language using PIC C compiler [3].

It is programmed such that it receives and sends data via serial communication through pin C6, C7. The data is analyzed and relevant operation is performed.

The value such as watt and unit allowed is saved in the Electrical Eraseable Programmable read only memory (EEPROM).

B. Centralized Control Unit

A centralized control unit is used to control the consumer's meter as well as to get the value of load connected and unit update. In order to accomplish this task, we have made a hyper terminal in C# language and programmed it in such a way that it displays the number of unit, watt and meter id. We have certain command button on the hyper terminal that receive and transmit signal from the energy meter using serial port of the personal computer. We can switch on/off the load connected to energy meter.

C. Power Line Carrier Communication

The information signal is coupled on the power transmission line (PTL) using power line communication module. Information signal sent on the PTL are of high frequency. The transmission and receptions of information signal from PTL is done with help of PLC module. The PLC module has a built in coupling circuit and the function of coupling circuit is to couple the PLC module with the high power AC transmission lines. The capacitors of the coupling circuit combine with the inductance makes a high pass filter that suppresses the low frequency signal i.e.50 Hz. It also isolates the high voltage tension line and PLC module in order to avoid passing of high voltage in the base circuit. The figure of PLC module KQ330 is shown in fig.1.

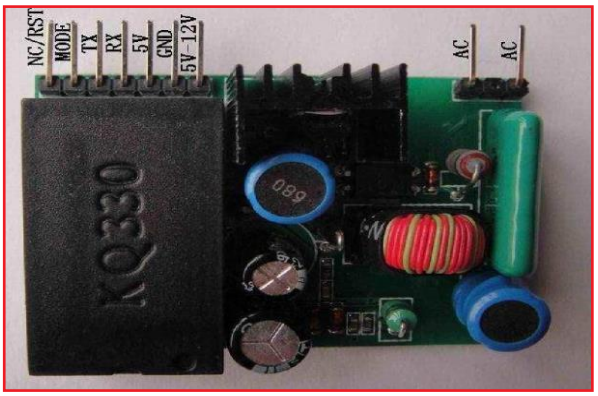

Fig 2. PLC Module KQ330

D. Information signal flow

Information signal moves to and fro in the PTL. The centralized control unit sends and receives data to and from the customer's energy meter. This Bidirectional data flow is carried out with the help of PLC module as shown in Fig. 2.

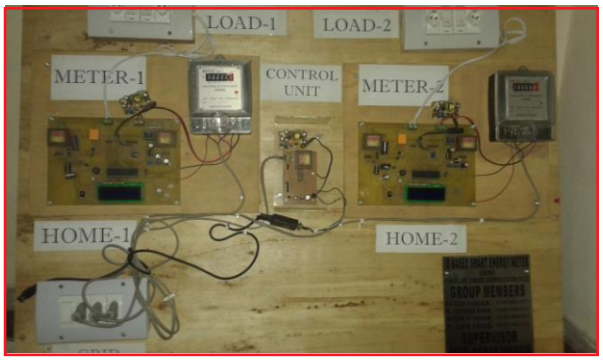

Fig 3. Implementation of ID Based Smart Energy Meter Using PLC

The Fig. 3 shows the implementation of research work at smaller scale. We have two meters named Meter 1 and Meter 2 installed in Home 1 and Home 2 respectively, both the energy meters are embedded with PLCC module. Between both is a control unit, which is connected to laptop acting as a control system. The entire system is connected to main power supply shown at the lower left corner of the picture. Both energy meter are connected to load1 and load 2 at the top of the picture. The command is sent by control unit to energy meter, executed by meter and results sent back to control unit.

VI. Conclusion

Keeping in view issue related to power system, we have to take decision that help to keep a better control of the energy flow in the power system. Employing "ID BASED SMART ENERGY METER USING PLCC" is one of the possible solution. Reading tempering problems are solved by this system. Water And Power Development Authority (WAPDA) Pakistan have many meter readers which are paid. Implementing this system, saving of time, electricity and money is possible. This system requires no extra wiring still ensures signal security.

Acknowledgements

We are very thankful to Engr.Noman Shabbir from the Department Of Electrical Engineering at Government College University Lahore for his suggestions and help in our research.

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MedRobo: A Dedicated Robot for Pharmaceutical Industry

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Abstract

Robotics technology deals with design, construction, operation and application of robots. Robotics has become an extremely large and eclectic discipline. By introducing applications of autonomous robotic, easy repetitive tasks can be accomplished keeping the demands of accuracy and speed in mind. Although many robots are available in market but our MedRobo is designed by fulfilling the needs of pharmaceutical industry. For the use in pharmaceutical industry man power is required however this unique robot separates the expired and other medicine cartons itself by using the IR sensors. MedRobo is designed in such a way that it is fixed on board in front of conveyor belt and it works in collaboration with PC instruction about separating the RED color or GREEN color tagged cartons and places them randomly in the work area. These RED color tagged cartons denote expired medicines and GREEN shows medicines having certain temperature requirement. Instructions for robot are programmed in C++ language that proceeds through PIC microcontroller and interfacing between PC.

I. Introduction

In pharmaceutical industry there is a stumbling block to separate medicines according to their expiry date, and temperature requirement, this is tiresome job for man. It will require more man power and more time consuming. To solve this issue it is the need of hour to introduce such interactive system that will work for human welfare and terminate access of harmful medicines from the users.

We are determined to build an interactive MedRobo that will separate the medicines according to the color tagging on the cartons.

Robotics develop man made mechanical device that can automatically move by themselves, which are must be modeled, planned, sensed activated, supervised and whose motion behavior can be influenced by programming. A Robot can be controlled or supervised by human operator, but mostly robotics are controlled by computer. Robot has two categories: Autonomous robots and Insect robot.

An autonomous robot acts as a separate system, with its own computer (called the controller). Insect robots work in fleets ranging from a few to thousands with all fleet members under the observation of a single controller.

II. Parameters

Kinematics

Cartesian, Parallel, Spherical, Cylindrical, Articulated organization and forms of joints is known as Kinematics of Robot. Our focus is on "Articulated Robot Type", which uses rotary joints to contact with its work space. Typically the joints are settled in a chain, so that one joint supports another in the chain. Articulated robots have the finest used to grip and lift small parts with abundant accuracy. The articulated robot is composed of trunk, shoulder, arm and wrist. With the capability to rotate all the joints, usually these robots have six degrees of freedom (DoF)[1].

Axis 1 Arm sweeps from side by side

Axis 2 Shoulder moves backward and forward.

Axis 3 Elbow moves in above and below direction.

Axis 4 Middle of forearm pivots up and below.

Axis 5 Wrist moves up and below.

Axis 6 Wrist sweeps from side to side.

Degree of Freedom

Number of points a robot can be directionally controlled. A human arm has 7 degrees. Articulated arms typically have up to 6 DOF as defined above [2] [3].

We are working with 4 DOF.

Axis 1 - Arm sweeps from side to side

Axis 2 - Shoulder moves forward and backward.

Axis 3 - Elbow moves up and down.

Axis 4 – A wrist moves up and down

Anatomy of Robot

The industrial robot is similar to the human arm in its bodily structure like the hand devoted with the human body. The robot exploiters of the robotic arm are attached to the base. Chest, upper arm and fore-arm in the human body compare with the links in the robot manipulators [4][5]. The elbow and the shoulder in the human hand are characterized by the joints in the robot arm. As the industrial robot arm compares with the human hand they are also known as anthropomorphic or articulated robot.

Table I. Anatomy of Robot

Anatomy	Representation
Body	Base
Chest	Link
Shoulder	Joint
Upper Arm	Link
Elbow	Joint
Fore Arm	Link
Wrist	Joint

The drives or motion of the link is provided at the joints. The joints motion can be rotational or translatory. The tool known as end-effector is attached to the wrist. The end-effectors are not considered as the part in the robot anatomy [2]. Robot Anatomy is shown in the figure below

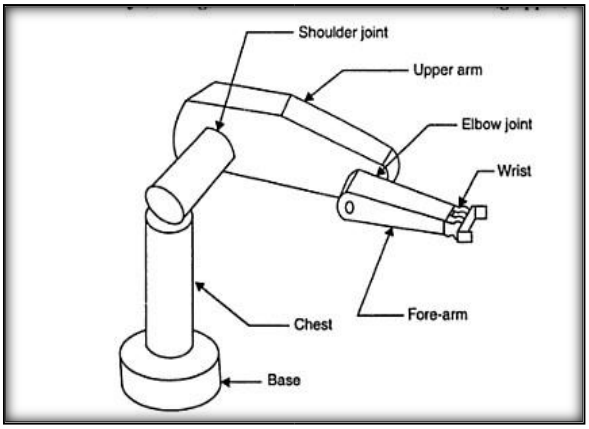


Figure 1. Robot anatomy

Work Space

The reach of the robot is defined as the workspace of the system. All programmed points within the reach of robot are part of the workspace. The workspace shape of the project robot is rectangular.

Robot Motion

The robot has two basic movements:

- The base travel movement.
- The arm rotational movement.

End Effector

The End-Effector is the hand linked to the machine arm. It is different from the humanoid hand. The end-Effector provides the mechanical system the flexibility essential for the process of the robot. The end- Effector of the project is a attractive gripper and is driven by 12V DC source.

Pay Load

Payload is the weight ability of the robot. The project robot has a low load of 130gm.

Actuations

The process of driving the machine axes is called actuation. The actuation system used in the robot is electrical.

Dimensions of Robot

We have designed a MedRobo of length 21 inches and width is 3 inches. The upper arm of our robot is 8.7 inches in length, fore arm has the length of 7 inches while wrist is 4.5 inches long.

Degree of Freedom

Human arm have seven degree of freedom but utmost every robotic arm has four degree of freedom with five servo motors which are organized by the use of only one PIC microcontroller.

Payload Capacity

MedRobo can lift substances up to 130gm but our designed Robotic Arm can lift up to 150 gm.

Maximum Reach

MedRobo could grasp things about 40cm in a hemisphere and it is made by aluminum that make it inexpensive and light weight. On the other hand Robotic arm has the ability to extent 35cm in the hemisphere.

Hardware Interface

Both the Robots having hardware interfacing with PC is done by USB port.

Software Interface

Developing the graphical user interface in NetBeans IDE 7.1.2 software using Java language, while robotic arm's GUI using only the open CV high GUI utilities.

Movement

Keeping the design of MedRobo grip modest as identical to human's hand grip, as well as executing the gripping mechanism with one servo motor only.

III. Hardware Design Detail

Servo Motors: A servomotor is a rotating actuator that permits for accurate control of rawboned location, speed and acceleration. It contains a appropriate motor joined with a device for location feedback. Typical servo motors have three wires, which are for power (4-6 V), ground and control. The dimensions and profile of the servo motors are reliant on the application. RC servo motors are the most used type of servo motors used in robotics due to their affordability, consistency and ease of regulate by microprocessors.

Programmable Interface Controller

PIC is electronic circuit that can be automated to carry out enormous jobs.

1. They can be designed as timers to control a manufacture line.
2. They are found in many electronic devices such as alarm systems, processor based control systems, iPhone etc.

3. There are many types of PIC microcontrollers, although the finest are established in the GENIE variety of programmable controllable micro-controllers.
4. These are designed and simulated by Circuit Wizard software Proteus.
5. PIC Microcontrollers are comparatively inexpensive and can be bought by any user as pre-built circuits kits.
6. A microcontroller has a devoted contribution device and frequently has a small LED or LCD display for production results. A microcontroller also receive input from the device and controls the device by conveying indicator signals to different components in the device.

IV. Methodology

MedRobo is programmed and designed in association with an interfacing PC. The interfacing between MedRobo and PC is accomplish by a USB port. PIC 18F452 microcontroller is used to regulate and control the process flow, to give instructions. MedRobo works with 4 axis of revolution and Servo motors 6V are used that permits accurate control of angular position, speed and acceleration of joints.

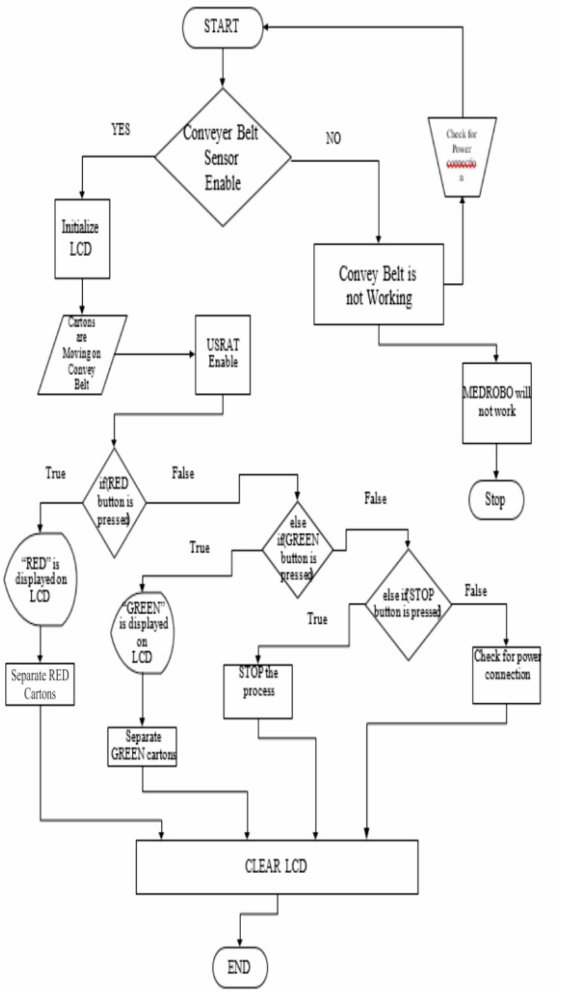
1. Medicine cartons are tagged manually either RED or GREEN. There are three colors in which cartons can be tagged RED, BLUE or GREEN.
2. A joining is made between MedRobo and PC through USB port and MAX232 IC is used with RS232 Communication connector in which the voltage conversion is required that makes TTL devices to be compatible with PC serial port.
3. A permanent magnet DC tackle motor of 12V is used along with this conveyor belt to route it. When input instruction is given, conveyor belt sensor enables and DC gear motor starts the conveyor belt.
4. USART is a chip that enables communication by a computer's serial port using the RS-232C protocol. It is empowered and checks for the instructions. There can be three inputs for conveyor belt.
    - From red button
    - From green button
    - From stop button

Here RED/ GREEN are considered to be “1” and S is considered to be “0” at back end in coding.

5. When cartons move on conveyor belt, IR sensors will dynamic that something is affecting the belt and then color detector turns on for red and green and start detecting color of specific wavelength in infra-red spectrum. If Red button is enable through PC, sensor for Red color enables and MedRobo starts separating Red tagged cartons and when GREEN is enable through PC, sensors for Green colors enable and MedRobo separates only green tagged cartons. MedRobo will place the separate cartons on the permitted location.
6. When Stop button is pressed Conveyor belt stops and the system stop working for cartons separation and LCD is reset.

V. Process Flowchat

Processing for MedRobo starts with manual tagging of the cartons. Cartons are tagged in two colors, Red and Green. Red colored cartons denote expired medicines that are needed to be separate from other medicines to avoid their access from public and Green color cartons show any certain medicine that require to be kept at certain temperature otherwise it may spoil and prove to be harmful. Power is switched on and these cartons are moved on conveyer belt. MedRobo is attached with PC through Serial port. Instruction is given to MedRobo to separate a particular tagged carton either Red of Green. It depends on particular button pressed through PC either RED or GREEN button. MedRobo separates the carton and drops it on allocated place. When we wish to stop the process, STOP button is press through PC and entire work terminates.



VI. Software Unit

MedRobo will separate the cartons according to colors. When we pressed “R”, RED will display on LCD and servo motors starts rotating accordingly as shown in figure 3.

When we pressed “G”, GREEN will display on LCD and servo motors starts rotating accordingly as shown in figure 4.

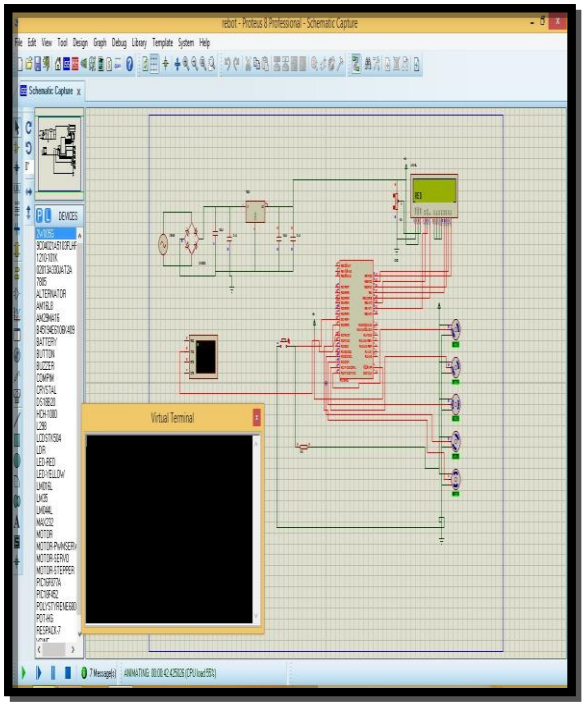


Figure 3. Proteus screenshot while RED displaying

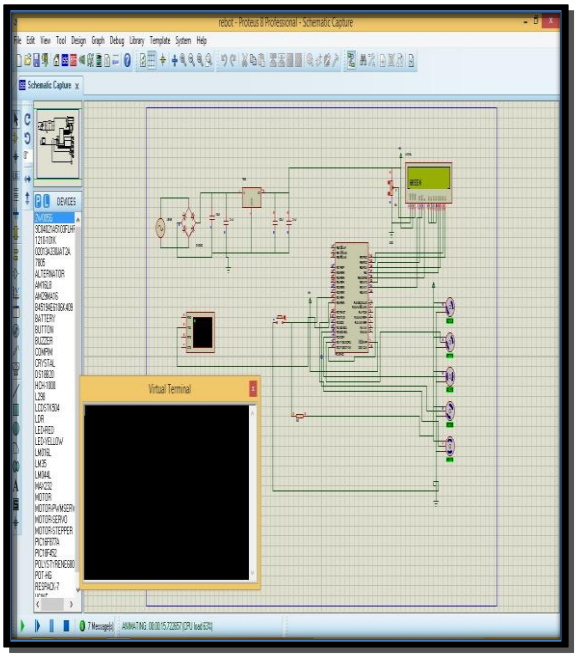


Figure 4. Proteus screenshot while GREEN displaying

VII. Structure

The structure of MedRobo is made up of aluminum. We use aluminum to build our robotic arm because it is cheap and light weight. The arm consists of Upper arm, lower arm and wrist.

Upper Arm

The upper arm of our robot is 8.7 inches in length. Two aluminum sheets of same length are joined together with a clip to fully support the motor attached. The motor is attached to move the upper arm in up and down direction. The upper arm is attached with the forearm.

Fore Arm

The fore arm of our robot is 7 inches long. Same as upper arm the fore arm is also made up of two acrylic sheets joined together with a clip. The motor attached to the fore arm allow it to move in upward and downward direction. The forearm is attached to wrist.

Table II. Structural details

Structure	constraint
Material	Aluminum
Upper Arm	8.7 inches
Fore arm	7 inches
Wrist	4.5 inches
Clip separation	7 inches
Conveyor Belt	Cylindrical path

Wrist

The wrist of our robot is 4.5 inches in length and the separation between the two clips is 7 inches. The motor attached to the wrist is also allowing it to move in upward and downward directions. The gripper is an electromagnet which is attached to the wrist of the robot.

The main structure of our Interactive MedRobo and Medeilo Management System consists of four main parts:

- Conveyor belt
- Robotic arm
- Electrical circuits
- PC

Conveyor Belt

The big box like and the main part of the structure is the conveyor belt on which the main task is performed. The conveyor belt moves in cylindrical path with an angle of 360. Permanent magnet DC gear motor initiates the conveyor belt. Two sensors are placed on

the track of conveyor belt. First one is the IR sensor which detects the object and the intensity of the object. Second is the color sensor which detects the color tagging of the object coming on the conveyor belt.

Robotic Arm

Color sensors and IR sensors give information to the microcontroller and in return microcontroller allows passing other colors and places the desired colored cartons besides the conveyor belt.

Electrical Circuits

Three electrical circuits are connected on the main base of the project board that are Microcontroller's circuit, Relay circuit, and LCD circuit. PIC microcontroller controls all the operations of the circuits. It also controls the relay portion and its instructions are displayed on LCD.

PC

All the main tasks of the sensors and color tagging are operated by the help of PC. We can also shuffle the colors of the sensor about which to pass and which to place aside.

Figure 5. Complete Structure of MedRobo

VIII. Results

The designed Medrobo with four degree of freedom and human anatomy parameter listed in section II uses the unique algorithm described in section V and VI. When the defined color tag on the medicine carton is of new medicine stock, the robot will allow passing them, but if the color tag is of the expired medicine the robot will pick it from the conveyor belt and place aside. Robot detects the conveyor belt path which uses IR sensors which detects the belt and sends the information to comparator and then to H bridge which controls the working of the arm. Microcontroller controls the other operations.

IX . PCB LAYOUT

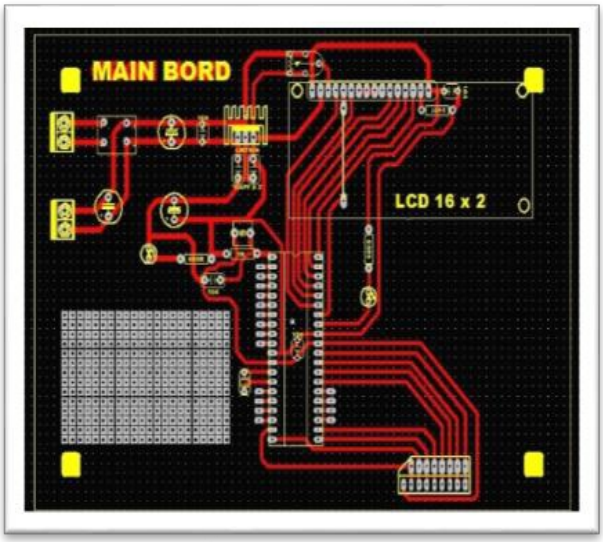


Figure 6. Main PCB Board

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Inter-Cell Interference in Relay Networks

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Abstract:

Inter-cell Interference (ICI) in multi-cell wireless networks is a major limitation in the performance of these networks. The number of sources of ICI increases in the relay-based wireless networks due to an increase in the number of transmitting nodes in the form of relays. In this paper, we analyze, highlight and briefly describe the effects of ICI in relay networks under different relaying topologies based on the simulations carried out.

Keywords: Relay Networks, , Relay Protocols, Cooperative Network, Multi-cell Networks

1. Introduction

Future wireless communication systems require the use of advanced technologies to effectively enhance the utilization of radio resources. Resource management in wireless systems is crucial to achieve the best system performance. Most of the initial work on Orthogonal Frequency Division Multiplexing (OFDM)-based relay network is focused on a single-cell scenario to provide the basic ideas of allocating resources to maximize the local performance gain. There are few works on multi-cell interference in relay networks [1-4].

In [1], inter-cell relay cooperation in forming the uplink precoders to maximize the Signal to Noise Ratio/ Signal-to-Interference-Noise Ratio (SINR) is investigated and its transmission rate is evaluated for a linear 3 cell topology. The authors in [2] have proposed a user pairing control method for multi-cell shared multi-user MIMO relay system. In their method, the RT is set on the cell boundary and multiple users located on the adjacent cells make pair for relay transmission. In [3] authors try to transform the non-convex optimization problem to a convex problem by relaxing the multi-cell interference to a limited Interference threshold and, then solving the relaxed convex problem which leads to a suboptimal solution. In [4] authors tried to solve the same problem in [3] but in a multi-cell relayed network which by relaxing the instant interference to a limited interference. In [5], author investigate the resource allocation in multi-cell downlink network using frequency reuse with various transmission modes. In our previous works [6, 7] we also focus on the single-cell scenario where Intra-cell interference and MUI are of our interest. However, in next generation wireless networks, a high frequency reuse factor and small cell size will be necessary in order to achieve higher data rate; and these lead to severe ICI. In reality, ICI severely degrades the system performance and hence should be considered in the resource allocation process.

This paper is organized as follows: In Section 2 ICI analysis is presented in different relaying techniques. Section 3 highlights the simulation environment and parameters while simulation results are presented in Section 4 followed by conclusions in Section 5.

2. ICI Analysis in Relaying Networks

Consider a fixed relay based multi-cell OFDM wireless network. Base stations are placed in a regular grid, following the hexagonal layout as described in [8]. A basic hexagonal layout with three cells per site is shown in Fig. 1. The ICI typically involves Mobile Terminals (MTs) in neighboring cells or sectors being scheduled on the same Resource Block (RBs) or Sub-carrier. The transmission rate of MTs can be degraded due to ICI, especially the MTs present at the edges of cells.

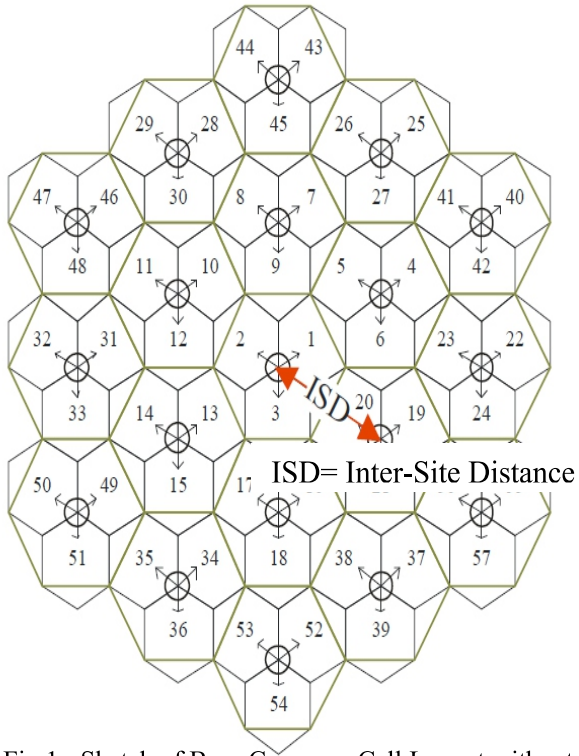


Fig.1: Sketch of Base Coverage Cell Layout without Relay Nodes [8]

Let us consider an example of three adjacent cells of three sites. By considering Cell 1 as the target cell, we investigate the interference signals from other

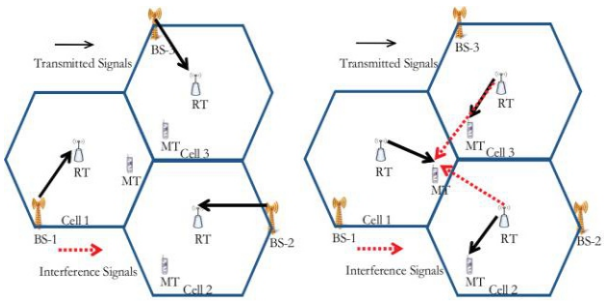
two neighboring cells in both One-way relaying (OWR) and Two-way Relaying (TWR) networks with Amplify and Forward (AF) protocol.

Notations

Symbol	Definition
M	Number of Mobiles Terminals (MTs)
R	Number of Relay Terminals (RTs)
K	Number of Resource Blocks (RBs)
$P_{x,m}^{k}$	Transmission Power of x to m^{th} MT on k^{th} RB
P_{T}^{k}	Total Transmission power for k^{th} RB
$h_{xy,m}^{k}$	Channel Gain form x to y for m^{th} MT on k^{th} RB
σ_{x}^{2}	Noise Power at x
g_{m}^{k}	Scaling/Amplification Factor for m^{th} MT on k^{th} RB
R_{x}	Instantaneous Throughput for x user over the k^{th} RB
γ	Signal to Noise Ratio/ Signal-to-Interference-Noise Ratio

A. ICI in OWR Networks

In OWR networks, two time slots are required in each phase for the MT and the BS to exchange information when relays are working in half duplex mode. In OWR, the spectral efficiency is lost as compared to full-duplex relaying. From a practical point of view, half-duplex relaying is always preferred over full-duplex operation even with this loss of spectral efficiency [9].



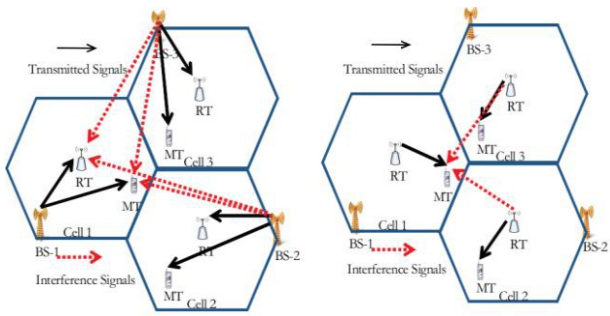
(a) The First Phase (b) The Second Phase

Fig.2: Multi-Cell OWR Downlink Transmission without the Direct Link

Usually it is assumed that a dedicated link can be established between a Base station (BS) and a fixed Relay Terminal (RT). Thus ICI can be avoided in this link in the multi-cell scenario. Therefore, there will be no ICI in the first phase if only the relay link is being used for transmission, as shown in Fig.2. On the contrary, there will be ICI in the first phase if the direct link between BS and MT is being used as shown in Fig. 3. Keeping in view the ICI signals in the first and second phases, mathematically, the SINR for the first case when there is no direct communication can be written as:

$$\gamma_{1}^{k}=\frac{g_{m}^{k\,2}P_{B,m}^{k}\left|h_{BR,m}^{k}\right|^{2}\left|h_{RM,m}^{k}\right|^{2}}{\sigma_{M}^{2}+g_{r}^{k\,2}\left|h_{RM,m}^{k}\right|^{2}\sigma_{R}^{2}+\sum_{i=1}^{I}P_{R,i}^{k}\left|h_{RM,i}^{k}\right|^{2}} \qquad (1)$$

where g_{m}^{k} is the scaling factor as given in [10] and $\sum_{i=1}^{I}P_{R,i}^{k}\left|h_{RM,i}^{k}\right|^{2}$ represents the interference signals in the second phase from all I neighboring cells. The $P_{R,i}^{k}$ is the transmission power of RT in i^{th} neighboring cell while $h_{RM,i}^{k}$ is the channel gain between RT in the i^{th} cell and the MT in target cell. From Fig. 3, it is clear that to include the direct link transmission; we also need to consider ICI signals on both RT and MT in the first phase of transmission. Using $\sum_{i=1}^{I}P_{B,i}^{k}\left|h_{BR,i}^{k}\right|^{2}$ and $\sum_{i=1}^{I}P_{B,i}^{k}\left|h_{BM,i}^{k}\right|^{2}$ the interference signals in the first the phase from BS to RT and MT in the target cell respectively, the SINR for this transmission can be calculated as (2):



(a) The First Phase (b) The Second Phase

Fig. 3: Multi-Cell OWR Downlink Transmission with the Direct Link

The $P_{B,i}^{k}$ represents the transmission power of BS in

i^{th} neighboring cell. The $h_{BR,i}^{k}$ is the channel gains between BS in the i^{th} cell and the RT in target cell while $h_{BM,i}^{k}$ is the channel gains between BS in the i^{th} cell and the MT in target cell. The amplification factor g_m^k with interference signals received at RT for m^{th} MT given as (3):

$$\gamma_2^k = \frac{g_m^{k\,2} P_{B,m}^k \left|h_{BR,m}^k\right|^2 \left|h_{RM,m}^k\right|^2}{\sigma_M^2 + g_r^{k\,2}\left|h_{RM,m}^k\right|^2 \sigma_R^2 + g_r^{k\,2} \sum_{i=1}^{I} P_{B,i}^k \left|h_{BR,i}^k\right|^2 \left|h_{RM,m}^k\right|^2 + \sum_{i=1}^{I} P_{R,i}^k \left|h_{RM,i}^k\right|^2} + \frac{P_{B,m}^k \left|h_{BM,m}^k\right|^2}{\sigma_M^2 + \sum_{i=1}^{I} P_{B,i}^k \left|h_{BM,i}^k\right|^2} \tag{2}$$

$$g_m^k = \sqrt{\frac{P_{R,m}^k}{P_{B,m}^k \left|h_{BR,m}^k\right|^2 + \sum_{i=1}^{I} P_{B,i}^k \left|h_{BR,i}^k\right|^2 + \sigma_R^2}} \tag{3}$$

$$\gamma_m^k(ANC) = \frac{g_m^{k\,2} P_{B,m}^k \left|h_{BR,m}^k\right|^2 \left|h_{RM,m}^k\right|^2}{\sigma_M^2 + g_r^{k\,2}\left|h_{RM,m}^k\right|^2 \sigma_R^2 + g_r^{k\,2} \sum_{i=1}^{I} P_{M,i}^k \left|h_{MR,i}^k\right|^2 \left|h_{RM,m}^k\right|^2 + \sum_{i=1}^{I} P_{R,i}^k \left|h_{RM,m}^k\right|^2} \tag{4}$$

$$\gamma_b^k(ANC) = \frac{g_m^{k\,2} P_{M,m}^k \left|h_{RB,m}^k\right|^2 \left|h_{MR,m}^k\right|^2}{\sigma_B^2 + g_r^{k\,2}\left|h_{RB,m}^k\right|^2 \sigma_R^2 + g_r^{k\,2} \sum_{i=1}^{I} P_{M,i}^k \left|h_{MR,i}^k\right|^2 \left|h_{RB,m}^k\right|^2 + \sum_{i=1}^{I} P_{RB}^k \left|h_{RB,i}^k\right|^2} \tag{5}$$

$$g_m^k = \sqrt{\frac{P_{R,m}^k}{P_{B,m}^k \left|h_{BR,m}^k\right|^2 + P_{M,m}^k \left|h_{MR,m}^k\right|^2 + \sum_{i=1}^{I} P_{i,m}^k \left|h_{i,r}^k\right|^2 + \sigma_R^2}} \tag{6}$$

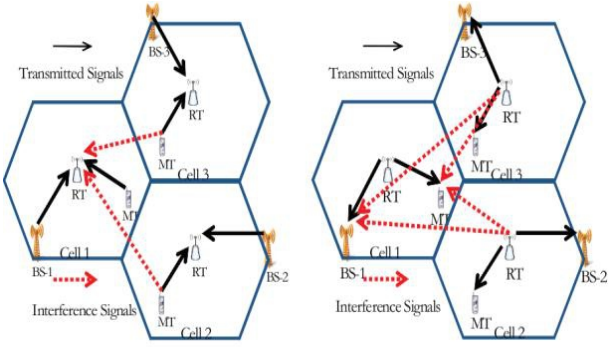
$$\gamma_{m,r}^k(\mathrm{TDBC}) = \frac{g_m^{k\,2} P_{B,m}^k \left|h_{BR,m}^k\right|^2 \left|h_{RM,m}^k\right|^2}{\sigma_M^2 + g_r^{k\,2}\left|h_{RM,m}^k\right|^2 \sigma_R^2 + g_r^{k\,2} \sum_{i=1}^{I} P_{BR,i}^k \left|h_{BR,i}^k\right|^2 \left|h_{BR,m}^k\right|^2 + g_r^{k\,2} \sum_{i=1}^{I} P_{M,i}^k \left|h_{MR,i}^k\right|^2 \left|h_{RM,m}^k\right|^2 + \sum_{i=1}^{I} P_{R,i}^k \left|h_{RM}^k\right|^2} + \frac{P_{B,m}^k Z}{1 + I_{BM,i}} \tag{7}$$

$$g_m^k = \sqrt{\frac{P_{R,m}^k}{P_{B,m}^k \left|h_{BR,m}^k\right|^2 + P_{M,m}^k \left|h_{MR,m}^k\right|^2 + g_r^{k\,2} \sum_{i=1}^{I} P_{BR,i}^k \left|h_{BR,i}^k\right|^2 + \sum_{i=1}^{I} P_{i,m}^k \left|h_{i,r}^k\right|^2 + \sigma_R^2}} \tag{8}$$

B. ICI in TWR Networks

The two types of TWR have been proposed in the literature [11] to overcome the spectral loss in OWR. These two types of AF-based TWR are known TWR-Analog Network Coding (ANC) and TWR- Time Division Broadcast (TDBC) protocols, respectively [12].The uplink and downlink transmissions occur simultaneously in TWR [11]. Therefore, unlikely OWR, the ICI from neighboring cells occurs in both hops of transmission even if we consider a dedicated link between BS and RTs. During the first phase in TWR-ANC, the ICI is received from MTs of others cells scheduled on the same RBs. There will be no ICI signal from BSs of other cell as the transmission between BSs and RTs are over dedicated links as shown in Fig. 4 (a). While in the second phase, ICI signals are received by both BS and MT in the target cell due to the broadcast nature of the signal from RTs as shown in Fig. 4 (b). Therefore, the SINRs at MT and BS in the target cell can be written as (4) and (5) while the amplification factor g_m^k with interference signals received at RT is given as (6).

On the other hand, in TWR-TDBC networks, there is more ICI present as shown in Fig. 5. As we know, the TDBC transmission takes three time slots to complete the information transfer from source to destination; and the ICI presents in each time slot. During the first phase, ICI arises from neighboring BSs to target RT and target MT, while in the second phase neighboring MTs scheduled on the same RBs produce ICI signal toward both target BS and target RT. In the third phase, when RTs are broadcasting the amplified signals, the neighboring RTs produce ICI in target cell on both BS and MT. Keeping in view all these interferences, the received SINR at MT in target cell can be expressed as (7) and the amplification factor is given as (8).



(a) The First Phase(b) The Second Phase

Fig. 4: Multi-Cell TWR-ANC Transmission

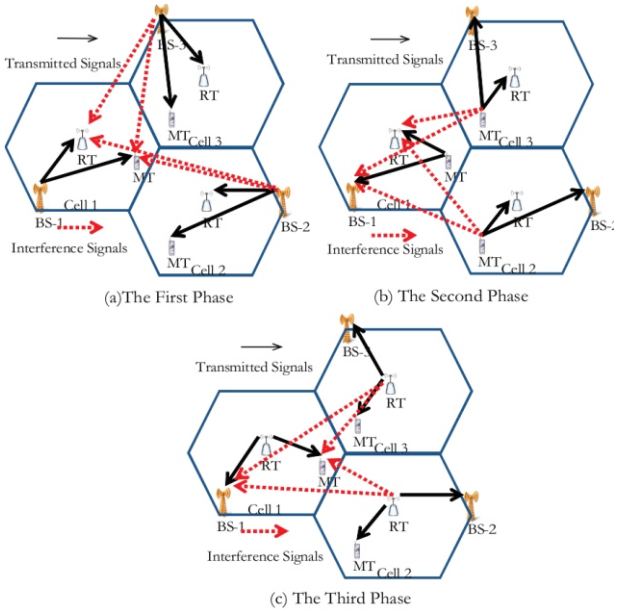


Fig. 5: Multi-Cell TWR-TDBC Transmission

3. Simulation Setup and Parameters

A. Cellular Architecture

The cellular network consisting of 7 sites is considered for simulation. Each site consists of three hexagonal cells and a RT is added to each cell as shown in Fig. 6. The relays are placed at the middle of each cell. The distance between two BSs is 1 KM.

B. Propagation Models

The shadowing and path losses are considered separately. The LOS path loss model is used for BS-RT link as we assume that relays are in LOS of BS which has directional antennas for transmission. The NLOS path loss model is used for RT-MT links. Both path loss models are given as in [8].

$$\text{PL\_LOS} = 36.7\log_{10}(d) + 22.7 + 26\log_{10}(f_c)\ \text{dB}$$
$$\text{PL\_NLOS} = 22.0\log_{10}(d) + 28.0 + 20\log_{10}(f_c)\ \text{dB} \quad (9)$$

The simplified model given in (10) is adopted for shadowing loss.

$$L_{\text{shadow}}(m) = \begin{cases} \rho\,\text{dB}, & \text{if } m \text{ is in a shadowed area} \\ 0\,\text{dB} & \text{otherwise} \end{cases} \quad (10)$$

where ρ is the standard deviation. While shadowing loss is considered at both MT-RT and RT-MT links, no shadowing loss is imposed for the dedicated BS-RT link.

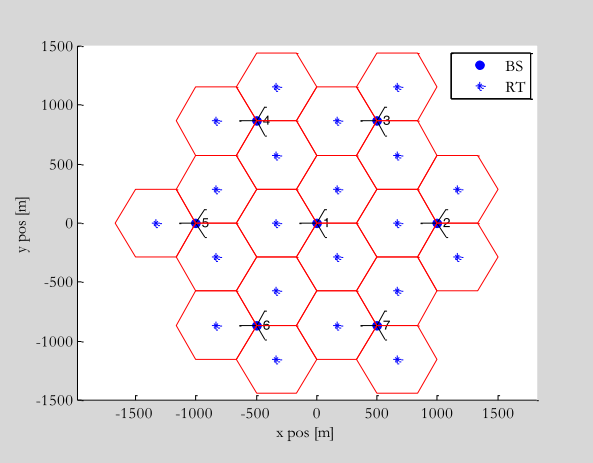


Fig. 6: Simulation Setup for Multi-Cellular Layout with Relays

C. Antenna Configuration

To take into account the ICI, the antenna pattern for all nodes should be considered. Here we assume that all BSs are equipped with both sectored directional antennas to support LOS transmission between BSs and RTs and omnidirectional antennas for direct transmission between BSs and MTs, while all RTs and MTs are equipped with a single omnidirectional antenna, respectively. Fig.7 shows the BS antenna pattern for 3-sector cells.

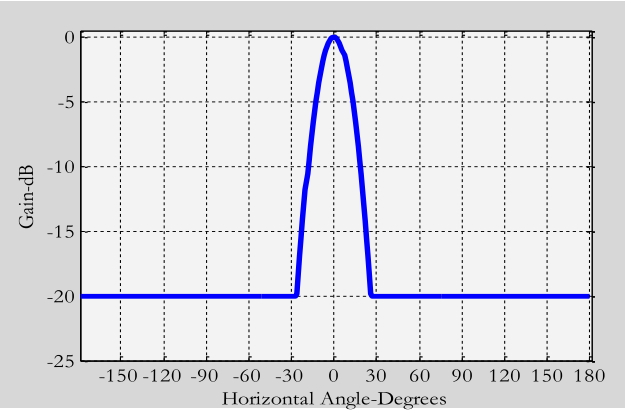


Fig.7: BS Antenna Pattern [8]

The antenna pattern for sectored antennas as proposed in [8] is given as:

$$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right] \quad (11)$$

where

$A(\theta)$ = Relative antenna gain(dB) in the direction θ;

$-180^\circ \le \theta \le 180^\circ$ is the angle between the direction of interest and the bearing direction of the antenna;

min [.], denotes the minimum function;

θ_{3dB} is the 3 dB beamwidth and $\theta_{3dB} = 70^\circ$;

$A_m = 20$ dB is the maximum attenuation;

4. Numerical Results

This section presents the simulation analysis on ICI in both OWR and TWR networks. For OWR we consider only downlink transmission while for TWR both uplink and downlink transmissions are considered simultaneously. Cell 1 of Site 1 is considered as target cell and all other neighboring cells are assumed as interfering cells. A single MT is placed in each cell at the same position for simplicity. Other simulation parameters are given in Table 1.

Figures 8 shows the ICI analysis on OWR with and without the presence of the direct link between BS and MT during transmission. It is clearly shown that higher transmission rate is achieved with the direct link due to the diversity gain.

Table 1: Simulation Parameters

Parameters	Value
Number of Sites	7
Number of Cells per Site	3
BS-BS Distance	1 Km
Number of RTs per Cell	1
RT-BS Distance	0.5 x Cell Radius
Carrier Frequency	2 GHz
Shadowing for NLOS Link	8.9 dB
OFDM Subcarrier Bandwidth	15 KHz
Number of Subcarrier per RB	12
Noise Power Density	-170 dBm/Hz
BS Max. Tx. Power	46 dBm
RT Max. Tx. Power	37 dBm
MT Max. Tx. Power	15 dBm

There are two points to be noted here. The first point is that transmission rate is much degraded due to the presence of ICI, and therefore ICI cannot be neglected in any practical scenario. The second point is that the difference in transmission rate between the case with direct link and that without direct link widens as the number of RBs increases, when ICI is not considered. However, this difference shrinks notably once ICI is taken into account. This is

because of the presence of the ICI signals in the first phase of transmission when the direct link is also being used for transmission along with the relay links. Fig. 9 presents an analysis of ICI on TWR network. Both ANC and TDBC protocols are considered. Like in OWR, the ICI degrades the sum-rate in TWR as well. As discussed in the previous Chapter, ANC is an efficient protocol than TDBC in terms of spectral efficiency due to the less number of time slots required to complete the exchange of information between source and destination, and here the same is again verified with and without the presence of ICI. As shown in Fig. 9, TDBC protocol experiences more interference than ANC protocol. Therefore the sum-rate difference between ANC and TDBC protocols increases when ICI is taken into account in TWR networks.

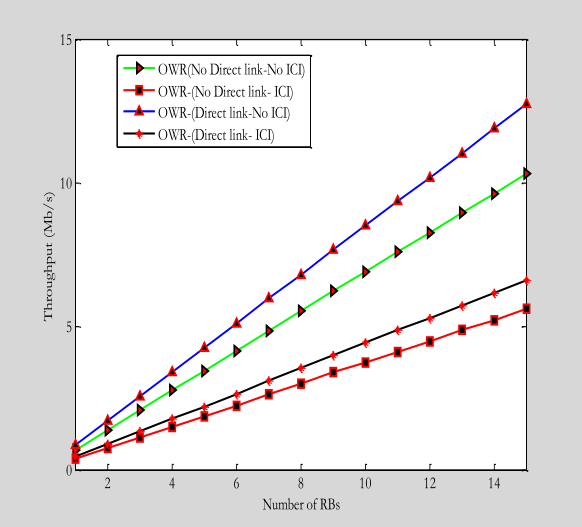


Fig.8: ICI Analysis on OWR Networks with and without the Direct Link

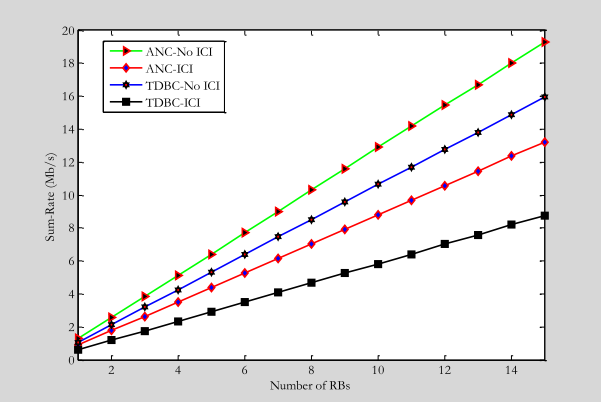


Fig. 9: ICI Analysis on TWR Networks with ANC and TDBC Protocols

5. Discussion and Conclusions

In this paper, the different ICI cases of relay networks are analyzed. Simulation results show that the throughput degrades significantly due to the presence of ICI. For simulation purposes, 7 sites were selected as this is a typical number in many literature. It makes the comparison easier with our results. It can be observed that the degradation differs slightly with different network relaying techniques and protocols. Based on the ICI levels, appropriate relaying schemes can be adopted. Further investigations will be carried out to mitigate the performance degradation due to ICI. Such work will explore use of efficient resource scheduling algorithms ICI in multi-cell scenarios.

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QUOTATIONS

- "The act of writing is the act of discovering what you believe.

  David Hare
- "Journal writing is a voyage to the interior."

  Christina Baldwin
- "Fill your paper with the breathings of your heart."

  William Wordsworth
- "Everyone should have a form of a diary. It's a great release."

  Stanley Victor Paskavich
- "What happens to us is not as important as the meaning we assign to it. Journaling helps sort this out."

  Michael Hyatt
- "Just write every day of your life. Then see what happens."

  Ray Bradbury
- "Whatever it is that you write, putting words on the page is a form of therapy that doesn't cost a dime

  Diana Raab
- "Don't trust your memory, jot it all down."

  Earl Schoaff
- "Don't forget – no one else sees the world the way you do, so no one else can tell the stories that you have to tell."

  Charles de Lint
- "It's not the mountain we conquer, but ourselves."

  – Sir Edmund Hillary
- "Millions say the apple fell, but Newton was the one to ask why."

  – Bernard M. Baruch
- "One of the most dangerous forms of human error is forgetting what one is trying to achieve."

  – Paul Nitze
- "Natural abilities are like natural plants; they need pruning by study."

  – Francis Bacon
- "Live every act fully, as if it were your last."

  – Buddha

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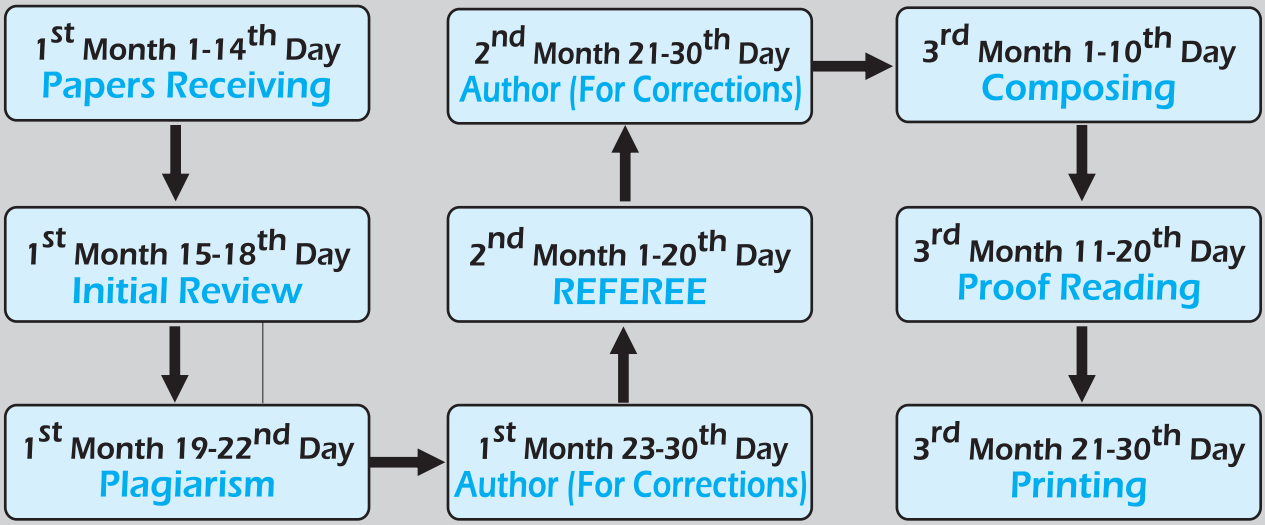
CarbFix--One of the Best Recent Innovations

Solving climate change is a huge international challenge now a days. And despite the concerted global effort, involving the governments of all nations, the individual actions are still crucial.

One of the innovative ideas of 2016 in engineering world, and an alluring solution to our climate woes is CarbFix. It is currently used in one power plant in Iceland and dissolves greenhouse gases in water, then pumps them into nearby basalt-laden volcanic rock, rather than letting them go into the atmosphere, where both convert into limestone within a few years. The ocean floor is rich in basalt, so the method could scale worldwide.

Time-Line for Papers Processing for IEEEP Quarterly Journal "New Horizons"



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Research Papers from engineers in the disciplines of Electrical, Electronics (Including Information Technology and Telecommunications), Controls, Mechatronics, Avionics, Computers and Medical Engineering are invited for publication in "New Horizons", HEC recognized Y-Category, quarterly research journal of the Institution of Electrical & Electronics Engineers Pakistan. A soft copy of the paper may please be sent to ieeep1969@gmail.com or info@ieeep.org.pk in the following format:-

1. The research paper should be prepared in MS Word Software in Two-Column Format.
2. Select A-4 size, 1 inch margins on all four sides, 1.0 line spacing, Times New Roman Font with size 12 and justification on both sides.
3. All headings should be in capital bold letters.
4. All figures and diagrams must be properly numbered and labeled.
5. All diagrams, tables, graphs and photograph must black outlined with white back ground.
6. All text within diagrams must be bold enough for readable clarity.
7. The papers must not contain more than 6 pages.
8. Complete references must be provided at the end of the paper.
9. Reference should be as per international standard. Format for one of the references is given below as a sample.

   N.E. Nilsson and J. Mercurio "Synchronous generator capability curve testing and evaluation" IEEE. Trans. Power. Del., Vol: 9, no: 1 , pp 414. 424, Jan 1994.

PLEASE NOTE: You are requested to provide a brief Resume of yourself and of the co-authors (if any) alongwith the paper(s). Also please provide contact numbers and email addresses of all authors. Kindly note that papers/material as PDF Files will not be accepted.

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