multipercurso são revistas. Utilizando o simulador SCOPE é investigado o uso de diversidade angular em sistemas de comunicação por infravermelhos para espaços interiores. Mostra-se que a utilização de receptores sectorizados com múltiplos segmentos de sectores, associada a um método de combinação do tipo selecção do melhor sector, permite reduzir a dispersão do sinal recebido. É proposta a utilização de diversidade angular no emissor e no receptor como forma, bastante eficaz, de combater a dispersão multipercurso do canal óptico.

Abstract

This thesis studies the propagation of optical signals in indoor environments, aiming the development of high speed and high performance wireless infrared communication systems. Special attention is given to aspects of modelling, simulation and optimisation of the optical channel.

An overview of wireless indoor optical communication systems is presented. The characteristics of the indoor optical channel are discussed, identifying the main issues that impair the performance of infrared communication systems. The main elements of the optical channel are modelled, namely, the source emitting pattern, the detector receiving pattern, the propagation of the optical signal in free-space and its reflection on indoor surfaces. This reflection is approximated through three models: the Lambert's model, the Phong's model and the Torrance-Sparrow's model. These models are used to approximate the measured reflection patterns of several surfaces. The results show that all the measured patterns are well approximated by the Phong's model and that the Lambert's model is not able to approximate correctly most f the measured reflection patterns. Three models for the propagation of optical signals in indoor channels are detailed: the line-of-sight model, the single reflection model and the multiple reflections model. Those models are used to approximate the signal propagation in the three most common system configurations: line-of-sight, quasi-diffuse and diffuse.

The models described are used to implement a simulation package, named SCOPE, that allows to simulate the propagation of optical signals in indoor channels. The simulation algorithm and the approaches/techniques used are detailed. The simulator allows to evaluate the main characteristics of the indoor optical channel, considering multiple reflections of the emitted signal. The SCOPE has reduced computation time, relatively to other existing simulators of the indoor optical channel. The effects of the first 5 signal reflections on the propagation characteristics of the indoor optical channel are evaluated.

The worst-case propagation losses of the indoor optical channel are, in general, high and change significantly with several factors, namely, the emitting and receiving patterns, the system configuration and the relative positioning of emitter, receiver and reflection surfaces in the communication cell. Using the simulator, the propagation losses in indoor spaces are studied for the three system configurations (line-of-sight, quasi-diffuse and diffuse). The dependence of the propagation losses with the main channel parameters is analytically represented through approximated equations. For each system configuration, the emitter radiation pattern is optimised to minimise the worst-case propagation losses, reducing also significantly the optical range of the received signal over the communication cell.

The IEEE 802.11 working group developed a specification for wireless local area networks, which includes an infrared physical layer. Some of the work presented in this Thesis has contributed for that specification. The IEEE 802.11 infrared physical layer is described and the specification of the emitter radiation pattern is detailed. The communication range of the systems conforming with the IEEE 802.11 standard is evaluated for a set of dissimilar indoor spaces. In all those spaces, the channel propagation characteristics degrade smoothly with the distance. It is shown that the specified emitter radiation pattern is in conformance with the most recent safety standards for laser radiation and it is safe for the user.

The multipath propagation results in time dispersion of the received signal, which may originate inter-symbol interference. The channel impulse responses for the three system configurations are compared. The multipath propagation depends on the system configuration, emitting and receiving patterns and on the relative positioning of emitter, receiver and reflection surfaces. In general, the resulting dispersion reduces the minimum channel bandwidth to values lower than about ten MHz. It is shown that the optimisation of the emitter radiation pattern to minimise the propagation losses results also in a reduction of the channel bandwidth.

The inter-symbol interference introduced by multipath propagation of the optical signal imposes a growing penalty for transmission rates above about ten Mbps. The main techniques used to combat the effects of multipath dispersion in communication systems are reviewed. By using the simulator, the use of angle diversity to combat the multipath dispersion in indoor infrared systems is investigated. The results show that the use of sectored receivers with multiple segments of sectors, associated with a best-sector selection, reduces the time dispersion of the received signal. The use of angular diversity in both emitter and receiver is proposed to combat effectively the multipath dispersion of the indoor optical channel.

Título: Caracterização do Tecido Cardíaco através de Imagens Obtidas por Ecocardiografia

***Title**: Myocardium Contractility Characterization from Echocardiograms using Optical Flow*

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Palavras Chave: Ecografia, processamento de imagem, fluxo óptico, miocárdio, caracterização tecidular
***Key Words**: Echocardiogram, image processing, optical flow, myocardium, tissue characterization*
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Resumo

Nesta tese é proposto um método de determinação da contractilidade local do miocárdio, utilizando o fluxo óptico obtido a partir de sequências de ecocardiogramas. O campo de deslocamento, que descreve o movimento 2D de uma região de interesse (ROI) é calculado entre pares de imagens, através da resolução das equações do fluxo óptico. Consideramos que o tensor 2D, representativo das forças de deformação, é constante em cada (ROI) e entre pares de imagens, consecutivas (restrição de velocidade linear) e também que a intensidade de um ponto pertencente a uma imagem permanece constante (estatisticamente) durante o seu movimento. É realizada uma procura através de correlação cruzada, destinada ao alinhamento da região de interesse, antes do cálculo do fluxo óptico, de forma a reduzir o deslocamento e a variância da matriz de cálculo da deformação. São obtidas curvas representativas da evolução temporal da deformação bidimensional do miocárdio. O seu cálculo é realizado através da integração dos valores próprios das matrizes de deformação (componentes principais de deformação), obtidos ao longo da sequência de imagens. Estas curvas podem revelar anormalidades de contracção: para uma região de interesse normal, as curvas de deformação bidimensional mostram encurtamento circunferencial e espessamento da parede miocárdica durante a sístole, enquanto que numa região com enfarte poderemos observar o oposto.

O método proposto foi primeiramente testado em sequências de imagens geradas por funções analíticas de deformação. Verificou-se que os parâmetros de deformação podem ser obtidos por este método.

Posteriormente, foi testado num conjunto de dados mais realista, através da utilização de um modelo de formação de imagem, considerando um corte segundo o eixo curto do ventrículo esquerdo. O ventrículo é modelado como sendo heterogéneo, isotrópico, incompressível e elástico, situado num anel sujeito a condições fronteira que variam ao longo do tempo. Neste modelo, a presença de uma inclusão numa região de interesse induz uma zona de contracção anormal. O campo de deslocamento, relativamente às imagens consecutivas é calculado através de uma biblioteca do programa MATLAB (PDE), destinado a resolver as equações de elasticidade de acordo com uma dada distribuição e um conjunto de condições fronteira. O campo de deslocamento obtido serve para realizar uma transformação geométrica de uma função representativa de um conjunto aleatório de pequenos elementos dispersores. A função de dispersão é posteriormente sujeita a uma convolução em coordenadas polares com uma função resposta impulsional do modelo utilizado; as imagens resultantes são submetidas a uma detecção de envolvente e convertidas num sistema cartesiano, de forma a obter a simulação de um ecocardiograma. O método de cálculo da deformação miocardial é ilustrado através de sequências de imagens clínicas, verificando-se a possibilidade de identificação de zonas de contractilidade anormal.

Abstract

In this thesis we propose a method to determine the local contraction patterns of the myocardium by computing the optical flow in a sequence of echocardiograms. The displacement field describing the 2-D motion of a region-of-interest (ROI) is computed between a pair of images by solving the optical flow equations under the assumption that the 2-D strain tensors constant within the ROI and between the pair of successive images (linear velocity field constraint) and that the intensity of an image point remains constant (statistically) during its motion. A cross-correlation search is performed for gross alignment of the ROI prior to optical flow computation in order to reduce the bias and the variance of the strain matrix estimation. Pairs of diagnostically useful curves representing the time course of the myocardial bi-axial strain level are then computed by "integrating' the eigenvalues of the strain matrices (principal strain components) computed along the image sequence. Such curves can reveal the contraction abnormalities: for a normal ROI, the bi-axial strain curves should show circunferencial shortening and myocardial wall thickening during systole while for an infarct ROI the opposite could be observed.

The method is first tested on a simple sequence ot images made of functions that are analytically deformed.

It is shown that the strain parameters can be well recovered using the proposed rnethod. It is then tested on a more realistic data set using an image formation model for a short axis view of a contracting left ventricle. The ventricle is modelled as a 2-D inhomogeneous, isotropic, incompressible elastic material set in a ring subjected to time-varying boundary conditions. In this model, the presence of an inclusion in a ROI is what induces the abnormal contraction pattern. The displacement field for the pair of consecutive images is computed using Matlab PDE Toolbox to solve the 2-D elasticity equations for a given elasticity distribution and set of boundary conditions. The displaceeeent field then serves to perforrn a corresponding geometrical transformation of a scattering function representing a random arrangement of small scatterers. The scatteririg function is then convolved in polar coordinates by an impulse response function; the resulting r.f. polar images are envelope detected and mapped in a Cartesian system to give a simulated echocardiognam. The myocardial strain computation method is then illustrated on sequences of clinical images and it is shown that abnormal contraction pattern can be characterized.