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Research Article

The Novel Microwave Stop-Band Filter

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The stop-band filter with the new band-rejection element is proposed. The element is a coaxial waveguide with the slot in the centre conductor. In the frame of this research, the numerical and experimental investigations of the amplitude-frequency characteristics of the filter are carried out. It is noted that according to the slot parameters the two typical resonances (half-wave and quarter-wave) can be excited. The rejection band of the single element is defined by the width, depth, and dielectric filling of the slot. Fifth-order Chebyshev filter utilizing the aforementioned element is also synthesized, manufactured, and tested. The measured and simulated results are in good agreement. The experimental filter prototype exhibits the rejection band 0.86 GHz at the level −40 dB.

1. INTRODUCTION

Review of the microwave filters technology, applications perspective, as well as filter designs is described in [1]. The narrow-band tunable filters are usually realized by using the rectangular waveguide with the dielectric resonator [2] or microstrip resonators [3]. In order to provide the wideband filter, the resonators with low Q-factor such as the ring resonator with direct-connected orthogonal feed lines [4] or coplanar stripline resonators [5] are applied.

The slot resonator as a basic element of the microwave filter has been proposed earlier in the paper [6]. The main advantages of this resonator are the small sizes, the simplicity of manufacturing, as well as a possibility of its natural integration into the coaxial line. In this paper, the slot resonators on the TEM waves are used in designing the stop-X-band filter.

The paper is organized as follows. In Section 2, the different designs of the band-rejection element as well as the EM field distributions in the slot are considered. Furthermore, the behavior of the resonance frequency and the loaded Q-factor is studied depending on the slot dimensions. The results of experimental investigations of the rejection filter with a single slot are discussed in Section 3 and point to the capability of developing the more complicated filter designs. Section 4 is devoted to the synthesis and experimental investigations of the Chebyshev rejection filter prototype.

2. BAND-REJECTION ELEMENT

Schematic view of the novel band-rejection element is presented in Figure 1. The band-rejection element is the axial-symmetrical structure which consists of the coaxial waveguide with the centre conductor radius a, and outer conductor b, respectively. The coaxial waveguide is filled by the dielectric with permittivity ε_1. The slot in the centre conductor has the width w and the depth d (Figure 1) and it is filled by the dielectric with permittivity ε_2. Two different filter designs can be realized by means of both the complete slot $d = a$ (Figure 1(1)) and the partial slot $d < a$ (Figure 1(2)).

In order to excite the resonance with the component $H_\rho = 0$ in this structure, the condition $w \ll d$ has to be realized [6]. In this case, the magnetic field distribution is the axial-symmetrical one. It should be noted that the two types of resonance can be excited in this structure depending on the relation between the slot depth d and the centre conductor radius a (Figure 1). The maximal magnitude is located in the slot centre for $d = a$ (Figure 2(a));

Table 1: Geometrical and physical parameters of the band-rejection element.

	$w = 0.5$ mm $d = 6.0$ mm $\varepsilon_2 = 1$	$w = 0.5$ mm $d = 5.0$ mm $\varepsilon_2 = 1$	$w = 1.5$ mm $d = 5.0$ mm $\varepsilon_2 = 1$	$w = 0.5$ mm $d = 9.0$ mm $\varepsilon_2 = 3.78$	$w = 1.5$ mm $d = 9.0$ mm $\varepsilon_2 = 3.78$
f_0 GHz	9	11	10.7	10.3	10.27
Q-factor	17	17	5	91	37
		Quarter-wave resonance			Half-wave resonance

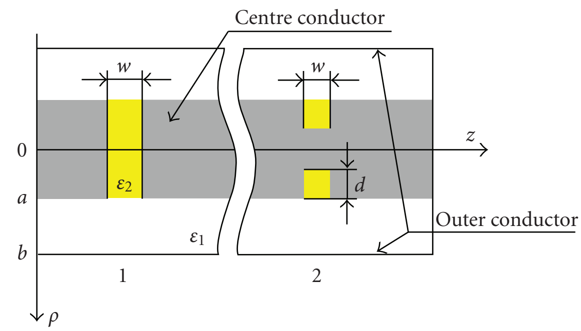

Figure 1: The problem geometry: (1) $a = d$; (2) $a > d$.

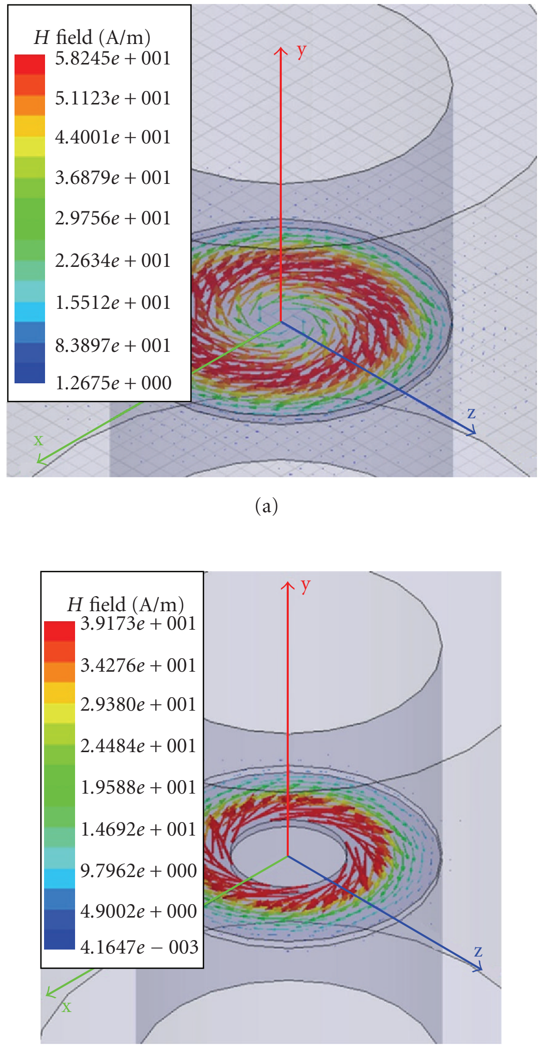

Figure 2: The magnetic field distribution in the slot: (a) $d = a$; (b) $d < a$.

whereas for $d < a$, the maximal magnitude is located on the centre conductor surface (Figure 2(b)). Based on the amplitude distributions of the magnetic field noted above, the authors of [6] called "half-wave resonance" when $d = a$ (Figure 2(a)) and "quarter-wave resonance" when $d < a$ (Figure 2(b)).

From the beginning, let us analyze the influence of the depth (d), width (w), and permittivity (ε_2) on the single-slot performance. For the quarter-wave resonance ($d < a$), the slot-depth increase leads to moving the resonance frequency from $f_0 = 9$ GHz to $f_0 = 11$ GHz (Figures 3(a) and 3(b), Table 1). In this case, the slot-width variation from 0.5 mm to 1.5 mm results in the Q-factor changing about 72% whereas the resonant frequency is slightly changed (Figures 3(b) and 3(c), Table 1).

We note that for the half-wave resonance ($a = d$), the slot width variation points to the similar results (Figures 4(a) and 4(b)). It is quite clear that the dielectric filling of the slot leads to changing the resonant frequency of the single element. So, the dielectric filling of the slot allows reducing the radius of the centre conductor of the given coaxial waveguide. In this case, there is a possibility to provide the efficient rejection-band control of the aforementioned filter.

With these remarks in mind, one may summarize that the resonance frequency is defined by the slot depth and the dielectric permittivity ε_2. At the same time, the Q-factor depends on the slot width and dissipations in the dielectric and the metal. For the illustration of these statements, the dependences of numbered above parameters on the slot dimensions are shown for both the half-wave ($d = a$) and quarter-wave ($d < a$) (Figures 5 and 6) resonances. In both cases, the radius of centre and outer conductors are constant. We have chosen the permittivity $\varepsilon_2 = 1$ for the slot when $d < a$ and $\varepsilon_2 = 3.78$, $\tan\delta = 0.0001$ for the slot when $d = a$. The choice of such values of dielectric permittivity ε_2 allows us to remain in the same frequency band. For both slots, the resonance frequency has the linear dependence on the slot depth (Figure 5). Q-factor reduction is explained by increasing the radiation losses with the slot-width increase (Figure 6). The highest value of Q-factor can be achieved by using the slot-width parameter $d = a$.

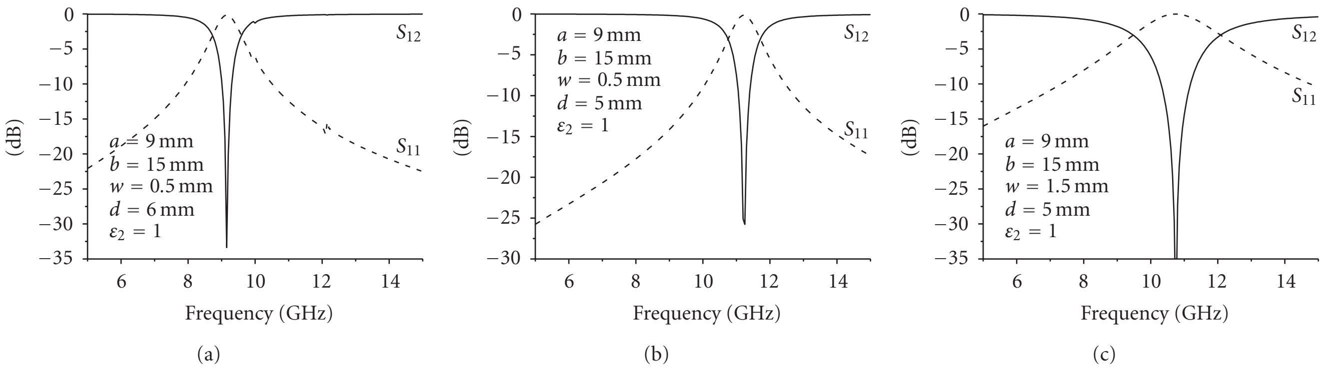

FIGURE 3: Amplitude-frequency characteristics of the band-rejection element in the case of the quarter-wave resonance.

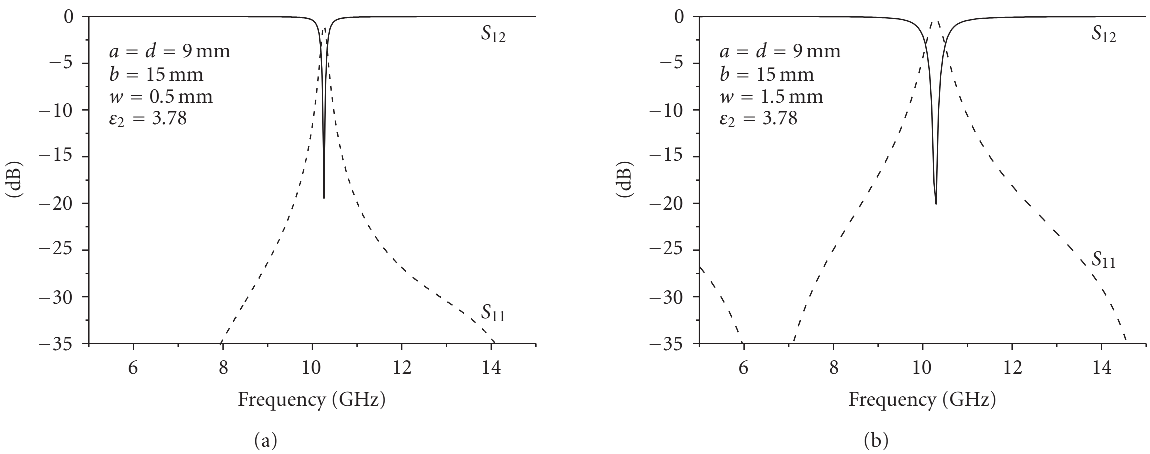

FIGURE 4: Amplitude-frequency characteristics of the band-rejection element in the case of the half-wave resonance.

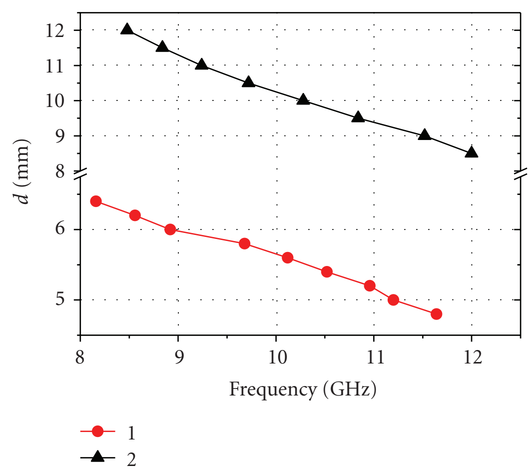

FIGURE 5: The dependence of the resonance frequency on the slot depth: (1) $a = 9$ mm, $b = 15$ mm, $w = 0.5$ mm, $\varepsilon_1 = \varepsilon_2 = 1$; (2) $a = d$, $b = 15$ mm, $w = 0.5$ mm, $\varepsilon_1 = 1$, $\varepsilon_2 = 3.78$.

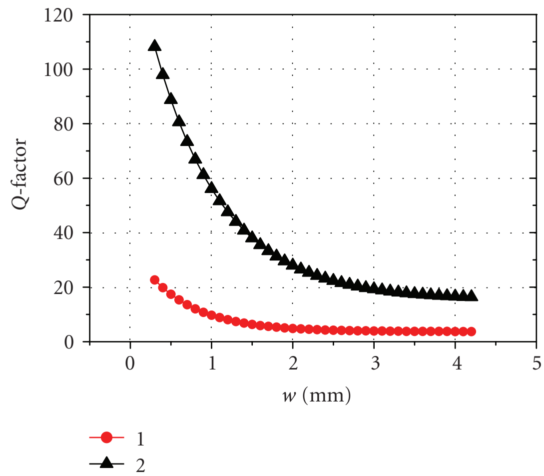

FIGURE 6: The dependence of the loaded Q-factor on the slot width: (1) $a = 9$ mm, $b = 15$ mm, $d = 5.5$ mm, $\varepsilon_1 = \varepsilon_2 = 1$; (2) $a = d = 9$ mm, $b = 15$ mm, $\varepsilon_1 = 1$, $\varepsilon_2 = 3.78$.

3. EXPERIMENTAL VERIFICATION

Experimental investigations of characteristics of the single-slot filter prototypes were carried out on the Agilent network analyzer PNA-L N5230A in the frequency band 8–14 GHz. The manufactured filter prototype is shown in Figure 7. The filter parameters are as follows: $d = a = 9$ mm, $b = 15$ mm, $\varepsilon_1 = 1$, and $\varepsilon_2 = 3.78$. A fair agreement

Table 2: The parameters of the Chebyshev filter.

The number of resonators	Ripple [dB]	f_1 [GHz]	f_2 [GHz]	f_0 [GHz]	$f_2 - f_1$ [GHz]	Source and load [OH]
5	0.1	9.5	10.5	10	1	50

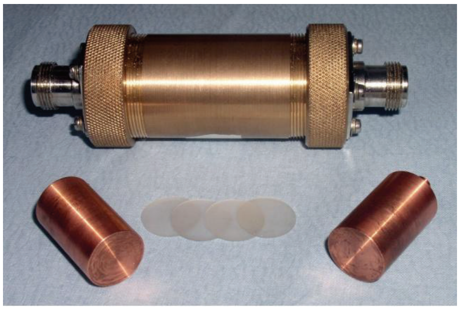

Figure 7: General view of the filter prototype with the single slot.

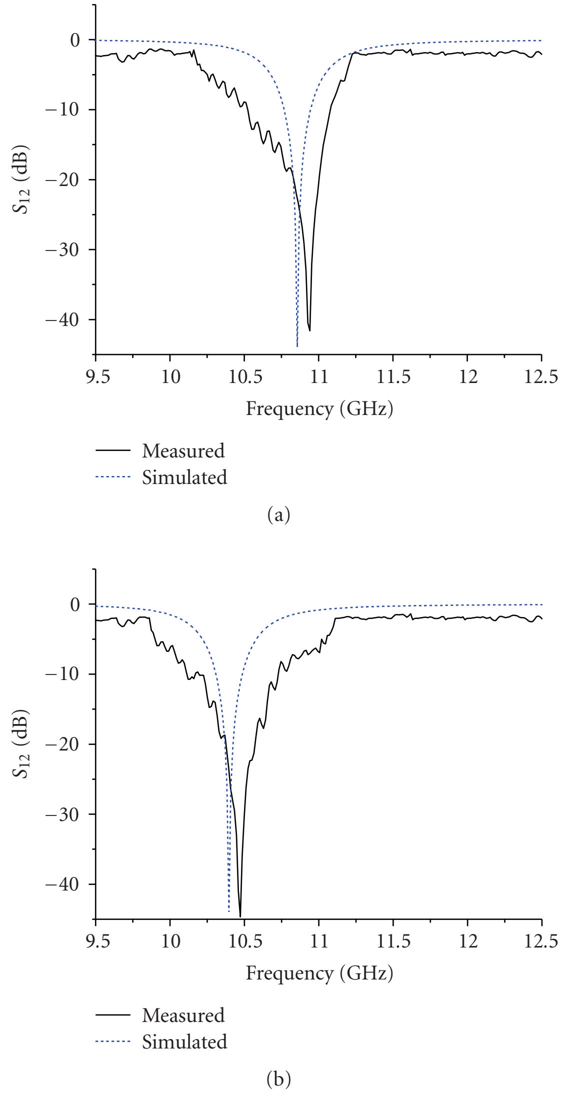

Figure 8: S_{12}-parameter of the filter prototype with the single slot: (a) $w = 1$ mm; (b) $w = 2$ mm.

between the measured and simulated S_{12}-parameters for the single slot with different widths ($w = 1$ mm and $w = 2$ mm) is observed (Figure 8). The dissimilarity at the resonance frequency is less than 0.05 GHz and can be explained by the manufacturing inaccuracy of the filter as well as by the difference between the real dielectric permittivity in the experiment and that used in the simulations.

4. SYNTHESIS OF THE CHEBYSHEV FILTER

The stop-band filter with initial parameters mentioned in Table 2 will be synthesized below. The slots filled with the air ($\varepsilon_2 = 1$) in the case of quarter-wave resonance were chosen as a basic element of this filter. Equivalent circuit of the filter is shown in Figure 9 (top). Based on the simulated results, the values of all elements of the equivalent circuit as well as the resonant frequency and Q-factor of each resonator were determined. The initial values of the geometric parameters of slots (w and d) were chosen from Figures 5 and 6. The desirable impedances were provided by the changing of centre conductor radius a. Further filter optimization was carried out by means of the full wave simulator developed by us earlier [6]. In this case, the resonators are located at the distance $3\lambda/4$ ($\lambda = 30$ mm) from each other to provide the minimal coupling between resonators (Figure 9, bottom). As the goal function, the S-parameters were chosen, and the slot width w and the slot depth d were varied within the limits $\pm 5\%$.

The optimized filter with parameters highlighted in Table 3 was designed, manufactured, and investigated. The S-parameters of the filter prototype noted above are shown in Figure 10. Based on the analysis of these data, we can formulate some conclusions, namely, (i) the measured S-parameters are in good agreement with the simulated ones at the most frequency points over the entire pass-band and stop-band; (ii) the rejection band is 0.86 GHz at the leve −40 dB.

Table 3: The geometrical parameters of the filter.

The number of resonators	1	2	3	4	5
w	0.29 mm	1.0 mm	1.25 mm	1.0 mm	0.29 mm
d	5.6 mm	5.6 mm	5.6 mm	5.6 mm	5.6 mm
a	9 mm	10.7 mm	11.72 mm	10.7 mm	9 mm

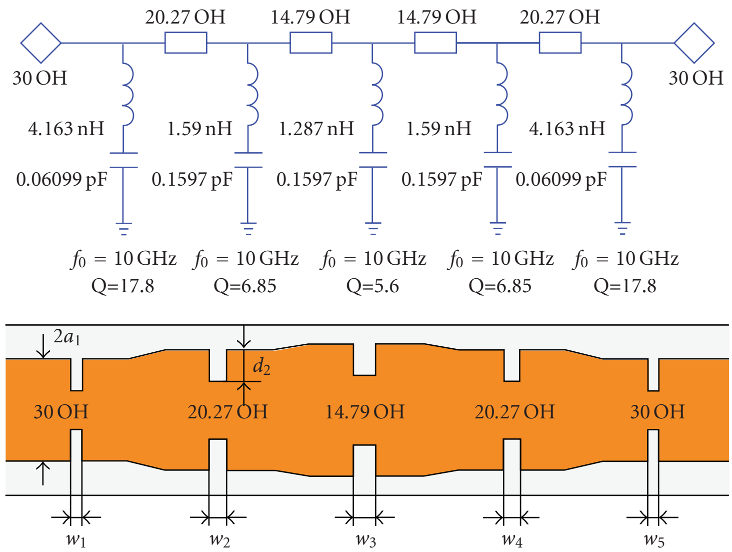

Figure 9: Low-pass block diagram and the general view of the Chebyshev filter prototype.

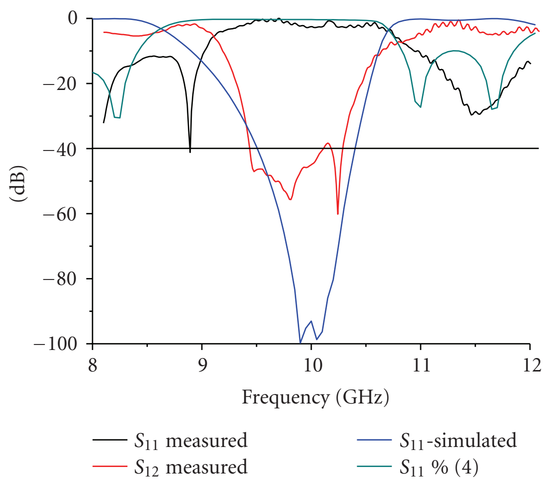

Figure 10: The measured and simulated S-parameters of the Chebyshev filter prototype.

5. CONCLUSIONS

The original band-rejection element as the slot in the centre conductor of the coaxial waveguide for designing the microwave stop-band filters is presented. The half-wave and quarter-wave resonances which are excited in this element have been studied and analyzed. The band-rejection element has been designed and manufactured. It has been found that for both cases the slot-width increase from $w/a = 0.056$ to $w/a = 0.23$ leads to decreasing the loaded Q-factor on 22%. The resonance frequency depends on the slot depth. The good coincidence of calculated and measured data is observed. Fifth-order Chebyshev filter with the given band-rejection element has been also synthesized, manufactured, and investigated. The measured S-parameters are in good agreement with the numerical ones at the most frequency points over the entire pass-band and stop-band. Notice that the filter characteristics are close to the simulated ones without any trimming elements. The rejection band is 0.86 GHz at the level −40 dB. The proposed stop-band filter can be naturally integrated into the coaxial waveguides and seems to be very attractive in different applications.

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Special Issue on Climate Change and Infectious Disease

Call for Papers

Virtually every atmospheric scientist agrees that climate change—most of it anthropegenic—is occurring rapidly. This includes, but is not limited to, global warming. Other variables include changes in rainfall, weather-related natural hazards, and humidity. The Intergovernmental Panel on Climate Change (IPCC) issued a major report earlier this year establishing, without a doubt, that global warming is occurring, and that it is due to human activities.

Beginning about two decades ago, scientists began studying (and speculating) how global warming might affect the distribution of infectious disease, with almost total emphasis on vector-borne diseases. Much of the speculation was based upon the prediction that if mean temperatures increase over time with greater distance from the equator, there would be a northward and southward movement of vectors, and therefore the prevalence of vector-borne diseases would increase in temperate zones. The reality has been more elusive, and predictive epidemiology has not yet allowed us to come to conclusive predictions that have been tested concerning the relationship between climate change and infectious disease. The impact of climate change on infectious disease is not limited to vector-borne disease, or to infections directly impacting human health. Climate change may affect patterns of disease among plants and animals, impacting the human food supply, or indirectly affecting human disease patterns as the host range for disease reservoirs change.

In this special issue, Interdisciplinary Perspectives on Infectious Diseases is soliciting cross-cutting, interdisciplinary articles that take new and broad perspectives ranging from what we might learn from previous climate changes on disease spread to integrating evolutionary and ecologic theory with epidemiologic evidence in order to identify key areas for study in order to predict the impact of ongoing climate change on the spread of infectious diseases. We especially encourage papers addressing broad questions like the following. How do the dynamics of the drivers of climate change affect downstream patterns of disease in human, other animals, and plants? Is climate change an evolutionary pressure for pathogens? Can climate change and infectious disease be integrated in a systems framework? What are the relationships between climate change at the macro level and microbes at the micro level?

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Interdisciplinary Perspectives on Infectious Diseases

Special Issue on The Human Microbiome and Infectious Diseases: Beyond Koch

Call for Papers

A century after Robert Koch linked individual cultured microbes to specific diseases (Koch's postulates), it is increasingly apparent that the complex community of microorganisms associated with the human body (the "microbiome") plays a key role in health and disease. The National Institute of Health (NIH) recently announced the Human Microbiome Project and among its goals is to understand the relationship between host-associated microbial communities and disease. Many physicians and researchers, however, have only passing familiarity with the concepts involved in the study and therapeutic manipulation of complex microbial communities. The aims of this special issue are (1) to familiarize the readers with the concepts and methods for the study of complex microbial communities, (2) to demonstrate how changes in the indigenous microbial community can play a role in diseases such as antibiotic-associated diarrhea, bacterial vaginosis, and cystic fibrosis, and (3) to review how probiotics may hold promise for the therapeutic manipulation of the indigenous microbiota. Review articles and original research papers are being sought for this special issue.

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EURASIP Journal on Image and Video Processing

Special Issue on Patches in Vision

Call for Papers

The smallest primitive employed for describing an image is the pixel. However, analyzing an image as an ensemble of patches (i.e., spatially adjacent pixels/descriptors which are treated collectively as a single primitive), rather than individual pixels/descriptors, has some inherent advantages (i.e., computation, generalization, context, etc.) for numerous image and video content extraction applications (e.g., matching, correspondence, tracking, rendering, etc.). Common descriptors in literature, other than pixels, have been contours, shape, flow, and so forth.

Recently, many inroads have been made into novel tasks in image and video content extraction through the employment of patch-based representations with machine learning and pattern recognition techniques. Some of these novel areas include (but are not limited to):

- Object recognition/detection/tracking
- Event recognition/detection
- Structure from motion/multiview

In this special issue, we are soliciting papers from the image/video processing, computer vision, and pattern recognition communities that expand and explore the boundaries of patch representations in image and video content extraction.

Relevant topics to the issue include (but are not limited to):

- Novel methods for identifying (e.g., SIFT, DoGs, Harris detector) and employing salient patches
- Techniques that explore criteria for deciding the size and shape of a patch based on image content and the application
- Approaches that explore the employment of multiple and/or heterogeneous patch sizes and shapes during the analysis of an image
- Applications that explore how important relative patch position is, and whether there are advantages in allowing those patches to move freely or in a constrained fashion
- Novel methods that explore and extend the concept of patches to video (e.g. space-time patches/volumes)
- Approaches that draw upon previous work in structural pattern recognition in order to improve current patch-based algorithms
- Novel applications that extend the concept of patch-based analysis to other, hitherto, nonconventional areas of image and video processing, computer vision, and pattern recognition
- Novel techniques for estimating dependencies between patches in the same image (e.g., 3D rotations) to improve matching/correspondence algorithmic performance

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EURASIP Journal on Image and Video Processing

Special Issue on Social Image and Video Content Analysis

Call for Papers

The performance of image and video analysis algorithms for content understanding has improved considerably over the last decade and their practical applications are already appearing in large-scale professional multimedia databases. However, the emergence and growing popularity of social networks and Web 2.0 applications, coupled with the ubiquity of affordable media capture, has recently stimulated huge growth in the amount of personal content available. This content brings very different challenges compared to professionally authored content: it is unstructured (i.e., it needs not conform to a generally accepted high-level syntax), typically complementary sources are available when it is captured or published, and it features the Şuser-in-the-loopŤ at all stages of the content life-cycle (capture, editing, publishing, and sharing). To date, user provided metadata, tagging, rating and so on are typically used to index content in such environments. Automated analysis has not been widely deployed yet, as research is needed to adapt existing approaches to address these new challenges.

Research directions such as multimodal fusion, collaborative computing, using location or acquisition metadata, personal and social context, tags, and other contextual information, are currently being explored in such environments. As the Web has become a massive source of multimedia content, the research community responded by developing automated methods that collect and organize ground truth collections of content, vocabularies, and so on, and similar initiatives are now required for social content. The challenge will be to demonstrate that such methods can provide a more powerful experience for the user, generate awareness, and pave the way for innovative future applications.

This issue calls for high quality, original contributions focusing on image and video analysis in large scale, distributed, social networking, and web environments. We particularly welcome papers that explore information fusion, collaborative techniques, or context analysis.

Topics of interest include, but are not limited to:

- Image and video analysis using acquisition, location, and contextual metadata
- Using collection contextual cues to constrain segmentation and classification
- Fusion of textual, audio, and numeric data in visual content analysis
- Knowledge-driven analysis and reasoning in social network environments
- Classification, structuring, and abstraction of large-scale, heterogeneous visual content
- Multimodal person detection and behavior analysis for individuals and groups
- Collaborative visual content annotation and ground truth generation using analysis tools
- User profile modeling in social network environments and personalized visual search
- Visual content analysis employing social interaction and community behavior models
- Using folksonomies, tagging, and social navigation for visual analysis

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EURASIP Journal on Image and Video Processing

Special Issue on Dependable Semantic Inference

Call for Papers

After many years of exciting research, the field of multimedia information retrieval (MIR) has become mature enough to enter a new development phase—the phase in which MIR technology is made ready to get adopted in practical solutions and realistic application scenarios. High users' expectations in such scenarios require high dependability of MIR systems. For example, in view of the paradigm "getting the content I like, anytime and anyplace" the service of consumer-oriented MIR solutions (e.g., a PVR, mobile video, music retrieval, web search) will need to be at least as dependable as turning a TV set on and off. Dependability plays even a more critical role in automated surveillance solutions relying on MIR technology to analyze recorded scenes and events and alert the authorities when necessary.

This special issue addresses the dependability of those critical parts of MIR systems dealing with semantic inference. Semantic inference stands for the theories and algorithms designed to relate multimedia data to semantic-level descriptors to allow content-based search, retrieval, and management of data. An increase in semantic inference dependability could be achieved in several ways. For instance, better understanding of the processes underlying semantic concept detection could help forecast, prevent, or correct possible semantic inference errors. Furthermore, the theory of using redundancy for building reliable structures from less reliable components could be applied to integrate "isolated" semantic inference algorithms into a network characterized by distributed and collaborative intelligence (e.g., a social/P2P network) and let them benefit from the processes taking place in such a network (e.g., tagging, collaborative filtering).

The goal of this special issue is to gather high-quality and original contributions that reach beyond conventional ideas and approaches and make substantial steps towards dependable, practically deployable semantic inference theories and algorithms.

Topics of interest include (but are not limited to):

- Theory and algorithms of robust, generic, and scalable semantic inference
- Self-learning and interactive learning for online adaptable semantic inference
- Exploration of applicability scope and theoretical performance limits of semantic inference algorithms
- Modeling of system confidence in its semantic inference performance
- Evaluation of semantic inference dependability using standard dependability criteria
- Matching user/context requirements to dependability criteria (e.g., mobile user, user at home, etc.)
- Modeling synergies between different semantic inference mechanisms (e.g., content analysis, indexing through user interaction, collaborative filtering)
- Synergetic integration of content analysis, user actions (e.g., tagging, interaction with content) and user/device collaboration (e.g., in social/P2P networks)

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