Improved Proportional Fair Algorithm for Transportation of 5G Signals in Internet of Medical Things

Asish B Mathews, G.GlanDevadhas

Abstract:The Internet of medical things (IoMT) is a hybrid network inwhich numerous technologies like Bluetooth, Wi-Fi, and Cellular technology are integrated on a single platform. The internet of things applied to the medical healthcare necessitates enormous data rate and tremendous bandwidth along with better battery life with reliable and versatile connectivity. The use of 5G network satisfies these prerequisite with its tremendous data rate capabilities and assists human health services diagnosis and treatment. In this paper, improved proportional fair algorithm is introduced and is compared with existing scheduling algorithm for developing revolutionary changes in the medical healthcare.5G networks represent a contemporary approach which encounter a hybrid digital network for developing Internet of things. Performance metrics considered for simulation studies are throughput, path-loss and SNR.

Keywords: 5G network, greedy algorithm, round robin algorithm and improved proportional fair.

I. INTRODUCTION

The medical healthcare indicates a set of medical standards which can incorporate much biomedical equipments such as sensing devices, diagnostic devices, real-time imaging, critical services and telemedicine technologies. The internet of medical things need enormous data rate and tremendous bandwidth for supporting 5g technology.The EO modulator, square-law detection, and fiber transmission have a nonlinearity property, so it distributes a nonlinear distortion in IM / DD systems. The performance of the system is wasted due to these properties, which overproduce the original signal on the receiving side. At present the communication systems has become necessary for various application of machine learning techniques. The 5G technology can aid to develop the medical infrastructure such as robotic surgeries with extra high reliability and very small latency.

Bandwidth, throughput and path loss are very important parameters in Internet of Medical things, without much compromise to connectivity and latency.Filter Bank Multi Carrier (FBMC) is used to linearly filter every subcarriers and Offset Quadrature Amplitude Modulation (OQAM) is used to mitigate the Inter Carrier Interference (ICI). This achieved higher spectrum efficiency and lower Out of Band Emission (OoBE).

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Yet the long filter acts as a hindrance in the usage of these waveforms in the cases of Internet of Things (IoT) applications and MTC. Filtered OFDM (f-OFDMA) localized the spectral waveforms thereby maintaining the interferences such as ISI and ICI within acceptable limits [1]. This f-OFDM provided 46% of throughput over traditional OFDM[22]. The advancement of f-OFDM helps in aggregating the seamless carrier sub-bands was described. It also achieved demonstrating gapless transmission of downlink and uplink signals over 6Gbps wireless and 20km fiber system.

Universal Filtered Multi Carrier (UFMC),alsocalled Universal Filtered Orthogonal Frequency Multiplexing (UF-OFDM) is employed for filtering the set of sub carriers which are set orthogonal to each other within the allowed sub-bands[2]. UFMC may not use Cyclic Prefix (CP) for preventing Inter carrier and intersymbol Interference (ISI). Therefore it is intricate to handle misalignments in time domain, causingleastperformance[23-26]. Filtered-Orthogonal Frequency Division Multiplexing (f-OFDM) is one of the types of OFDM based waveforms that deployed sub-band filtering 3f-OFDM deployed one CP per symbol in order to reduce spectrum efficiency especially when there is a requirement of short symbols which is quite similar to OFDM.

The fiber dispersion and nonlinear effects are key details of the rate-limiting factors in the existing optical communication systems[16], the ANN applications, and are referred to as the universal function approximate[17], for channel equalization is the majority preference for prodigious research attention[8]. The CP has been exceeded in[19] and numerous filters have been installed. A novel DSP is based on a bandwidth-efficient mobile front haul aggregation and de-aggregation technique. GFDM is a 5G waveform that depends on sub-band filtering to lower OoBE[20]. GFDM which can cover the 4G waveforms and can enhance the performance of waveforms. Existing methods like OFDM, F-OFDM have few defects like reduced performance in covering the extreme distance in the area which are densely populated and does not eliminate the dispersion and nonlinear effects proficiently [21].

Generalized Frequency Division Multiplexing (GFDM) is a 5G signal that relies on sub-band filtering to lower OoBE. GFDM has an ability to cover the 4G waveforms. GFDM has many pros in giving freedom to improve the performance of waveforms. Densification of users is in need of high speed data that led to the evolution of obtaining the maximum coverage area without losing the average data capacity[27-31].

Existing methods like OFDM, F-OFDM do not provide higher performance in covering the extreme distance in the largely populated areas. And also do not overcome the dispersion and non-linear effects effectively [4]. The essential concerns in the present IoT standards are the lack of required spectrum and exceedingly compatible transmission of regular communications [5,32]. Now a days, present trend shows negative scalability and do not guarantee provider delivery in huge scale community deployments.

Some researches proposed a new routing protocol named as Reliable on-demand routing protocol (RORP) to compute the running span between two connected nodes in the network by using mobility prediction [6,33-36]. It also makes use of GPS (Global Positioning System) to estimate the time duration. Initially, it explores the request region in search of new routes in the network. Whenever the routing protocol finds a broken link, then the routing path is disconnected[45-47]. This provides a back path for maintaining the route in case of broken routes.

The proposed GFDM uses microcells to reach the maximum coverage area compared to picocells and femtocells. A microcell is a unit that covers the area of 2km and it has a power control to reduce its range limits and specifications. It is smaller than picocells and helps in reaching maximum area with the support of GFDM [7,37-44].

II. PROPOSED TECHNOLOGY AND ALGORITHMS

In this section, the system proposed architecture is analyzed and discussed. Figure 1 shows the architecture of the proposed system. The proposed architecture contains three section, such as transmitter, wireless medium and receiver. Generalized Frequency Division Multiplexing (GFDM) signal is given to the transmitter side. The GFDM modulator is used to modulate the input signal. Greedy Algorithm, Round Robin or Improved proportional fair algorithm allocate the resources of the system. This modulated signal is converted into optical signal before being sent to the receiver using Radio over Fiber (RoF) based technique. Finally the signal is reconstructed with the help of GFDM demodulator. The GFDM signal is demodulated and the original message signal is retrieved.

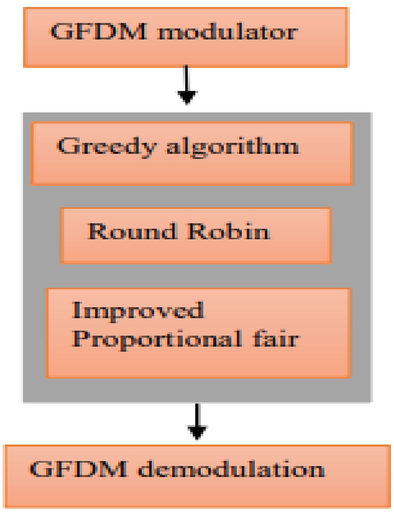

Fig 1: Proposed system model

A. Internet of Medical Things

Several Internet of Medical things requirements are pertinent to many reliable applications.

These requirements include:

•The high speed communication load is minimized.

• Support diverse platforms.

• Technology for controlling congestion.

• Access of various real time communication resources

• Reliability

All these system specifications and requirementsare done with reference to IEEE 802.11p.

B. Round Robin Scheduler

At each instant, a scheduling policy chooses among the set of all active instances exactly one instance for being executed on the processing unit. The idea presented is to define scheduling policies through a priority function, which gives the priority of every instance at any time t. The resource allocation rule is the Highest Priority First Rule which means that the scheduler will always select the pending job with the highest priority for being executed.

C. Greedy Algorithm

A novel greedy algorithm is of some degree of forward-looking method. In this algorithm, all the choices at the moment are evaluated more globally before the best one is selected. The greedy idea and enumeration strategy are both reflected in this algorithm, and we can adjust the enumeration degree so we can balance the efficiency and speed of algorithm.

D. Proposed GFDM Improved Proportional Fair

GFDM Improved Proportional Fair (GFDM Improved PF) is a scheduling algorithm, used in the context of GFDM system to successfully overcome the Successive Interference Cancellation (SIC) at the receiver's end. The PF scheduler treats the resource block independently and keeping the updates of the system in every time slots, However the performance of this scheduler is still limited because PF is not fully optimized for mobility. It can be seen when some user equipment (UE) in a mobility position the throughput will drop significantly with the increasing speed of the UE also it can still retain the fairness for the UE. Due to the issues, Improved PF scheduler will be developed which takes into account the channel conditions of all the users and redistribute the resources accordingly while maintaining significant fairness towards its users. Improved PF scheduler divides a single sub-frame into multiple time slots and allocates the resource block to each slot for targeted users on CQI feedbacks from UE. This algorithm maximizes the total throughput in the wired or wireless networks while permitting at least a minimal level of services to the users simultaneously. This algorithm outperforms other conventional algorithms like Greedy, Proportional Fair and Round Robin (RR). Improved PF allocates more resources to the users without relatively losing its quality in channels. It helps the GFDM system to provide better channel quality thereby covering long distance.

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This algorithm also offers higher throughput as well as satisfyingly good fairness.

The transmitter at sender's side provides the feasibility rate or channel rate to the every scheduled users. The conventional scheduling Improved PF algorithm monitors the average throughput of each users $T_k(t)$ at every window length. The scheduling slot for user K^+ can be expressed as:

$$K^+ = arg \underset{k}{max} \frac{R_k(t)}{T_k(t)} \quad (1)$$

E. Path Loss Model

Path loss is the main criteria in communication system. The path loss mainly depend upon the quality of the transmitted signals. The performance measures are evaluated by using these signals, which contain delay, throughput, and successful link probability. These metrics are based on the values of SNR and that eventually provide some loss of paths in the channels. The path loss model can be expressed using the following equations (2) and (3):

$$P_{los} = 20 \log d + 20 \log f + 20 \log(4\pi/C) + \eta_{los} \quad (2)$$

$$P_{nlos} = 20 \log d + 20 \log f + 20 \log(4\pi/C) + \eta_{nlos} \quad (3)$$

Where *d*- distance, *r*-radius given that $d = \sqrt{h^2 + r^2}$ and *f*-frequency of the system.

III. RESULTS AND DISCUSSION

The simulation results are obtained using MATLAB 2016a and Optisystem and the given input is an optical signal. GFDM signal is used in the proposed method to cover maximum distance without losing paths. These microcells are used to cover the region of ~2km thereby sending data to the receiver without losing considerable amount of paths. The performance curves for pathloss and throughput are also obtained where NOMA and GFDM Improved Proportional Fair (PF) outperforms others.

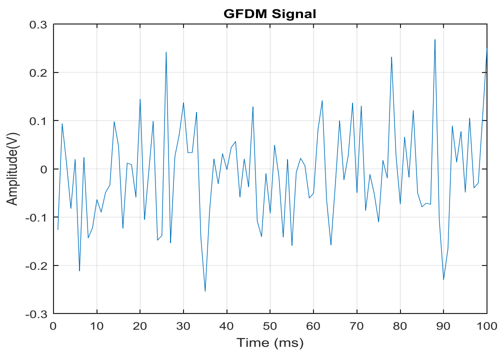

Figure 2 GFDM Signal

The input signal is given to the GFDM modulator where it modulates the signal to produce GFDM signal which is shown in the figure 2.

Figure 3 shows the comparison curve of frequency plotted against the path loss in decibels (dB).

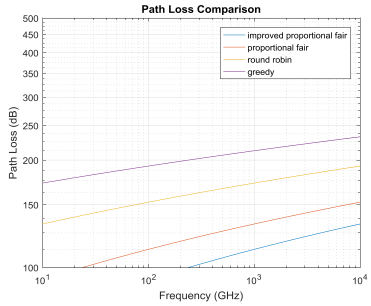

Figure 3 Path Loss Comparison

The proposed method uses Improved Proportional Fair (PF) to allot the resources with less path loss. Using Improved PF obtain better results compared to PF, Round Robin and Greedy algorithm applied on them. Improved PF is a scheduling algorithm and it allocates the resources and maintains the maximum throughput at the consistent intervals. Here, the data rates computed at each interval are inversely proportional to the resource consumption.

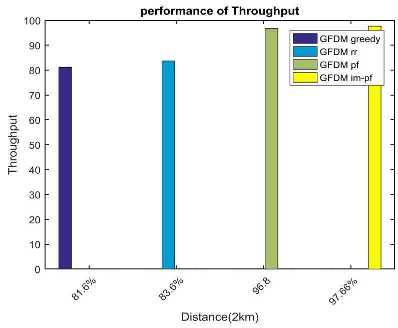

Figure 4 Performance Chart -Throughput

In figure 4, the throughput of GFDM system is analyzed. The throughput is computed for the distance of 2km. It is proved that the proposed GFDMImproved PF is a better technique in allocating the resources to the users and improves the performance of the system efficiently.

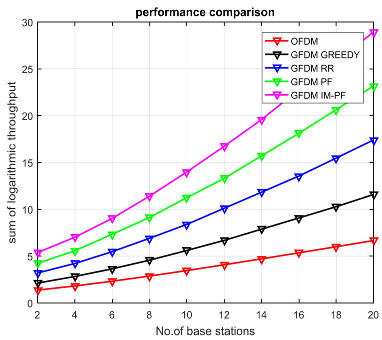

Figure 5 Comparison of different scheduling algorithms

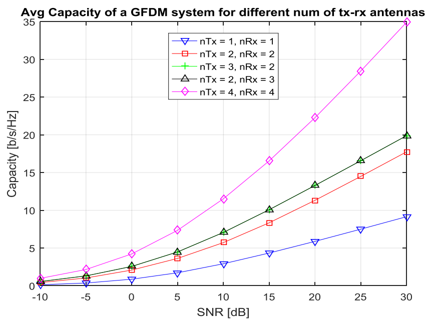

Fig. 6. Variation of capacity with respect to SNR

Figure 6 indicates the results showing sum of logarithmic throughput.

In this curve it is shown that, in Improved PF offers better performance. The results shows that improved proportional fair algorithm has reduced path loss compared to other scheduling algorithms. This concept relies on the fact that as path loss is reduced to a greater extent, the signal can be transmitted to a larger distance.

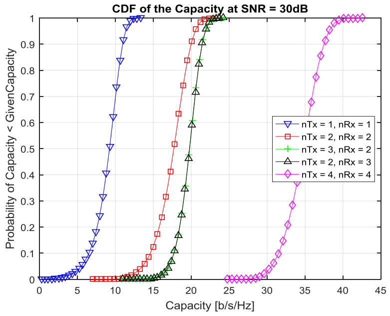

Fig. 7 Probability of capacity curve at SNR=30dB

In figure 7, it is indicated the various SNR values and the corresponding capacity for distinct number oftx-rx antennas. The results shows that eventhough the number of transmitters and receivers are increased, improved proportional fair algorithm shows enhanced capacity with considerable signal to noise-ratio.

IV. CONCLUSION

In this article, we provide an overview of the relevant 5G building blocks in the context of Internet of Medical things. The proposed Hybrid GFDM architecture uses microcells to cover a longer distance without losing the consistent data capacity. Various performance factors like throughput, path loss model, scheduling algorithms for allocating resources were also discussed and successfully evaluated. The obtained throughput performance of GFDM based Improved PF is 97.66% and this enhances the overall GFDM system's performance. It is proved that the proposed improved PF gives better results.

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