# Soil Remediation and Plants

## Prospects and Challenges

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# Recent Trends and Approaches in Phytoremediation

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## INTRODUCTION

The tremendous progress in scientific technology has evolved human life globally and these developments have raised new issues which pose challenges to the environment, particularly protection and conservation (Bennett et al., 2003). Further, in industrialized society exposure to toxic chemicals and metals becomes unavoidable. Various anthropogenic activities lead to heavy metal enrichment, especially in developing countries where it has become a serious threat to the environment (Wang et al., 2001) by affecting the health of animals as well as humans. The pollution by heavy metals degrades the quality of water, soil and air, thus having deleterious effects on agricultural production. The governments around the world are duty bound to their citizens to advocate a safe environment free from pollution. However, these environmental issues are outweighed by other concerns for the countries' economic, agricultural and industrial development for ever-increasing populations. Thus this prioritization in a particular direction becomes the driving force actually responsible for environmental pollution (Ikhuoria and Okieimen, 2000). Plants play a pivotal role in transforming solar energy to green energy and have tremendous potential to remediate soil from heavy metals. The conventional methods available currently for the remediation of heavy-metal-contaminated soils are expensive and are not necessarily eco-friendly. However, phytoremediation is a novel 'green technology' which utilizes plants' potential to restore the health of the environment. The conclusions drawn on the basis of fundamental and applied research is that the plants possess tremendous potential for eliminating, degrading or neutralizing a variety of heavy metal toxicants. The wonderful nature of this technology is in its cost effectiveness, simplicity, sustainability, environmental compatibility and the fact that it is more aesthetically attractive than the conventional classical technologies. It can be

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**TRACK: ALGORITHMS**

# Extracting Academic Social Networks Among Conference Participants

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***Abstract*—Academics establish relations among them in multitude ways, co-authorship being one of them. In fact co-authorship has the advantage of being the best recorded among all forms of academic collaborations. Co-authored publications appear in the form of research articles, conference and workshop proceedings, technical reports, etc. As per DBLP, one of the major digital libraries, around 55 percent of the publications appear in conference and workshop proceedings. This implies that conference and workshops provide a rich environment for academics to portray their co-authorship based academic social networks. In this paper we extract academic social networks among conference participants, study their collaboration patterns, analyze their evolution over time and use social network analysis metrics to quantify them.**

***Keywords— information reterival; social networks; co-authorship; disambiguation; conference participants; contemporary computing***

## I. INTRODUCTION

Understanding collaborations through Social Network Analysis (SNA) is not new to academics and has been used a good number of times to study the collaborations and collaboration patterns between institutions and individuals at local, national and international level [1]. Studying patterns of research collaborations among academics is important because research collaborations play a pivotal role in creation and dissemination of new knowledge [1]. It has been observed that joint research or collaborative research has been instrumental in enriching scientific discoveries, generating new ideas, innovations and development of new industries [2].

It is necessary to analyze various forms of collaborations among academics because such an analysis may help understand important aspects related to the patterns of collaboration, their evolution over a period of time, factors that influence these collaborations, flow of knowledge in the network, identification of prominent actors in a collaboration network, etc. Social network analysis has been employed by a number of studies for understanding quantitatively these collaborations. Academics establish relationship through co-authoring, co-supervising, working on a project jointly, etc. [3]. Among all forms of academic collaborations co-authorship is the best documented and most tangible form of research collaborations [3]. This relationship is established when two or more people co-author a research publication. In order to understand such collaborations one needs to focus on joint publications [2]. The co-authorship relations can be converted into a graph with nodes representing authors and edges representing co-authorship relation. In order to derive and understand these networks one needs to have disambiguated publications data in the first place [4].

Conferences serve as an important platform for academics, particularly young researchers to present their findings, getting feedback on their work, opportunities for networking with other people working in their area of interest, etc. Worldwide there are a number of reputed conferences which have attracted a number of researchers repeatedly. In Indian context, International Conference on Contemporary Computing (IC3) being organized by Jaypee Institute of Information Technology, Noida and University of Florida, USA, for the last seven years, has been a niche destination in the field of Computer Science and Information Technology. The conference is indexed by major computer science databases including Scopus and digital libraries including DBLP. It has been host to a number of researchers and academics from different nations of the world.

In this work we extract and analyze academic social networks among the participants of this conference from the publications data available online. From this data we obtained co-authorship relationship after these publications were disambiguated. There are a number of techniques that have been proposed in the literature for the purpose of author name disambiguation. The reader can refer to [5, 6] for a detailed survey and discussion about these name disambiguation techniques. We performed the disambiguation task using a modification of [7].

The rest of this paper is organized as follows: In section 2 we present the related work; section 3 presents the data collection; section 4 presents the proposed social network extraction technique, whereas Section 5 presents the experiments conducted and the results obtained. In section 6 we conclude the work and give some future directions.

## II. RELATED WORK

Automatically extracting social networks from publically available documents on the Web was first attempted by Katz et al. [8] in the year 1997. They develop an automated tool for identification of interactions among people of a specific domain which were then transformed in the form of social networks. This was followed by a considerable number of

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**Abstract**

Author name ambiguity has long been a problem confronting the effective management of digital literature and digital libraries. Uncertainty about the real authors of a publication sometimes lead to wrong credits to authors or otherwise. Previous studies have tried to solve this problem by using traditional computational techniques. Soft Computing promises to be a good option one can look forward to deal with the problems of uncertainty. In this paper, we present the result of our ongoing work for resolving name ambiguity problem in digital citations. We propose a model that uses both traditional and fuzzy clustering approaches in a two stage framework to solve this problem. The results of our name disambiguation approach which we obtained on DBLP data are very encouraging and we have been able to achieve very good disambiguation performance in comparison to other baseline methods. On an average the values of Precision, Recall and F1 were 94.17, 91.56 and 92.42 percent respectively.

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*Keywords:* Name Disambiguation; Soft Computing; Fuzzy Clustering; DBLP

## 1. Introduction

The advent of Information Technology has paved the way for proliferation of scientific knowledge and researchers find themselves highly benefited from the use of Information & Communication Technology (ICT) for furthering their research activities (Chang, Huang, 2014). It has been argued (Zhao, Strotmann, 2014) that advances in ICT has led to an increase in research productivity, increased level of research collaborations between researchers geographically far apart from each other, increase in citations, etc. This has also led to accumulation of large amount of bibliographic data in digital libraries like DBLP, CiteSeerX, Microsoft Academic Search, etc. ICT which has made the work of researcher more worthwhile has also compounded the problem for digital libraries by either mixing or splitting the research publications of authors sharing a common name. This is because of the reason that more and more authors with similar names are contributing to scientific knowledge by way of publishing their research work. This is evident from a steep rise in the number of publications in the recent past (Tang, Walsh, 2010).

In research publications or bibliographies, the name ambiguity problem arises in two different forms, (a) when same name is expressed in different formats and (b), when different authors express their name in similar ways (Shin et al, 2014). In first case, the ambiguity arises because of not following a uniform naming pattern by an author. This could happen because of different naming conventions by different journals, conferences, book publishers etc. (Han et al, 2003). A case in point is an author Richard Taylor, Professor Emeritus, Information and Computer Sciences, University of California, Irvine. The publications of Richard Taylor appear under six different name variations: Richard N. Taylor; Taylor, R. N.; R.N. Taylor; Richard Taylor; Taylor, R.; and R. Taylor, even on his homepage†, leave aside digital libraries. In second case, the ambiguity arises because of multiple authors sharing a common name (Han et al, 2003). This can happen because of limited number of name options that our parents have while choosing a name for us (Arif et

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# Articles

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# Privacy Preserving Data Mining using Fuzzy based Approach

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**Abstract**

The process of data mining delivers valuable and previously unknown nuggets of information from vast volumes of data. The success of data mining is dependent on the quality of data submitted for data mining process. Most of the times, quality or accuracy of data collected for data mining purpose can be trusted but for some apprehensions like confidentiality, privacy or sensitiveness of the data, the real owners can submit false data. In addition, that, in turn, can affect the final results of the data mining. This is where privacy preserving data mining has to play a role, to develop confidentiality of the data, the data owners don't want to reveal and at the same time the results of the data mining are not affected or are least affected. The aim of this paper is to propose a technique where results are not affected and at the same time, the privacy of data is preserved.

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*Keywords*: PPDM;K-Means; Fuzzy; Fuzzy Membership Function;Clustering

## 1. Introduction

With the advent of low cost storage devices, fast processors and extensive use of information technology large amounts of data is being collected every year in data repositories from almost every field that affects human life (Ann Cavoukian, 1977 and C. Li & G. Biswas, 2002). Such data in the data repositories can contribute in decision making and critical analysis provided sophisticated algorithms are available to extract the useful information (A. Ahmad and L. Dey, 2007). A lot of research has been done to achieve the same but till now it has proven to be a challenging task. Data mining is a specialized automated mechanism to achieve the goal of extracting useful information from enormously large data repositories (Zhihua, X, 1998). Modern computational and statistical techniques are being applied to uncover hidden and useful patterns in large data repositories (Tsantis L & Castellani J., 2001, Luan, J., 2002 and A. Ahmad and L. Dey, 2007). The data repositories may be distributed vertically or even horizontally. Data mining algorithms are being widely used to solve real world and real time problems associated extraction of unknown information from large data repositories. The need for data mining has been felt long ago in almost every field of life from banking to agriculture, medical diagnosis, telecommunication, intrusion detection, genetic engineering, education, marketing, investments, weather forecasting etc. (M. B. Malik et al, 2012). Conventional tools and techniques of data mining have to face certain challenges like high dimensionality, distributed databases, non-standardization of databases, missing values, changing data and even handling expired data (M. B. Malik et al, 2012).

## 2. Soft Computing

Soft computing addresses many of such problems (Sushmita Mitra et al, 2002). Soft computing in itself is a consortium of synergistic mechanism to provide flexible and subtle processing of data related to the domain of real life ambiguous problems (L. A. Zadeh, 1994). The role model is human brain and it handles challenges like imprecision, uncertainty and partial truth successfully (M. B. Malik et al, 2012). A number of solutions have been developed using

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# Big Data: A Growing Tide not Hype

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**Abstract**

Data revolution is just at its infancy; everyone is talking about Big Data. Big Data is an explosion of data and as such traditional systems are not scalable enough to handle this enormous data. The explosion of the Big Data is a very recent phenomena it is quite recently, companies have started to realize that they should capture all this data that is being producing and not only capture they should try to analyse it and try to get some value of it. This paper explores the Sources of Big Data, Architecture of Big Data, challenges and issues produced by it and Hadoop, a Big Data tool

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*Keywords*: Big Data: Architecture: Hadoop

## 1. Introduction

Data is a new class of economic asset, like currency and gold (World Economic Forum 2012). Data is growing at enormous rate, so it is very difficult to manage and handle this huge and gigantic volume of data. It is very difficult to handle this enormous data because it is growing so rapidly in comparison to the computing resources. The term Big Data is very confusing as it gives us a feeling that after a certain size the data is big and below a certain size the data is small (Dong, X.L and .Srivastava, D). The Big Data could start from any point. There is no definitive definition for Big Data. However it is mostly defined this way that "Big Data is a data that becomes difficult to be processed because of its size using traditional system".

Traditional systems including relational databases are not capable of handling the Big Data and challenges spring up at multiple levels including capturing, storing, analysing, searching, sharing, transforming the data and even visualizing the data. The Big Data becomes a challenge for traditional systems not merely because of its size that could be a challenging point but challenge may also arise because of its speed at which the Big Data is coming in and also because it is unstructured and it could contain data items of various formats. So Big Data is usually measured by three attributes, velocity, volume and variety. The velocity refers to the speed at which the data is coming in e.g. the Scientific Experiments that they do at atomic reactors where they do the collision of sub-atomic particles, 40TB of data could come in within one sec, so that is a very high speed. Volume is of course a problem, the data keeps on accumulating and the file becomes too large to be handled by traditional system. The Facebook is generating 25TB of data daily so just imagine the size of the files that are there since the beginning of time. In traditional systems data is structured and is stored well in planned tables, each table has specific columns and each column could accept values of specific data types. However in case of Big Data, the third V creates problem sometimes i.e. variety. When the Big Data comes in it may include items of variety of formats. It could have audio files, video files, and unstructured data like text messages so that becomes challenging sometimes for a traditional system to handle. The explosion of the big data is a very recent phenomenon and it is quite recently, companies have started to realize that they should capture all this data that is being produced and not only capture they should try to analyse it and try to get some value out of it. These days the decision making is solely performed on structured data which is mostly stored in applications like ERP's and other related applications that are running in an Enterprise. So, the most of this unstructured data gets wasted, it is not captured and

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# English-Kashmiri Machine Translation: Issues and Challenges

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**Abstract**

Machine Translation is now considered as a challenging task for research by the academicians. It is an interesting and promising study of research, even though a flawless and correct translation by an intelligent computer is yet a dream to be realized due to the complexity and challenges that slowly came to notice. Most of these problems are independent of the methodology or tools used to achieve overall translation but still vary with each language pair. Every language pair puts forth a different level of challenges and issues which latter on becomes the reason of undesirable translation quality and fluency. This work tries to bring forth few of the main challenges that are faced at the very initial stages of the process of machine translation for English-Kashmiri machine translation.

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*Keywords:* Machine Translation; English-Kashmiri Translation; Challenges with Machine Translation; Divergence in English-Kashmiri

## 1. Introduction

Machine translation is not merely an automatic linguistic word by word translation, rather a translation of one natural language to another and preserving the meaning just like a human translator. And just like a human translator, machine translators also face multiple divergences in any language pair. The languages differ in their lexicon, syntax, semantics, pragmatics, culture and background so these need to be taken in account for a reliable translation.

Kashmiri culture, its beauty, its Sufi saints and its literature is diverse and unique and so is its language. However, the language (like other around 3000 languages) is facing a treat of extinction. That is why globalization of its language is the need of the hour. Machine translation is a promising solution. But Kashmiri language has a really scarce corpus available online or in digital form. And the development of a huge database of parallel corpora is one of the biggest challenges. Also like any language pair, English-Kashmiri translation also exhibits a general and an idiosyncratic difference in realization of their syntax and word order and has a lexical and morphological divergence. These divergences put forth some issues and challenges, most of which creep in usually the initial stages of machine translation and continuously damage the overall efficiency of the translation. The main challenges and issues that arise are a result of the ambiguity in source language, divergence across the languages and finally the variations in the target language. A study of these root causes is necessary as these are to be kept in view while devising algorithms for machine translation.

## 2. Source Language Ambiguity

Nagamani and Ananth proposed an image compression technique for high resolution, grayscale Satellite urban images. The proposed technique used discrete wavelet transform together with EZW (Embedded Zero tree wavelet) and SPIHT (Set Partitioning in Hierarchical Trees) coding techniques in order to achieve high compression ratio and better image quality. The compression ratio and peak signal to noise ratio determined using EZW and SPIHT codings have been compared to each other for same set of images. The results obtained showed possibility to achieve higher

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# غالبؔ

## لسانیاتی وضع، متن و معنی اور شعری نظام

ڈاکٹر محمد آصف ملک

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# نقوش



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# ملك راج آنند

## موجز عن حياته ودراسة لرواياته

الدكتور محمد عفان

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ملك راج آنند: موجز عن حياته ودراسة لرواياته

الدكتور محمد عفان

إن الأدب الإنجليزي الهندي عبارة عما أنتجته وتنتجه قرائح الأدباء الهنود المقيمين بالهند وخارجها باللغة الإنجليزية، وهو أدب ثري يمثل الهند ومجتمعها وتقاليدها وطقوسها وعاداتها وواقعها السياسي والاجتماعي على غرار ما تمثله آداب لغاتها المتنوعة...كانت البداية الحقيقية لفن القصة في الهند باللغة الإنجليزية على أيدي "الثلاثة الكبار" الذين ولدوا في مطلع القرن العشرين وأتحفوا القراء بمآثر خالدة في فن الرواية باللغة الإنجليزية بالهند وهم "ملك راج آنند" (١٩٠٥-٢٠٠٤)، وآر كيه نارايان (١٩٠٦-٢٠٠١)، وراجا راؤ (١٩٠٨-٢٠٠٦)، ولكل منهم مزية خاصة في فن الرواية تميز بعضهم عن الآخر... وقد كان ملك راج آنند الذي اختاره كاتبنا الدكتور محمد عفان لدراسة أعماله أشدهم التصاقا بالمجتمع الهندي وأعمقهم تعبيرا عن قضايا ومشكلات وهموم الطبقات المهمشة في المجتمع الهندي خاصة طبقة المنبوذين وجور النظام الطبقي المتمثل في استغلال الطبقة الدنيا على أيدي الطبقة العليا في المجتمع الهندي...أهنأ الكاتب الدكتور محمد عفان على هذه الدراسة المهمة لأعمال عبقري الرواية الإنجليزية في الهند الذي لقب بجدارة شارلز ديكنز الهند لما أتى به من وصف دقيق وشامل للأحوال الاجتماعية ولاسيما للمهمشين والمستضعفين والمطحونين في المجتمع الهندي. لقد أتى المؤلف بدراسة شاملة ومسهبة لأعماله يستطيع القارئ من خلالها الإطلاع على مختلف أبعاد وجوانب أعماله وأحوال المجتمع الهندي في طور تحوله السياسي والاجتماعي قبيل استقلال الهند وبعده أيضا. لا يفوتني أن أشير إلى اللغة العذبة والأسلوب السلس الراقي الذي يتميز به هذا البحث العلمي، كما أن سردا موجزا لتطور الأدب الإنجليزي في الهند يضيف إلى قيمة الكتاب. آمل أن هذا الكتاب سوف يشكل حلقة مهمة في سلسلة الدراسات الأدبية عن الهند باللغة العربية.


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# Design Optimization of Permanent Magnet Synchronous Machine for Vertical Axis Wind Turbine using Gravitational Search Algorithm

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***Abstract*—This paper presents the design of permanent magnet synchronous machine (PMSM) used as a generator at medium speed in vertical axis wind turbine. The designed PMSM is used as inner rotor configuration. This paper addresses optimization of objective function as weight of PMSM, which is a paramount aspect using proposed designs and compares their performance indices using different approaches such as gravitational search algorithm (GSA) and its hybridization with particle swarm optimization (PSO).The formulated optimization problem is programmed in MATLAB and results using GSA and GSA-PSO have been obtained and compared in detail. The GSA-PSO provides better results at reduced weight with increased efficiency and minimum regulation.**

***Keywords—Wind energy conversion system; permanent magnet synchronous machine; Gravitational Search Algorithm and vertical axis wind turbine.***

## NOMENCLATURE

$P_{shaft}$= shaft power (watts)
$\rho_{air}$= density of air (kg.m$^{-3}$)
$R_{blade}$= blade radius (m)
U= wind speed (m/sec)
$C_p$= turbine power coefficient
$\lambda$= tip speed ratio
$w_r$= angular frequency (radians/sec)
$T_{shaft}$ = shaft torque (N-m)
$B_g$= magnetic specific loading (wb/m$^2$)
$S_r$= electrical loading (AT)
S= number of slots
n= speed (rps)
D= diameter. (m)
L= length of the core (m)
$B_{av}$= average air gap flux density(wb/m$^2$)
$b_p$= pole arc
$\tau_p$= pole pitch
$V_a$= peripheral speed
$L_i$= net iron length (m)
$b_s$= slot width (m)
$N_{st}$= number of slots
$A_s$= area of slots (m$^2$)
$h_{tt}$= height of tooth (m)
$h_y$= height of yoke (m)
$F_{pc}$= cross section area of pole core (m$^2$)
$F_{py}$= cross section area of pole yoke (m$^2$)
$d_{shaft}$= diameter of the shaft. (m)
$d_p$= width of pole/diameter of round pole.
$h_{pcs}$= height of pole core shoe. (m)
$T_m$= thickness of the magnet (m)
$l_g$= airgap length (m)
$\tau_s$= slot pitch (m)
$w_s$= sloth width(m)
f= frequency (hz)
$T_{ph}$= turn per phase
$K_c$= cording factor
$K_d$ = distribution factor
$K_w$= winding factor
Q= output of a machine KVA
$C_o$= output coefficient
$D_o$= outer radius (m)
$B_t$= maximum flux density in tooth (wb/m$^2$)
$W_T$= weight of machine (kg)
$W_s$= weight of stator (kg)
$W_r$= weight of rotor (kg)
$F_{ij}$= force between agent i and j
G(t)= gravitational constant
$R_{ij}(t)$= Euclidian distance between two agents *i* and *j*.
$a_i$= acceleration
X(i)= position vector
V(i)= velocity vector
$\eta$= efficiency
$R_{eg}$= regulation
T=temperature ($^o$C)

## I. INTRODUCTION

Despite of thermal, hydro, nuclear energy the world seems to be under crises for electrical energy, another factor which is more critical is the environmental concerns. The scientists are keen to find out the alternate ways to reduce the use of conventional fuels to produce electrical energy and increase the use of clean energy. Among all, wind energy has given hope to the utility as the base units. A number of efforts have been made to increase the power generation using wind energy. Recently small-scale wind energy conversion systems have been installed at on-shore and off-shore locations [1-4]. Permanent magnet synchronous machine (PMSM) are used in small-scale and medium-scale for generation of power because of its high efficiency, high power factor, flexibility in design and no use of external supply for excitation [5-6]. Due to these advantageous features of PMSM, its use has been increased day by day. Apart from the choice of PMSM for power industries, it

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by

**Dr. Layaqat Naiyer**

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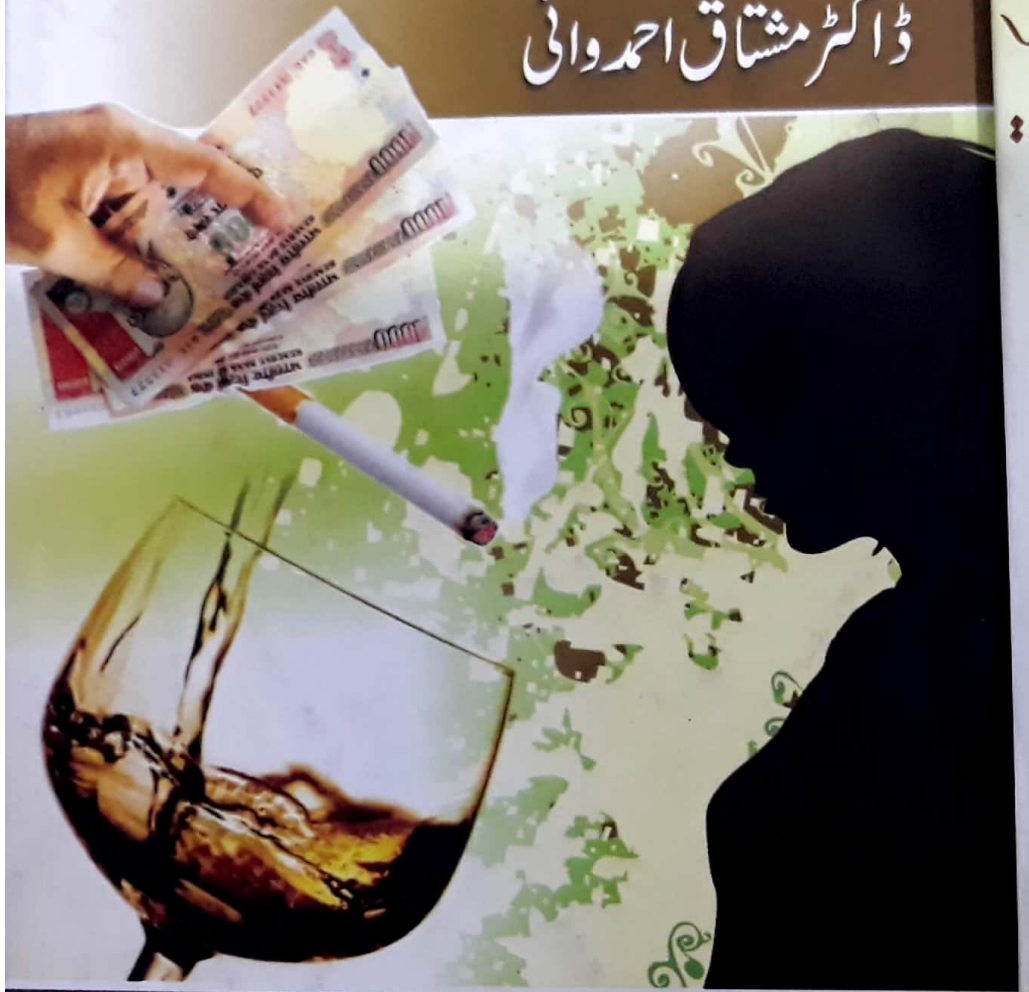

# اندر کی باتیں (افسانے)

اندر کی باتیں (افسانے)

ڈاکٹر مشتاق احمد وانی

EPH

# ANDAR KI BATEIN
(Short Stories)
by
Dr. Mushtaq Ahmed Wani

مشتاق احمد وانی جتنا اچھا مومن ہے اتنا ہی کھرا افسانہ نگار بھی ہے اس کی افسانوی کارگزاری صرف اس کے آبائی صوبے جموں کشمیر تک ہی محدود نہیں بلکہ ہندوستان بھر میں رسائل وجرائد کے وسیلے سے پھیلی ہوئی ہے! مشتاق کے ہاں کہانی پن شروع تا آخر موجود رہتا ہے جس کی وجہ سے قاری اُس کے افسانے کی روح تک پہنچ جاتا ہے! وہ مجرّد اور مبہم، استعاروں سے پرہیز کرتا ہے! اپنے قاری کو گنجلک اور بے کیف پہیلیاں نہیں بجھاتا! مشتاق وانی صرف اُنہیں موضوعات کا انتخاب کرتا ہے جن کا علاقہ ہماری زمین اور انسانی زندگی سے استوار ہوتا ہے! زندگی کے مختلف شعبہ جات میں برپا سیاسی ومعاشی بدعنوانیوں کے زہر کو وہ آتی قطرہ قطرہ اپنے روح وقلب میں اتارتا ہے! جب موضوع اپنی تمام تر جزئیات کے ساتھ اُس پر روشن ہوجاتا ہے تب اس کی افسانوی ادائیگی کے لئے وہ اسلوب اور الفاظ تلاشتا ہے! وانی کے افسانوں میں عام آدمی کے خوں چکاں تجربات ومشاہدات اس طور اجاگر ہوتے ہیں جیسے وانی نے ان کو اپنے حساس وجود پر خود بھوگا ہوا ہو!! مشتاق وانی کے افسانوں کا اختتامیہ ایک خوبصورت نظم ایک خوبصورت شعر کی طرح ہمیں چونکاتا ہے اور اس کا افسانہ تادیر وجدان میں محفوظ رہتا ہے۔

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# اندر کی باتیں

(افسانے)

ڈاکٹر مشتاق احمد وانی

ایجوکیشنل پبلشنگ ہاؤس، دہلی ۶

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# OFDM: Basic Concepts, Scope & its Applications

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***Abstract*—**Orthogonal frequency division multiplexing (OFDM) is a special case of multicarrier transmission where a single DataStream is transmitted over a number of lower rate subcarriers. In July 1998, the IEEE standardization group decided to select OFDM as the basis for their new 5-GHz standard aiming a range of data stream from 6 up to 54 Mbps. This new standard is the first one to use OFDM in packet-based communications. In wireless communication, concept of parallel transmission of symbols is used to achieve high throughput and better transmission quality. Orthogonal Frequency Division Multiplexing (OFDM) is one of the techniques for parallel transmission. The idea of OFDM is to split the total transmission bandwidth into a number of orthogonal subcarriers in order to transmit the symbols using these subcarriers in parallel. In this paper we will discuss the basics of OFDM techniques, role of OFDM in this era, its benefits and losses and also some of its application.

***Keywords*—** Orthogonal frequency division multiplexing(OFDM); BER; ISI; PAPR; DVB; DAB.

## I. INTRODUCTION

With the increase of communications technology, the demand for higher data rate services such as multimedia, voice, and data over both wired and wireless links is also increased. New modulation schemes are required to transfer the large amount of data which existing techniques cannot support. These techniques must be able to provide high data rate, allowable Bit Error Rate (BER), and maximum delay. Orthogonal Frequency Division Multiplexing (OFDM) is one of them. OFDM has been used for Digital Audio Broadcasting (DAB) and Digital Video Broadcasting (DVB) in Europe, and for Asymmetric Digital Subscriber Line (ADSL) high data rate wired links. OFDM has also been standardized as the physical layer for the wireless networking standard 'HIPERLAN2' in Europe and as the IEEE 802.11a, g standard in the US, promising raw data rates of between 6 and 54Mbps. Orthogonal Frequency Division Multiplexing (OFDM) is a digital transmission method developed to meet the increasing demand for higher data rates in communications which can be used in both wired and wireless environments [1].

### *A. What is OFDM?*

Orthogonal frequency division multiplexing (OFDM) is a widely used modulation and multiplexing technology, which has become the basis of many telecommunications standards including wireless local area networks (LANs), digital terrestrial television (DTT) and digital radio broadcasting in much of the world. In the past, as well as in the present, the OFDM is referred in the literature as Multi-carrier, Multi-tone and Fourier Transform. The OFDM concept is based on spreading the data to be transmitted over a large number of carriers, each being modulated at a low rate. The carriers are made orthogonal to each other by appropriately choosing the frequency spacing between them. A multicarrier system, such as FDM (aka: Frequency Division Multiplexing), divides the total available bandwidth in the spectrum into sub-bands for multiple carriers to transmit in parallel. [2] It combines a large number of low data rate carriers to construct a composite high data rate communication system. Orthogonality gives the carriers a valid reason to be closely spaced with overlapping without ICI [3].

### *B. Why OFDM?*

In contrast to conventional Frequency Division Multiplexing, the spectral overlapping among subcarriers are allowed in OFDM since orthogonality will ensure the subcarrier separation at the receiver, providing better spectral efficiency and the use of steep band pass filter was eliminated. OFDM transmission system offers possibilities for alleviating many of the problems encountered with single carrier systems. It has the advantage of spreading out a frequency selective fade over many symbols. This effectively randomizes burst errors caused by fading or impulse interference so that instead of several adjacent symbols being completely destroyed, many symbols are only slightly distorted. This allows successful reconstruction of majority of them even without forward error correction. Because of dividing an entire signal bandwidth into many narrow sub bands, the frequency response over individual sub bands is relatively flat due to sub band are smaller than coherence bandwidth of the channel. Thus, equalization is potentially simpler than in a single carrier system and even equalization may be avoided altogether if differential encoding is implemented.

### *C. Principle of OFDM*

In digital communications, information is expressed in the form of bits. The term symbol refers to a collection, in various sizes, of bits [4]. OFDM data are generated by taking symbols in the spectral space using M-PSK, QAM, etc, and convert the spectra to time domain by taking the Inverse Discrete Fourier Transform (IDFT). Since Inverse Fast Fourier Transform (IFFT) is more cost effective to implement, it is usually used instead [3]. The main features of a practical OFDM system are as follows:

- Some processing is done on the source data, such as coding for correcting errors, interleaving and mapping of bits onto symbols. An example of mapping used is QAM.



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