

Arun K. Somani · Rajveer Singh Shekhawat ·  
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Vivek Kumar Verma *Editors*



# Smart Systems and IoT: Innovations in Computing

Proceeding of SSIC 2019

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Editors

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# Chapter 1

## Statistical Image Processing for Enhanced Scientific Analysis



Deepak Kumar

**Abstract** Image acquired through various sensors accrue multi-faceted distortions due to the failure of either sensor or platform and consequently, images get distorted. But for any kind of image analysis, it is a prerequisite that each image pixel should be refurbished. In recompensing these, image processing assists in image restoring to its best possible natural form. Recent image processing techniques have significantly advanced and are capable of removing any kind distortions. The present work exhibits the statistical image processing approach, which has been tested over the Landsat series of satellite image having data gaps of approximately 22% of the loss from the normal scene area that occurred due to the failure of Scan Line Corrector (SLC). The method has precisely estimated the missing values to fill the data gaps in the images for making more visually sensible and analytical. The results presented and authenticated the statistical processing approach as a potential tool for gap filling of lost pixels for the satellite imagery, which can enable more scientific usage of the acquired data sets.

**Keywords** Optical sensors · Sensor applications · Pixel · Statistics · Sensor signal processing and sensor fusion

### 1.1 Introduction

Satellite remote sensing deals a wide range of image data with diverse characteristics in terms of temporal, spatial, radiometric and spectral resolutions. An image of ‘superior quality’ refers to higher spatial or higher spectral resolution, which can only be obtained by more advanced sensors. Remotely sensed images can be useful for a lot of interpretations without any intervention for better quality of the images.

---

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Satellite imagery assists in creating a knowledge base to address issues with the usage of scientific analysis investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge [1]. It uses the analysis methods based on empirical or measurable evidence subject to specific principles of reasoning to analyze data acquired from satellites or ground-based platforms using statistical and image analysis software to solve regional, national, and global problems in areas of natural resource management, urban planning, and climate and weather prediction [2].

However, many of the times, satellite images could have distortions in terms of data gaps. In order to improve the capability of analysis of these satellite images, a different approach for image processing is required [3]. Therefore, it is necessary and very useful to process images with the proper approach to achieving gap-filled image data with higher spatial information. But it will have a severe effect on the image interpretation and consequent analysis if some of the pixels or pixel elements/ digital number (DN) in the acquired satellite images are missing. These missing pixels are referred as gaps, which influence the process of image classification and ultimately hinder the spatial information contained in the pixel [4]. To recognize each object or features depending on the presence of original pixel data, so to achieve this, the various methods/approaches have been used for remote sensing image processing but almost all the methods have some distress in the image.

Restoration of missing or damaged portions of images is an ancient technique consisting of filling in the lost areas or modifying the damaged ones in a non-detectable technique [5]. Earlier image processing utilized the traditional methods which include image sharpening, image smoothing, image rectification and image restoration, image enhancement but very less attention has been paid for the image restoration in context to missing pixels [6].

This satellite imaging processing is a prerequisite for producing seamless sharpened images with fewer distortions and data loss for the applications [5]. It also helps in image quality improvement for better pattern recognition, object detection, content-based retrieval approaches [7]. Geographic object-based image analysis (GEOBIA) moreover augment to scientific analysis work for further spatial analysis in conjunction with classification and feature extraction approaches [8]. Hence, the current approach was attempted to improve the eminence of image processing for gap filling techniques.

The recent method was tested with the processing of Landsat 7 image having a noise frame in the scene, which occurred due to the failure of SLC (Scan Line corrector) led to the stripping or missing of the scan line in the satellite image. The usage of the image was challenging, therefore, ways to repatriate the data gaps was taken up for the current research [9]. The current work also encompasses the understanding of image processing techniques for the images having missing pixels to provide the finer datasets for analysis.

## 1.2 Methodology

Gap filling of the satellite images can be classified as a single source, multi-source, and hybrid methods. Multi-source methods involve more than one image for reconstruction. Single-source methods use the same image information to fill gaps. The hybrid method combines both of the above approaches [10]. Processing of images utilizes the techniques of remote sensing technology for image and signal processing of optical datasets with conjunction to the image enhancement, image restoration, machine intelligence, data fusion techniques [11]. Several methods are now available for the image improvement, which are embedded conventionally into the remote sensing software package but these correction modules need to be customized and parameterized with the appropriate methods and values to deliver the required results after the image processing procedure.

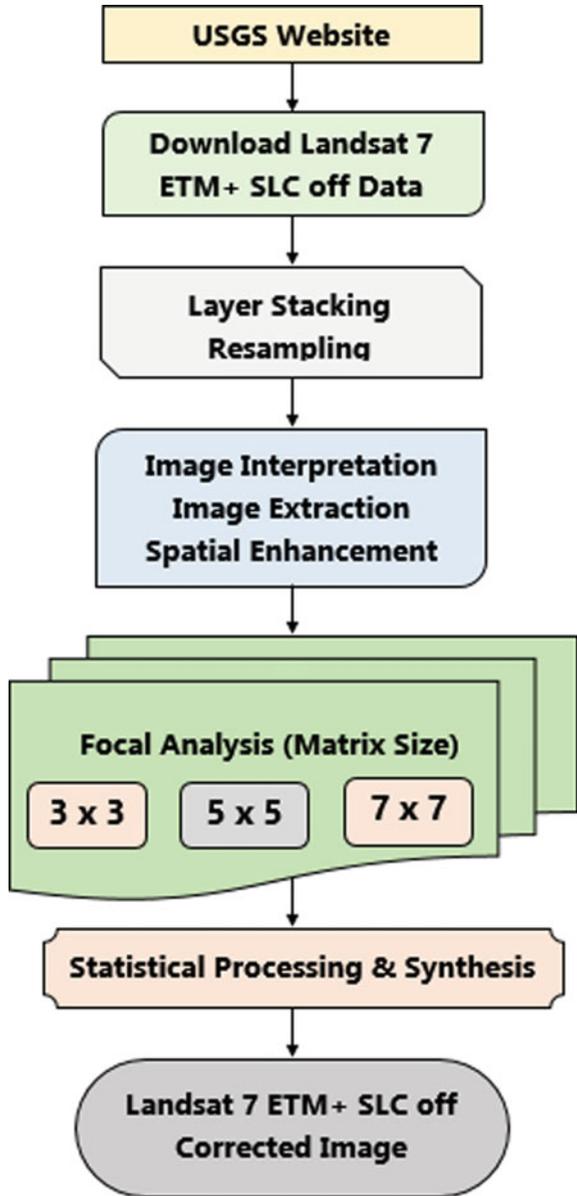
### A. Gap Filling of Landsat SLC-Off Single Scene

Figure 1.1 illustrates the procedure followed for statistical image processing. The method is intended to modify neighboring pixels in a single Landsat 7 SLC-off scene, creating a final corrected image, which can be used for scientific analysis. The method was adapted with the help of ERDAS Imagine software for initial image processing as well as for final filled image verification. Here, the idea was to apply different mathematical matrix functions in an iterative manner (depending on the loss of pixel in the raw image) for gap filling in the satellite images. After examining various functions, matrix sizes, and properties, the best technique and matrix size were adopted based on a statistical matrix report of the corrected image block. The current approach of statistical image processing for ETM+ images was tested for gap filling of the distorted image that occurred due to instrumentation error, losses of image data during transmission. Table 1.1 exhibits the scientific significance and spectral characteristics of the ETM+ sensor bands.

By manipulating imagery data values and positions, it is possible to see features that would not normally be visible and to locate geo-positions of features that would otherwise be graphical [12]. The current image processing method focused on performing image enhancement to develop operational methodologies for finer spatiotemporal satellite image dataset usability at a wider scale. Therefore, the link/pipeline between the end-users' requirements and the scientific community for facilitating the required quality of datasets must be established. The shaded regions in Fig. 1.2a exhibits the data losses and red rectangular boxes (i.e., at upper and lower parts) which are in red show the regions considered/used for computing the values of missing pixels/digital numbers (DNs).

Though, the synergistic use of statistical image processing methodologies may result in the possibility of solving complex problems related to the data gaps in the imagery acquired by various sensors but still some more comparative studies for multiple test areas must be done for validation of the results. Therefore, the present study is a footstep effort aimed for image restoration through the state-of-the-art statistical techniques of gap filling.

**Fig. 1.1** Overview of statistical processing of SLC-off Landsat ETM+ images for scientific analysis



**Table 1.1** Usability of Landsat 7 ETM+ different bands

Band	Spectral range ( $\mu\text{m}$ )	EMR region	Applications
1	0.45–0.52	Visible blue	Soil-vegetation discriminations, coastal water mapping
2	0.52–0.60	Visible green	Vegetation region assessment
3	0.63–0.69	Visible red	Chlorophyll absorption for vegetation
4	0.76–0.90	Near-infrared	Biomass assessment and water bodies differentiation
5	1.55–1.75	Middle infrared	Vegetation-soil moisture assessment and snow-cloud discrimination
6	10.40–12.50	Thermal infrared	Thermal mapping, soil moisture studies and plant heat stress studies
7	2.08–2.35	Middle infrared	Hydrothermal mapping
8	0.52–0.90	Near-infrared	Large area mapping, urban change studies

Source <http://www.landcover.org/data/landsat/>

Likewise, Fig. 1.2b exhibits the different filter sizes (i.e.,  $3 \times 3$  or  $5 \times 5$  filter) used for processing of the image having the data losses.

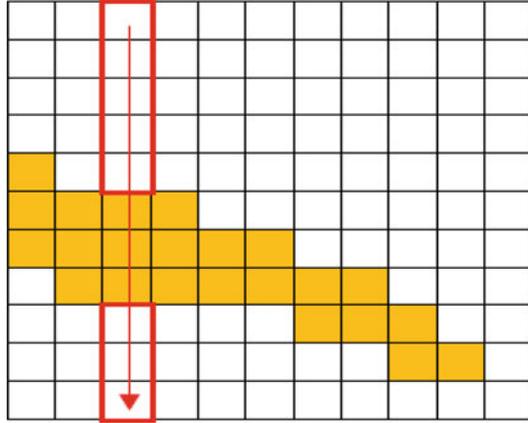
## B. Study Area and Dataset

To evaluate the performance of our proposed technique, investigation was performed on real Landsat ETM+ data of unscanned location (obtained from Landsat ETM+ data) for Kalaburagi (*erstwhile Gulbarga*) City, Karnataka province, India (*Row 048 Path 145 in World Reference System 2, around  $17^\circ\text{N}$  and  $76^\circ\text{E}$* ). The major land cover types in this area include agricultural fields, urban area, forest, and bare soil. Corresponding bands 1-5 and 7 were used in level L1T obtained from the USGS website (<http://glovis.usgs.gov/>). Figure 1.3a exhibits the original raw image of the study area and Fig. 1.3b shows the subset of the same scene to showcase the missing pixels in the image.

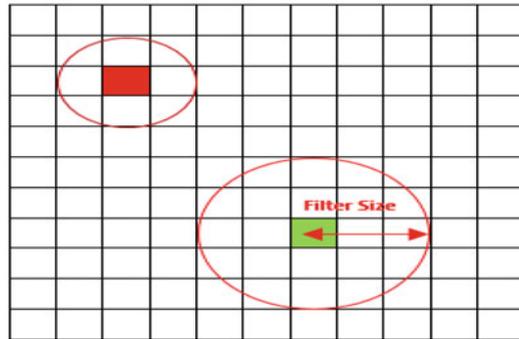
## C. Software Tools and Methods/ Technology

There are multiple systems/software for processing the satellites image using efficient algorithms to provide an enhanced image as an output. Commonly ERDAS Imagine (*a software application for satellite image processing*) is used to process the remote sensing data. For the current work, ERDAS Imagine 2014 were used for data processing, preparing and display of the enhanced digital images. It also facilitated to implement the various statistical techniques to augment several image processing algorithms.

**Fig. 1.2** Overview of statistical processing and synthesis. **a** Configuration for statistical image processing approach. **b** Matrix size for the statistical processing method



(a) Configuration for Statistical Image Processing Approach

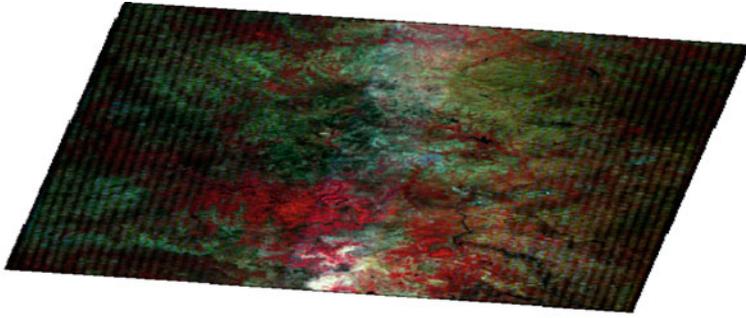


(b) Matrix size for statistical processing method

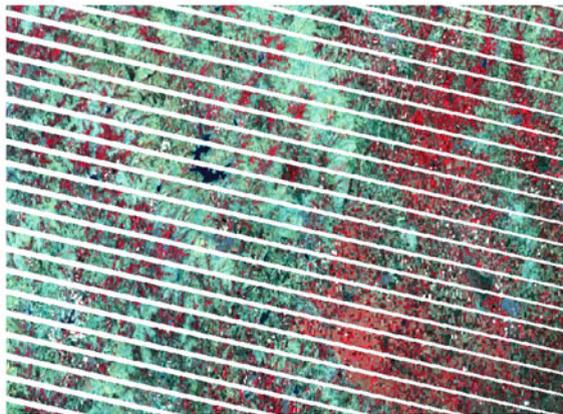
## 1.3 Results and Analysis

### A. SLC-Off Image (Raw Image)

Figure 1.4 illustrates the raw image (distorted) acquired from the SLC-Off Sensor). The majority of image processing techniques developed to overcome this setback were contingent upon the use of SLC-on as primary imagery. These techniques suffered for their unpredictable rendering of various factors which changed over time and were, therefore, unsuitable for many of the systems. Various algorithms for gap filling methods of satellite image suffer from sharp radical changes in images due to change in sun glint change, snow, cloud, etc. These algorithms were having the concern in terms of computational time. Therefore the requirement of the powerful technique was a prerequisite for larger as well as a small area having less computational time. Therefore, the current work attempted to avoid these drawbacks through the statistical image processing method to provide a high level of accuracy for correct-



(a) Original Scene of Gulbarga District (Path-145/Row-048)



(b) Part of Scene 145/048 of Gulbarga District

**Fig. 1.3** a Original scene of Gulbarga District (Path-145/Row-048). b Part of scene 145/048 of Gulbarga District

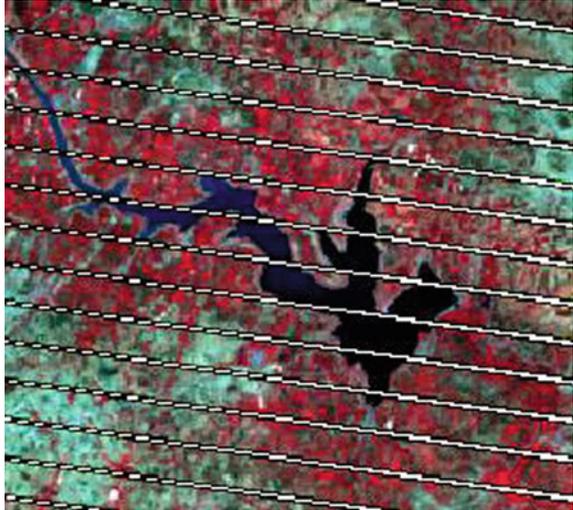
ing pixels from a single image via the techniques of one-dimensional interpolation and filtering.

## B. Processed Image

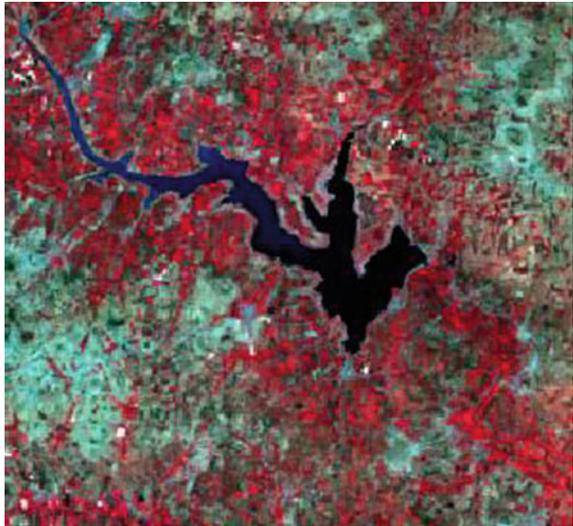
Figure 1.5 depicts the processed satellite obtained after statistical image processing of the raw image.

Figures 1.6a and 1.6b exhibit the transformation occurred at the pixel level of the satellite image. The statistically processed images were compared with original images for the pixel distribution and to calculate RMSE values between each image. An analysis of the coefficients of determination of two-dimensional correction results, in terms of the pixel distribution, demonstrates the variation in the pixel data values. Therefore, Fig. 1.6a exhibits the original pixel values or digital numbers

**Fig. 1.4** Distorted original raw image



**Fig. 1.5** Image after statistical processing



(DN) values in the distorted image and Fig. 1.6b depicts the values after applying statistical processing methods to the image.

0										
0	0	0	0							
0	0	0	0	0	0					
	0	0	0	0	0	0	0			
						0	0	0		
								0	0	

(a) Original DN (Pixel) matrix values in raw image

28										
35	32	51	89							
45	54	69	53	58	47					
	67	78	71	33	62	94	52			
						87	43	56		
								59	72	

(b) Altered DN (Pixel) matrix values in processed image

**Fig. 1.6** Illustration for conversions in image in DN matrix values. **a** Original DN (Pixel) matrix values in the raw image. **b** Altered DN (Pixel) matrix values in the processed image

## 1.4 Conclusion

People were working, in the past, on ways to improve the severely damaged image quality for using the images more efficiently. The idea worked at least to some degree, but very little attempt was made for retrospectively improving the damaged scenes. The metamorphosis of the proposed system over the conventional algorithm is the theory of the statistical approach being applied for the missing pixel value estimation guided by the adjacent value rather than the distance pixel. As the image restoration processes take place in pixel by pixel manner so the calculation of each pixel is dependent on adjacent pixels. In other words, the proposed concept generates one pixel using the functions among adjacent directly surrounding the empty location, whose value is almost equal to the value generated by the conventional bilinear interpolation algorithm. The trial outcomes presented more superior images after restoring the image gaps to resolve the inconsistencies of the image to be used in any scientific analysis. The simulated trial validated that the proposed approach (*statistical/focal analysis approach*) as a finer image restoration approach in both visual and statistical aspects.

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# Chapter 2

## Performance Analysis of Network with Different Queuing Mechanisms in TCP/FTP and UDP/FTP Scenario



Nehal Patel and Radhika Patel

**Abstract** Implementation, performance analysis, and network management are the leading issues in the vast field of computer. The choice of the several queues completely depends on the requirement of the broadcast of data. Safe and reliable propagation of data is an elementary obligation of a computer network. In the present situation, there is a strong necessity of calibration, testing, and extensive deployment of queue organization patterns in routers, which is liable for the enhancement of today's performance of the Internet. Queues presentation calculation needs a tangible research effort in the measurement as well as utilization of router workings, which developments to guard the Internet from drifts that are not adequately amicable to notification of congestion. In this paper, we assess the act of Drop Tail, RED, SFQ, and FQ by varying the queue size. We are representing the detailed performance analysis and comparison of the various queues in terms of throughput and packet loss.

**Keywords** NS2 · Drop tail · RED · SFQ · FQ · Packet drop · Queue size · Throughput

### 2.1 Introduction

The importance of Computer Networks and Internetworking layer has been tremendously increased in the recent decade. In the digitalized era of computer networks, sharing of information is only possible through networking where end-devices are connected via various links. But the transmission of the data packet in the network is carried out with the help of transport protocols. Among various transport protocols,

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TCP, i.e., Transmission Control Protocol is the most significant protocol consisting of perfect mechanism such as management of connections, error control, flow control, and congestion control.

The transportation of packets/message/information from any source to the desired destination through any medium at any instance of time entails a proper order of processes being done. Interface development is to be managed in order to complete a successful packet transmission [1].

Packets are being sent in the network through two mediums, namely, TCP/FTP sender and UDP/FTP sender. Analysis until the date delivers the knowledge that TCP/FTP sender technique for packet transmission is better. In TCP/FTP technique, TCP represents a protocol of transport layer and FTP is a protocol of application layer that represents traffic agent of a specific presentation through which TCP data is conduct [2].

TCP/FTP and UDP/FTP scenario offer reliable, bidirectional, and conforming characteristics. It has been found that the performance of the network differs according to the queuing mechanisms used. In this paper, the performance parameters such as packet delivery ratio and throughput are analyzed in NS2 using different queue management approaches in TCP/FTP and UDP/FTP scenarios. The next section describes all the queue management approaches in brief. In the remaining part, simulation environment and experimental results along with a conclusion and future work are described.

## 2.2 Queue Management Approaches

Queue management is expounded as the method which can manage the size of packet queues through packet dropping. It can be categorized into three groups [3] (Fig. 2.1).

### 2.2.1 *Passive Queue Management*

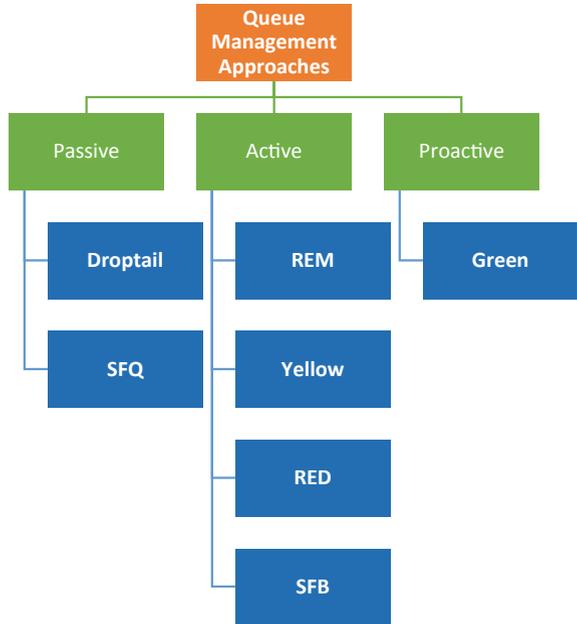
In PQM method, a router sustains a set of queues which holds packets for scheduling. For instance, Drop tail and Stochastic Fair Queuing [SFQ].

#### 1. **Drop Tail**

Drop Tail is a modest queue mechanism that is utilized by the routers. Whenever queue or buffer is full, then incoming packets are dropped till queue or buffer has an adequate vacuum to accept new packets. It is the most extensively used due to its simple implementation and quite a high efficiency.

Unfortunately, drop tail is having some problems such as lack out, full queue, bias against bursty traffic and global synchronization.

**Fig. 2.1** Types of queue management approaches



**2. SFQ**

SFQ queuing mechanism is established on the fair queuing procedure and suggested by John Nagle in 1987. It practices a hashing scheme that distributes the traffic above a restricted number of queues. SFQ allocates a pretty large number of First In First Out (FIFO) queues [4].

**2.2.2 Active Queue Management**

AQM queuing mechanism is dropping packets before the router’s queue is full. It is suggested to substitute a drop tail queue scheme in demand to increase network performance in relationships of link employment, system fairness, delay, and packet loss rate. There are many AQM algorithms like RED (Random Early Detection), SRED, REM (Random Exponential Marking), BLUE, SFB, etc. [6].

**A. REM**

It can achieve equally high consumption with minor packet loss as well as delay in a very modest and accessible way. The main idea is to decouple congestion measure from performance measure for instance delay, packet loss, and queue length [7].

## B. *YELLOW*

For managing the problem of congestion, yellow practices the load aspect, i.e., link usage as a chief virtue. Along with link utilization, a queue control function is familiarized to upgrade congestion control performance. Yellow leave behind the newly anticipated AQM procedures in relation to link consumption, packet loss as well as robust performance over widespread recreations [8].

Yellow algorithm practices the disparity among the input amount and link capability as the prime metric. Moreover, the queue dimension is considered as a subordinate metric. Queue dimension shakes the load issue consuming Queue Control utility, which is figured out by a nonlinear hyperbola function of instantaneous queue length and reference queue size [8]. Yellow delivers an early controlling queuing delay preserving the main load value. The average queue length and standard deviation of queue length of Yellow are slightly affected by UDP flows [8].

## C. *RED*

RED stands for Random Early Detection. It is an overcrowding prevention queuing contrivance, which is hypothetically useful, chiefly in high-speed transfer networks. It comes under the active queue managing mechanism. RED functions on the average queue size as well as drop packets on the source of statistics information. If the buffer is vacant all entering packets are accredited. The possibility of dumping a packet increases with the increase in the size of the queue. When the buffer is full probability and turns out to be 1 and all entering packets are dropped.

## D. *SFB*

SFB, i.e., Stochastic Fair BLUE is an innovative practice for guarding TCP flows in contradiction of nonresponsive flows consuming the BLUE algorithm. SFB is extremely ascendable and imposes equality using a tremendously minor quantity of state and a minor quantity of buffer space [9]. It is based on two self-governing algorithms, namely, BLUE queue management algorithm and bloom filters. This algorithm uses a solitary marking possibly to spot packets at the time of congestion. The probability of spotting increases linearly with congestion. The subsequent algorithm is built on bloom filters [1]. This algorithm allows for the distinctive grouping of objects through the usage of numerous, self-determining hash functions. By means of bloom filters, object classification can be complete with an awfully minor quantity of state information.

### 2.2.3 *Proactive Queue Management*

A proactive queue management (PQM) algorithm known as Generalized Random Early Evasion Network smears acquaintance of the steady-state performance of TCP connections to dropped packets perceptively and proactively. It prevents congestion from ever happening and guaranteeing a greater grade of equality between flows.