JPEG 2000.JP2 Image Transmission Using PSO Method OVER OFDM-Based Cognitive Radio Networks

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Abstract

Intellectual Radio is a proficient method for range usage since auxiliary clients with transfer speed requesting applications, for example, media can gain admittance to authorized recurrence assets entrepreneurial and resolve their transmission capacity restrictions. Among all interactive media positions, JPEG 2000.JP2 is an appropriate possibility for intellectual radio systems because of its remarkable highlights. In customary asset distributions for Cognitive Radio frameworks, all information bits are accepted similarly critical. Notwithstanding, unique parts of the JPEG 2000.JP2, piece stream have distinctive commitments to the nature of the got picture. In this way, in this undertaking, an unequal power assignment technique is utilized to allow the accessible capacity to the coded bits in light of their significance in the picture quality. Reenacted Particle swarm enhancement (PSO) is utilized to take care of the unequal power designation issue. Moreover, bits with higher noteworthiness are additionally ensured by utilizing sub-channels with better channel quality. In this way, the probability of critical bits being gotten effectively is expanded. The ideal arrangement is acquired by limiting the picture bending without disregarding the impedance imperative to the essential clients.

Key Words: Particle swarm optimization (PSO), JPEG 2000.JP2, cognitive radio.
1. Introduction

The quick advancements in innovation have made a wide range of uses accessible in a solitary portable handset, and mixed media applications are the most prevalent. The developing interest in remote picture and video transmission requires high information rate and solid transmission of sight and sound stream over serious channel conditions. Be that as it may, such administrations are transfer speed serious, and the time-fluctuating remote channels are shared by an immense number of clients. These issues alongside the aggregate power utilization confinements force challenges in keeping up brilliant got recordings and pictures. Examinations have demonstrated that an extensive segment of the authorized recurrence range is either totally unused or only here and there being used. Normally, a more compelling usage of the range is attractive. Intellectual radio (CR) has developed as an intense plan for unlicensed gadgets to utilize authorized groups under specific conditions, and the plan was endorsed by the Federal Communication Commission (FCC) in 2002.

The cross-layer arrange engineering of CN in is likewise named as Embedded Wireless Interconnection (EWI) rather than Open System Interconnection (OSI) convention stack. The CN engineering depends on another meaning of remote linkage. The new theoretical remote connections are reclassified as self-assertive common co-tasks among an arrangement of neighboring (nearness) remote hubs. In examination, customary remote systems administration depends on point-to-point "virtual wired-joins" with a foreordained match of remote hubs and allocated range.

This network architecture also has the following three primary principles:

**Functional Linkage Abstraction**

In view of the meaning of unique remote linkage, remote connection modules are actualized in singular remote hubs, which can set up various sorts of dynamic remote connections. As indicated by the utilitarian deliberations, classifications of remote connection modules can include communicating, unicast, multicast, and information accumulation, and so on. In this way, organize usefulness can be coordinated in the plan of remote connection modules. This likewise brings about two various leveled layers as the compositional rudiments, including the framework layer and the remote connection layer, individually. The base remote connection layer supplies a library of remote connection modules to the upper framework layer; the framework layer arranges the remote connection modules to accomplish viable application programming.

**Opportunistic Wireless Links**

In understanding the psychological remote systems administration idea, both the possessed range and the taking an interesting hub of a unique remote connection
are artfully controlled by their immediate availabilities. This standard chooses the plan of remote connection modules in the remote connection layer. The framework execution can enhance with bigger system scale since higher system thickness presents additional decent variety in the shrewd arrangement of any dynamic remote links. [10]

**Global QoS Decoupling**

Global application or system QoS (Quality of Service) is decoupled into nearby necessities of co-activities in neighboring remote hubs, i.e., remote connection QoS. All the more particularly, by decoupling worldwide application-level QoS, it permits the framework layer to better compose the remote connection modules that are given by the remote connection layer. For instance, by decoupling worldwide system level QoS, for example, throughput, end-to-end deferral, and postpone jitter, the remote connection module configuration can accomplish the worldwide QoS prerequisites. In view of the given remote connection modules, the intricacy at singular hubs can be free of the system scale. Remote connection modules give framework planners reusable open system reflections, where the modules can be separately refreshed, or new modules might be included into the remote connection layer. High particularity and adaptability could be basic for middleware or application advancements. EWI is additionally a sorting out style design, where the framework layer composes the remote connection modules (at the remote connection layer); and associate remote connection modules can trade module administration data by cushioning bundle headers to the framework layer data units.

Five sorts of remote connection modules were proposed, including communicated, distributed unicast, multicast, to-sink uni-cast, and information accumulation, individually. Other subjective kinds of modules might be included, setting up different sorts of unique remote connections without constraint. For instance, the communications module basically spreads information parcels to encompassing hubs. The distributed unicast module can convey information parcels from source to goal over numerous remote jumps. The multicast module sends information parcels to different goals when contrasted with distributed uni-cast. The to-sink uni-cast module can be particularly valuable in remote sensor systems, which uses higher abilities of information gatherers (or sinks), in order to accomplish better information conveyance. The information conglomeration module sharply gathers and totals the setting related information from an arrangement of nearness remote hubs.

The above works, in any case, have for the most part focused on the boost of the through pit of the framework under asset limitations with the suspicion that all data bits in the transmitted piece stream are similarly vital. Applying these plans to the transmission of versatile mixed media bitstreams brings about poor asset usage. Along these lines, a few endeavours have been made to address this issue. In this improved video gushing to abuse more channel assets for SI by building up an adaptable detecting transmission conspire. In a cross-layer
quality-mindful asset distribution calculation to streamline OFDM get to based (OFDMA-based) CR organize execution was proposed, by considering the flawed channel state data between the SI and PI. It additionally considers quality-mindful asset allotment utilizing the H.264/AVC standard. The examination in proposed a bit-mistake rate-driven (BER-driven) asset portion for adaptable piece streams over OFDMA frameworks, which can be connected to the CR systems with a few changes in the thought about limitations. In this task, we enhance the got picture quality in a CR framework by exploiting the versatile piece stream and unequal power distribution in two phases. The main stage streamlines the power distributed to the JPEG 2000 piece stream at the coding pass (CP) level to limit the aggregate got mutilation. The second stage utilizes subcarrier allotment, versatile regulation, and power change in accordance with meeting the impedance prerequisites, in view of channel conditions, and in the meantime keeps a similar through pit for the framework. This system is required to upgrade the picture quality since essential parts of the picture will be transmitted all the more dependable.

2. Problem Fixed in Existed Work

System model -1

The general framework square chart of the proposed conspire has appeared in Fig. 1, where the primary square encodes the info picture into the JPEG 2000 organization. In the JPEG 2000 coding process, first, the crude picture is apportioned into various rectangular non-covering squares which are alluded to as tiles. At that point, a discrete wavelet change (DWT) is connected to each tile to disintegrate it into sub-groups at various determination levels. The principal disintegration level has four sub-groups, \( LL1, LH1,1, \) and \( HH1 \). The low-recurrence sub-band, \( LL1 \), can be additionally decayed by applying DWT. Each sub-band is parcelled into rectangular squares called code squares (CBS). Next, quantization is connected to wavelet coefficients of each CB. Each CB is then decayed into various piece planes, various layers subject to target bit rate limitation of each layer. Each layer comprises of an enhanced blend of continuous CPs from each CB. The primary layer creates a low quality-quality of the picture and different layers improve the decoded picture quality. At any stage, the picture can be reproduced by truncation of these layers. The second square in Fig. 1 is the auxiliary data recovery unit, which removes the header data from the code stream. This data is thought to be transmitted blunder-free and gives data about the number of layers, CBS and CPs inside each CB. The following square plays out the unequal power distribution (UPA) streamlining calculation on the coded bit stream of the JPEG 2000 picture, where an ideal measure of intensity is assigned to each piece keeping in mind the end goal to limit the aggregate bending of the got picture. The yield of this square is a vector that contains the enhanced capacity to be designated to each piece in the code stream. A serial to parallel support separates the acquired vector into a few squares of size \( N \), where \( N \) is the number of subcarriers in the OFDM transmitter.
At high piece rates, ancient rarities turn out to be about intangible, so JPEG 2000 has a little machine-estimated loyalty advantage over JPEG. At bring down piece rates (e.g., under 0.25 bits/pixel for grayscale pictures), JPEG 2000 has a critical favorable position over specific methods of JPEG: ancient rarities are less obvious and there is no blocking. The pressure increases over JPEG are credited to the utilization of DWT and a more modern entropy encoding plan JPEG 2000 breaks down the picture into a numerous determination portrayal throughout its pressure procedure. This pyramid portrayal can be put to use for other picture introduction purposes past pressure.

![Diagram of JPEG 2000 compression process]

**Fig. 1: Annealing Method**

**Annealing Algorithm**

1. $P_{current} = P_{initial}$
2. $D_{current} = (current)$
3. $D_{min} = (initial)$
4. $D_{old} = 1010$
5. iter = 0
6. while (iter $\leq$ iter Max) do
7. $P_{new} = chooseRandomNeigh(\text{current})$
8. $P_{norm} = normal(\text{ew})$
9. $D_{new} = (orm)$
10. (ew $<$ Dmin)
    then
11. $P_{best} = P_{norm}$
12. $D_{min} = D_{new}$
13. endif
14. (ew $<$ Dcurrent) r (with certain probability)
15. $P_{current} = P_{norm}$
16. $D_{current} = D_{new}$
17. endif
18. iter++
19. if(remainder(iter 20)=20)
\begin{verbatim}
20 if (D_{new} - D_{old}) < 0.1
21 \text{}\text{iter} = \text{iter}_{max} + 1
22 \textbf{end if}
23 D_{old} = D_{new}
24 end while
\end{verbatim}

Power Calculation

\[ P_{\text{new}} = P_{\text{current}} + \left( \frac{\text{iter} - \text{iter}_{\text{max}}}{\text{iter}_{\text{max}}} \right) \times \frac{P_{\text{final}}}{L} \cdot z. \]

3. Channel Allocation and Power Adjustment in Sa Method

The motivation behind the divert portion obstruct in Fig. 3 is to additionally secure the critical JPEG 2000 bits by transmitting them over subchannels with higher quality. On the channel allotment square, subchannels with better conditions are doled out to the critical layers of JPEG 2000 picture. It can be seen from Eq. (7) that by expanding \( SP \), the forced impedance on the PU increments. In this way, the proportion amongst \( HSS \) and \( HSP \) can be a worthy portrayal of the channel condition. This proportion is utilized as a file to look at channel characteristics (higher proportion demonstrates better quality). We consider sub-channels with the proportion amongst \( HSS \) and \( HSP \) more prominent than a preset limit, \( r_{th} \), as "higher quality", and those with the proportion not exactly \( r_{th} \) as "lower channels. Amid each flagging period, information from the most vital layer of the JPEG 2000 bits stream is sent on "higher quality"

<table>
<thead>
<tr>
<th>Parameter</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbol duration, ( T_s (\mu s) )</td>
<td>4.0</td>
</tr>
<tr>
<td>Subcarrier’s occupied band width, ( \Delta f (MHz) )</td>
<td>0.3125</td>
</tr>
<tr>
<td>Primary user band width, ( BPU )</td>
<td>5.0</td>
</tr>
</tbody>
</table>

sub-channels and information from the less imperative layers are sent to bring down quality sub-channels. The above calculation has appeared in Table 1.

Since CSI is thought to be accessible at the season of transmission, after channel designation for each OFDM image, the power is balanced with the end goal that both channel blurring [20] and the breaking point on obstruction forced to the PU are considered. As demonstrated previously, the enhancement issue in Eq. (1) is figured under the suspicion of AWGN channel with no blurring. The impact of blurring, in any case, ought to be considered at the season of transmission. Power change unit adjusts for blurring by utilizing momentary estimations of the blurring factor from them-tap channels. The pay is performed
by separating the appointed intensity of each piece by the size of the channel coefficient comparing to the time interim in which the bit is transmitted. This division will increment or diminish the allocated capacity to each piece contingent upon whether the blurring factor is bigger or littler than solidarity, separately. A square blurring remote channel is considered for the transmission medium. Along these lines, we accept that the blurring coefficients stay steady amid each time interim, which joins preparing arrangement for channel estimation, criticism postponement, and transmission of information. Subsequently, once the negative impact of blurring is adjusted, the calculation executes in the same class as an AWGN transmission channel [20].

4. Proposed Work

Fig. 2: PSO Algorithm Flow Diagram
**Step by Step Process**

For each particle

- Initialize particle

Do until maximum iterations or minimum error criteria

- For each particle
  - Calculate Data fitness value
  - If the fitness value is better than pBest
    - Set pBest = current fitness value
  - If pBest is better than gBest
    - Set gBest = pBest

For each particle

- Calculate particle velocity
- Use gBest and velocity to update particle Data

**JPEG2000 for Wireless Applications (JPWL) scheme proposed to reduce the error in bit stream.**

The JPWL encoder scheme consists of three blocks such as JPEG 2000 Encoder, Error detection and error correction. The input image bits are encoded with JPEG 2000 encoder, The error correction process detects the occurrence of errors and corrects them whenever possible. The result is a JPWL code stream robust to transmission errors. Computationally in expensive in terms are of both memory requirements and speed. It requires simple mathematical operations.

**Block Diagram**

Here Adaptive M-array quadrature amplitude modulation (MQAM) is used to modulate the bit stream generated by the JPWL scheme. Modulation is the process by which a carrier wave is able to carry the message or digital signal (series of ones and zeroes).

Quadrature amplitude modulation (QAM) is a popular scheme for high-rate, high bandwidth efficiency systems. Cyclic Prefix is the addition of symbols to the prefix of a symbol, provided a guard interval to reduce inters symbol interference from the original symbol.
The basic concept behind the OFDM cyclic prefix is quite straightforward. The cyclic prefix performs two main functions.

- The cyclic prefix provides a guard interval to eliminate intersymbol interference from the previous symbol.
- It repeats the end of the symbol so the linear convolution of a frequency-selective multipath channel can be modeled as circular convolution, which in turn may transform to the frequency domain via a discrete Fourier transform.

The cyclic prefix is created so that each OFDM symbol is preceded by a copy of the end part of that same symbol. Different OFDM cyclic prefix lengths are available in various roots in the proposed method.

**Fig. 3: PSO Block Diagram**

**Provides robustness:** The addition of the cyclic prefix adds robustness to the OFDM signal, the data that is retransmitted can be used if required.

**Reduces inter-symbol interference:** The guard interval introduced by the cyclic prefix enables the effects of inter-symbol interference to be reduced.

## 5. Simulation Results

To assess the proposed method, a grayscale image of Lenna, with the size of $512 \times 512$ and 8 bit/pixel is used for transmission and the software is utilized as the JPEG 2000 image coder.

The image is processed with one level of decomposition and is divided into $64 \times 64$ CBs and $128 \times 128$ precincts. The final image has 3 layers with the same size. For the baseline scenario, 16 sub-carriers, one PU, and one SU are considered. Below fig shows the selected values for the model parameters based on the IEEE 802.11a standard.

The wireless channel is modelled as a frequency-selective channel with 2 multipaths. Each multipath is assumed to have Rayleigh-fading distribution with AWGN, and is independent of the other one.
The average peak signal to noise ratio (PSNR) at the SU receiver for various SNRs is used to indicate the decoded image quality. The PSNR (in dB scale) is related to the MSE by:

\[
\text{PSNR (dB)} = 10 \log_{10} \left( \frac{1}{MSE} \right)
\]

Here, the allocation period \( \tau \) is assumed to be the time needed for transmission of the entire image. As mentioned earlier, an adaptive MQAM is used for modulation.

The proposed PSO algorithm protects important bits by allocating them higher
powers, and the proposed channel allocation algorithm allows transmission of more importance bit streams through stronger sub channels. By combining them together, we get lower protection of less important bits and consequently a higher BER at low SNR. However, the PSNR is significantly higher for Scenarios 3 and 4. For SNR < 9 dB, the PSO algorithm has a preference to set the power of some less important CPs to zero in order to minimize the distortion of the received image. This leads to a BER of 50% for bits with zero power and consequently a higher average BER over all bits. The number of CPs with assigned power of zero is gradually decreased as the SNR increases.

Table 2: Improved Performance of PSO

<table>
<thead>
<tr>
<th>S no</th>
<th>Parameter</th>
<th>Value</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Symbol duration, $T_s$ (μs)</td>
<td>5</td>
<td>25%</td>
</tr>
<tr>
<td>2</td>
<td>Subcarrier’s occupied band width, $Δf$ (MHz)</td>
<td>0.36</td>
<td>50%</td>
</tr>
<tr>
<td>3</td>
<td>Primary-user of bandwidth, $BPU$</td>
<td>4</td>
<td>-25%</td>
</tr>
</tbody>
</table>

Fig 7 explains that (a) is the original image and (b) is full channel bandwidth available time (c) is proposed image when channel at busy time (BW is less)

References


