International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 3, Issue 3, March 2016

DAWN Algorithm for Cellular Data Usage on the Quality of Service (QOS) Requirements of the Applications

[1]V.Rajanaik [2] B. Neelima [3] A.Rajani
[1]M. Tech Student (DSCE), [2][3]Assistant professor,
Annamacharya Institute of Technology and Science (AITS)
[1]sv.rajanaik92@gmail.com, [2] bittiguntaneelima@gmail.com, [3]rajanirevanth446@gmail.com

Abstract: **The Wi-Fi offloading with delay-tolerant applications under usage based pricing is the major problem in cellular data usage. We aim to achieve a good tradeoff between the user's payment and its QoS characterized by the file transfer deadline. A general *D*elay-*A*ware *W*i-Fi Offloading and Network Selection (DAWN) algorithm for a general single-user decision scenario was used. We then analytically establish the sufficient conditions, under which the optimal policy exhibits a threshold structure in terms of both the time and file size. As a result, we propose a monotone DAWN algorithm that approximately solves the general offloading problem, and has a much lower computational complexity comparing to the optimal algorithm. Simulation results show that both the general and monotone DAWN schemes achieve a high probability of completing file transfer under a stringent deadline, and require the lowest payment under a non stringent deadline as compared with three heuristic schemes.**

***Index Terms*— Mobile data offloading, cellular and Wi-Fi integration, dynamic programming, threshold policy.**

I. INTRODUCTION

3G cellular networks are currently overloaded with data traffic generated by various bandwidth-hungry smartphone applications, especially in metropolitan areas [9]. although several cellular operators have already upgraded their networks to lte (4g) for higher capacity, the traffic demand from end-users also continues to increase. mobile data offloading may relieve this problem by using complementary communication technologies (considering the increasing capacity of wi-fi) to deliver traffic originally planned for transmission over cellular networks. although wi-fi has been shown to be promising for mobile data offloading in wiffler [1] and by lee et al. [13], there are still several challenging issues when offloading mobile traffic for smart phones. first, wiffler [1] is designed for pcs (e.g., net books) on vehicular networks without considering the offloading energy consumption. lee et al. [13] evaluate the energy saving of offloading through a trace-driven simulation with several simplified assumptions, but how to harvest the energy gain of mobile data offloading in practice is still an open problem. second, through our extensive war-driving and war-walking measurements using smart phones in three cities of us and europe, we found that the number of open accessible wifi access points (aps) is very limited. therefore the schemes using only open aps as in wiffler [1] may not be enough. finally, the goal of previous work is to increase the amount of delay-tolerant data traffic that can be offloaded to wi-fi networks. however, delay-tolerant applications generate only a small amount of data traffic, compared to streaming applications [16]. to address the above challenges, we propose mad net, a collaborative mobile data offloading architecture for smart phones. the main design principle of mad net is to extend smart phone battery life. according to our measurements, transferring the same amount of data may consume more energy on a low throughput wi-fi network than transferring over a high speed 3g accesses. if a scheme only aims to increase the offloaded traffic to wi- fi networks without considering the energy consumption on smart phones, it may drain the battery much faster than using only 3g networks. furthermore, due to the limitation of wi-fi antennas deployed on existing smart phones, offloading mobile data traffic for smart phones is much more challenging than that for pcs. to compensate such existing restrictions, a dedicated scheme is needed.

II. LITERATURE SURVEY

M. H. Cheung and j. Huang, proposed optimal delayed Wi-Fi offloading, [1]mobile data offloading through complementary network technologies such as wifi and femtocell can significantly alleviate network congestion and enhance users' qos. In this paper we consider a market where mobile network operators (mnos) lease third-party deployed wifi or femtocell access points (aps) to dynamically offload the traffic of their mobile users. We assume that each mno can employ multiple aps and each ap can concurrently serve traffic from multiple mnos. We design an iterative double auction mechanism that ensures the efficient operation of the market, where mnos maximize their offloading benefits and aps minimize their offloading costs. Such a mechanism incorporates the special characteristics of the wireless network, such as the coupling of mnos' offloading decisions and aps' capacity constraints. The proposed market scheme does not require full information about the mnos and aps, incurs minimum communication overhead, and creates nonnegative revenue for the market broker.

Cisco visual networking index: global mobile data traffic forecast update cisco systems, san francisco, ca, usa, white paper, feb. 2014 [2]. This article quantifies the global carbon footprint of mobile communication systems, and discusses its ecological and economic implications. Using up-to-date data and life cycle assessment models, we predict an increase of co2 equivalent emissions by a factor of three until 2020 compared to 2007, rising from about 86 to 235 mto co2e, suggesting a steeper increase than predicted in the well-known smart2020 report. We provide a breakdown of the global carbon footprint, which reveals that production of mobile devices and global radio access network operation will remain the major contributors, accompanied by an increasing share of emissions due to data transfer in the backbone resulting from rising mobile traffic volumes. The energy bill due to network operation will gain increasing importance in cellular business models. Furthermore, technologies to reduce energy consumption are considered a key enabler for the spread of mobile communications in developing countries. Taking into account several scenarios of technological advancement and rollout, we analyze the overall energy consumption of global radio access networks and illustrate the saving potential of green communication technologies. We conclude that, conditioned on quick implementation and alongside other "classical" improvements of spectral efficiency, these technologies offer the potential to serve three orders of magnitude more traffic with the same overall energy consumption as today.

L. Gao, g. Iosifidis, j. Huang, l. Tassiulas, and d. Li, proposed bargaining-based mobile data offloading [3]. The unprecedented growth of mobile data traffic challenges the performance and economic viability of today's cellular networks and calls for novel network architectures and communication solutions. Data offloading through third-party wifi or femtocell access points (aps) can effectively alleviate the cellular network congestion in low operational and capital expenditure. This solution requires the cooperation and agreement of mobile cellular network operators (mnos) and ap owners (apos). In this paper, we model and analyze the interaction among one mno and multiple apos (for the amount of mno's offloading data and the respective apos' compensations) by using thew nash bargaining theory. Specifically, we introduce a one-to-many bargaining game among the mno and apos and analyze the bargaining solution (game equilibrium) systematically under two different bargaining protocols: 1) sequential bargaining, where the mno bargains with apos sequentially, with one apo at a time, in a given order; and 2) concurrent bargaining, where the mno bargains with all apos concurrently. We quantify the benefits for apos when bargaining sequentially and earlier with the mno, and the losses for apos when bargaining concurrently with the mno. We further study the group bargaining scenario where multiple apos form a group bargaining with the mno jointly and quantify the benefits for apos when forming such a group. Interestingly, our analysis indicates that grouping of apos not only benefits the apos in the group but may also benefit some apos not in the group. Our results shed light on the economic aspects and the possible outcomes of the mno/apos interactions and can be used as a roadmap for designing policies for this promising data offloading solution.

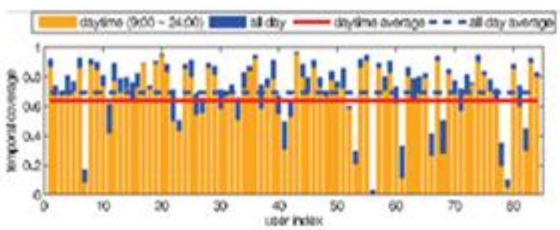
G. Iosifidis, l. Gao, j. Huang, and l. Tassiulas,[4] proposed a double-auction mechanism for mobile data-offloading markets. The unprecedented growth of mobile data traffic challenges the performance and economic viability of today's cellular networks, and calls for novel network architectures and communication solutions. Mobile data offloading through third party wi-fi or femtocell access points (aps) can significantly alleviate the cellular congestion, and enhance user quality of service (qos), without requiring costly and time-consuming infrastructure investments. This solution has substantial benefits both for the mobile network operators (mnos) and the mobile users, but comes with unique technical and economic challenges that must be jointly addressed. In this paper, we consider a market where mnos lease access points (aps) that are already deployed by residential users for the offloading purpose.

We assume that each mno can employ multiple aps, and each ap can concurrently serve traffic from multiple mnos. We design an iterative double auction mechanism that ensures the efficient operation of the market by maximizing the differences between the mnos' offloading benefits and aps' offloading costs. The proposed scheme takes into account the particular characteristics of the wireless network, such as the coupling of mnos' offloading decisions and aps' capacity constraints. Additionally, it does not require full information about the mnos and aps, and creates non-negative revenue for the market broker.

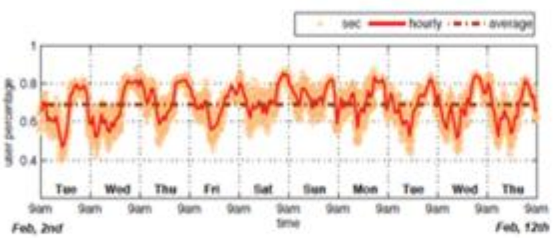
III. OFF-LOADING PROBLEM AND PERFORMANCE EVALUATION

Uses an application called dtap, that records wifi connectivity, and sends recorded data to servers. Scanned every 3 minutes for an ap. Records gps location as well as duration, data rate, and time.

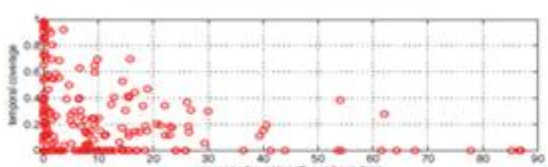
Fig. 1. Temporal coverage per user, time and hourly mobility



(a) Temporal coverage of users



(b) Temporal coverage of time



Does not perform offloading in and of itself. Why? Offloading for arbitrary data such as this drained too much battery. 97 volunteers who own iphone 3g/3gs in korea were asked to use dtap for a period of 18 days. Diverse occupational background and various major cities used. Collected 705 valid daily traces.

A. Offloading efficiency

With the findings and tracings, a simulation can be created. Using the simulation, offloading efficiency is defined as the total bytes transferred via wi-fi, divided by all the bytes generated. To further understand mobile traffic, projection data released from cisco is used.

The amount of traffic offloaded to wifi from a 3g network is then measured. Experiment assumes that all transfers of video and data are delayed. Surprisingly, on-the-spot offloading also achieves extremely high offloading efficiency. Furthermore, due to the above, if most mobile traffic is placed onto smart phones, 65% of data traffic can be offloading to wifi automatically. Why? Average users spend more time in wifi zones than traveling between them ala war-driving. With delayed added, offloading efficiency increases substantially. 100 seconds or less was negligible. Long deadlines can bring efficiency up to 88% admittedly unrealistic, as users may ignore delayed transfers and opt for on-the-spot only.

Parameters	**Video**	**Data**	**P2P**	**Audio(VoIP)**	**Total**
Ratio	64.0%	18.3%	10.6 %	7.1%	100%
Data/month	4.48 GB	1.28 GB	470 MB	500MB	7GB
Avg.IAT	1hour	2hrs	2hrs	1hour	-
Traffic vol.	10MB	5.7 MB	3.3 MB	1.1MB	-
Traffic dist	0.5	←	←	Expon-ential	-
On the spot	0sec	0sec	0sec	0sec	-
DL: Short	30min	30min	0sec	0sec	-
DL: Medium	1hour	1hour	0sec	0sec	-
DL: long	6hour	6hour	0sec	0sec	-

Table I
Accuracy measurements of different parameters

IV. MOBILE DATA OFFLOADING

Mobile data offloading, often known as wifi offloading is the use of complementary network technologies for delivering data originally targeted for cellular networks. Offloading reduces the amount of data being carried on the cellular bands, freeing bandwidth for other users. It is also used in situations where local cell reception may be poor, allowing the user to connect via wired services with better connectivity.

Rules triggering the mobile offloading action can be set by either an end-user (mobile subscriber) or an operator. The code operating on the rules resides in an end-user device, in a server, or is divided between the two. End users do data offloading for data service cost control and the availability of higher bandwidth. The main complementary network technologies used for mobile data offloading. It is predicted that mobile data offloading will become a new industry segment due to the surge of mobile data traffic.

V. CELLULAR-WI-FI INTEGRATION

Cellular and wi-fi radio technologies originated and evolved from two fundamentally different objectives. The former was motivated by the desire to make telephony technology mobile, and the latter by the desire to make data communications wireless. Over time, each has trended towards the other, with wireless data a central use of cellular technology today while over-the-top services provide voice over data networks. This confluence seems headed towards a fundamentally integrated cellular and wi-fi landscape, but the evolutionary nature of the trend has resulted in a broad variety of approaches and solutions. Significant advancements in data over wireless began to emerge in the early 1980s.

Interdigital helped pioneer this capability, with tdma access in a dsp-based implementation in the 1980s laying the technological blocks for the digital wireless revolution of the 1990's, followed by interdigital's wcdma system using cdma in channels as wide as 20 mhz to provide high-capacity fixed wireless access. With the introduction of the etsi's gsm system (a digital tdma system with dsp-based devices), the vision of ubiquitous connectivity was at last beginning to appear real. By the late 1990's, etsi and then 3gpp were already looking towards providing packet connectivity, first as the gprs "add-on" system to gsm and then, with umts (a cdma system), as a fundamental capability. At the same time a completely different vision of wireless access emerged. This vision was based on the success of local area networks – particularly ethernet – in connecting the enterprise "intranet" into a highly capable local network.

Using the "free-for-all" ism bands, first allocated by the us fcc in 1985, the ieee 802.11 working group began looking at taking the ethernet wireless. With no reliance on expensive licensed spectrum and fewer concerns regarding qos, wi-fi technology emerged as a strong consumer – and, increasingly, enterprise – wireless solution by the mid-2000s. The initial response from the cellular community was purely defensive. Rather than embracing and integrating the new technology, 3gpp embarked on a fundamental re-architecture of its system which resulted in a completely ip-based packet-focused evolved packet core (epc). Combined with ofdm based lte access technology, this was supposed to be the answer to the threat posed by wi-fi. The response from the wi-fi community to the customer demand for integration with mobile communication solutions was similarly lukewarm.

With the mip family of ip enhancement, ietf took the lead in trying to provide mobility support to ip-based systems such as wi-fi. However, the limited traction these protocols did find was in 3gpp where mip and pmip have been adopted as solutions for the epc. Until very recently the focus of the wi-fi community remained on delivering access to evergreater bandwidth (with 802.11n), while the need for qos management and mobility was completely ignored. That mutual defensiveness has now reversed, fuelled both by consumer demand regarding data to new device types and operator efforts to relieve network pressure. From the cellular side, small, localized cells, such as wi-fi ap coverage regions, are growing in importance. As an ip-based system, the epc is well positioned for integration of multiple heterogeneous access technologies and 3gpp is now moving towards taking advantage of epc to delivery solution for real integration of technologies such as wi-fi with andsf, an integrated policy-based management system for how devices access spectrum 3gpp has already taken a first step in that direction.

On the other hand, the wi-fi community has finally acknowledged that when using mobile devices (for example, the iphone), consumers expect to receive the same quality of service whether they use wi-fi, 3g or lte. By extension, wi-fi must provide operators with the tools to manage wi-fi networks in the same way that they can manage their own 3g or lte networks, and the recent hotspot 2.0 profile and the associated pass point certification program sees the wi-fi alliance beginning to move towards delivering such "carrier-grade" wi-fi solutions to the market.

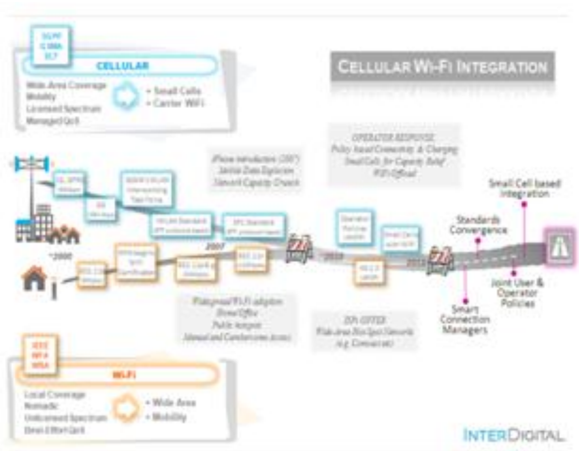


Fig. 1. Chronological developments in cellular/wi-fi integration

Finally, the trend towards true integration is beginning to come to the fore. The need is particularly acute in small cells – designed to address the high spectrum needs of local consumer and enterprise networks and hotspots. Thus, through its work on integrated femto-wi-fi (ifw), the small cells forum is already taking steps towards defining the near-future of such spectrum integration. What will this future hold? A combination of integrated small-cell solutions, smart connection management at the terminal, within a policy framework that provides management controls to both users and operators.

VI. DYNAMIC PROGRAMMING

Dynamic programming (usually referred to as dp) is a very powerful technique to solve a particular class of problems. It demands very elegant formulation of the approach and simple thinking and the coding part is very easy.. If the given problem can be broken up in to smaller.

a. There are two ways of doing this.

1.) Top-down : start solving the given problem by breaking it down. If you see that the problem has been solved already, then just return the saved answer. If it has not been solved, solve it and save the answer. This is usually easy to think of and very intuitive. This is referred to as memorization.

2.) Bottom-up: analyze the problem and see the order in which the sub-problems are solved and start solving from the trivial sub problem, up towards the given problem. In this process, it is guaranteed that the sub problems are solved before solving the problem. This is referred to as dynamic programming. Note that divide and conquer is slightly a different technique. In that, we divide the problem in to non-overlapping sub problems and solve them independently, like in merge sort and quick sort.

In case you are interested in seeing visualizations related to dynamic programming try this out. Complementary to dynamic programming are greedy algorithms which make a decision once and for all every time they need to make a choice, in such a way that it leads to a near-optimal solution. A dynamic programming solution is based on the principal of mathematical induction greedy algorithms require other kinds of proof.

VII. THRESHOLD POLICY

Thresholding is the simplest method of image segmentation. From a grayscale image, thresholding can be used to create binary images. The simplest thresholding methods replace each pixel in an image with a black pixel if the image intensity $i_{i,j}$ is less than some fixed constant t (that is, $i_{i,j}<t$), or a white pixel if the image intensity is greater than that constant. In the example image on the right, this results in the dark tree becoming completely black, and the white snow becoming complete white. Colour images can also be threshold. One approach is to designate a separate threshold for each of the rgb components of the image and then combine them with an and operation. This reflects the way the camera works and how the data is stored in the computer, but it does not correspond to the way that people recognize colour. Therefore, the hsl and hsv colour models are more often used; note that since hue is a circular quantity it requires circular thresholding. It is also possible to use the cmyk colour model.

VIII. CONCLUSION

In this paper, we studied the user-initiated wi-fi offloading problem for delay-tolerant applications under usage-based pricing. The user aims to minimize its total data usage payment, while taking into account the deadline of the file transfer. We first proposed a general dawn algorithm for the general case using dynamic programming. We then established sufficient conditions under which the optimal policy has a threshold structure in both dimensions *k* and *t*. As a result, we proposed a monotone dawn algorithm with a lower complexity that approximately solves the general offloading problem. It should be noted that the proposed algorithms are highly non-trivial, and they cannot be obtained simply by a standard application of dynamic programming.

Contrary to the practices in some heuristic schemes that favour offloading traffic to wi-fi networks whenever possible, our simulation results showed that it is not always optimal for a user to perform wi-fi offloading when the deadline requirement is stringent and the data rate in the cellular network is much higher than that in the wi-fi network (e.g. A 4g lte-a cellular system versus a congested wi-fi network). On the other hand, when the file transfer can be completed easily by the deadline, the delay-aware design in dawn and wiffler helps reduce the payment of the users. Overall, our results suggested that future cellular and wi-fi integration system should include dynamic offloading policies that take into account the users' qos and the real-time network loads, instead of using simplistic and static offloading policies. In this work, we have focused on the single file transfer by a given deadline. For future work, we will consider the case of multiple file transfers at the same time, and solve the problem by dynamic programming with additional states and decision variables.

REFERENCES

[1] M. H. Cheung and J. Huang, "Optimal delayed Wi-Fi offloading," in *Proc. 11th Int. Symp. WiOpt*, Tsukuba Science City, Japan, May 2013, pp. 564–571.

[2] " Cisco visual networking index: Global mobile data traffic forecast update, 2013-2018," Cisco Systems, San Francisco, CA, USA, White Paper, Feb. 2014.

[3] L. Gao, G. Iosifidis, J. Huang, L. Tassiulas, and D. Li, "Bargaining-based mobile data offloading," *IEEE J. Sel. Areas Commun.*, vol. 32, no. 6,pp. 1114–1125, Jun. 2014.

[4] G. Iosifidis, L. Gao, J. Huang, and L. Tassiulas, "A double-auction mechanism for mobile data-offloading markets," *IEEE/ACMTrans. Netw.*,2015, to be published. [Online].

[5] G. Eason, B. Noble, and I.N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529-551, April 1955. (*references*)

[6] "Wi-Fi roaming: Building on ANDSF and Hotspot2.0," Alcatel- Lucent British Telecommun., Boulogne-Billancourt, France, White Paper,2012.

[7] "Carrier WiFi opportunities: Enabling offload, onload and roaming," Disruptive Anal. Ltd., London, U.K., White Paper, Aug. 2011.

[8] "Mobile data offload & Onload: Wi-Fi, small cell & carriergrade strategies 2013-2017," Juniper Res., Basingstoke, U.K., Rep.,Apr. 2013.

[9] *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications—Amendment 9: Interworking With External Networks*,IEEE Std. 802.11u, Feb. 25, 2011.

[10] "Architecture enhancements for non-3GPP accesses," 3rd Generation Partnership Project, Sophia-Antipolis Cedex, France, TS 23.402. [Online]. Available: http://www.3gpp.org/ftp/Specs/html-info/23402.htm.

[11] "Integration of cellular and Wi-Fi networks," 4G Americas, Bellevue,WA, USA, White Paper, Sep. 2013.

[12] A. Balasubramanian, R. Mahajan, and A. Venkataramani, "Augmenting mobile 3G usingWiFi," in *Proc. ACM MobiSys*, San Francisco, CA, USA,Jun. 2010, pp. 209–222.

[13] K. Lee, I. Rhee, J. Lee, S. Chong, and Y. Yi, "Mobile data offloading:How much can WiFi deliver?" in *Proc. ACM CoNEXT*, Philadelphia, PA,USA, Nov. 2010, pp. 1–12.

[14] S. Sen, C. Joe-Wong, S. Ha, J. Bawa, and M. Chiang, "When the price isright: Enabling time-dependent pricing of broadband data," in *Proc. ACMSIGCHI*, Paris, France, Apr. 2013, pp. 2477–2486.

[15] S. Rayment and J. Bergstrom, "Achieving carrier-gradeWi-Fi in the 3GPPworld," Ericsson Rev., Stockholm, Sweden, 2012.

[16] N. Ristanovic, J.-Y. Le Boudec, A. Chaintreau, and V. Erramilli, "Energy efficient offloading of 3G networks," in *Proc. 8th IEEE MASS*, Valencia, Spain, Oct. 2011, pp. 202–211.

[17] M. H. Ngo and V. Krishnamurthy, "Optimality of threshold policies for transmission scheduling in correlated fading channels," *IEEE Trans. Commun.*, vol. 57, no. 8, pp. 2474–2483, Aug. 2009.

[18] M. L. Puterman, *Markov Decision Processes: Discrete Stochastic Dynamic Programming*. New York, NY, USA: Wiley, 2005.

[19] M. H. Cheung, R. Southwell, and J. Huang, "Congestion-aware network selection and data offloading," in *Proc. 48th Annu. Conf. Inf. Sci. Syts.*, Princeton, NJ, USA, Mar. 2014, pp. 1–6

[20] A.J. Nicholson and B. D. Noble, "BreadCrumbs: Forecasting mobile connectivity," in *Proc. ACM MobiCom*, San Francisco, CA, USA, Sep. 2008, pp. 46–57.

[21] D. Niyato, P. Wang, E. Hossain, W. Saad, and A. Hjorungnes, "Exploiting mobility diversity in sharing wireless access: A game theoretic approach," *IEEE Trans. Wireless Commun.*, vol. 9, no. 12, pp. 3866–3877,Dec. 2010.

Mr. S. V. Rajanaik, did his bachelor of Technology in Electrical and Electronics Engineering at Vaishnavi institute of technology (VIT), Tanapalli , and doing Master of Technology in Digital Systems and Computer Electronics (DSCE) in Annamacharya Institute of Technology & Sciences (AITS), Karakambadi, Tirupati, Chittoor, Andhra Pradesh, India.

[2]**Ms. B. Neelima** Obtained her B.Tech degree at Gokul Krishna College of Engineering, Sullurpeta and Master degree in JNTU, Ananthapur (JNTUA) in 2013. She is currently working as Assistant Professor in the Department of ECE, Annamacharya Institute of Technology & Sciences (AITS), Tirupati. Her research interests are in Digital Image processing and Signal Processing.

[3]**Ms. A. Rajani** Obtained her B.Tech at Chaitanya Bharathi Institute of Technology (CBIT), Gandipet, Hyderabad and Master degree in Sri Venkateswara University College of Engineering (SVUCE), Tirupathi. Persuing (Ph.D) in Sri Venkateswara University College of Engineering (SVUCE), Tirupathi. Her area of interest is Digital Image processing And Signal Processing. She has 7 years of teaching experience. She is currently working as Assistant Professor in the Department of ECE, Annamacharya Institute of Technology & Sciences (AITS), Tirupati. Her research interests are in Digital Image processing and Signal Processing.