FACULTY OF ELECTRICAL ENGINEERING
KTE
September 10 - 12, 2007
Pilsen, Czech Republic

NOISE INFLUENCE ON 2D UNWRAPPING

ING. RADEK KUBASEK, PHD.
MARTIN KUNC

Abstract: *Paper describe influence of additive noise on unwrapping process. Noisy 2D-data, an image, is very hard to unwrap, mainly for low S/N ratio. By denoising, we can achieve a significant better result. Paper give us a global overview and shows basic dependencies between noise and unwrapped data quality.*

INTRODUCTION

2D unwrapping is mathematical fundamental discipline with use in many technical areas like radio interferometry surface scanning, imaging by nuclear magnetic resonation and others.

There are two basic tasks in 2D unwrapping. First is to find algorithm for successful image unwrapping with residuals. [1]. Second is noise robustness of that algorithm and noise influence in phase images and possible denoising operations [2].

This article shows noise influence in phase images for unwrapping Describe basic dependencies and possible solutions for improve noise immunity. All examples are programmed in Matlab environment [3].

1 RESIDUAL THEOREM

Presence of phase step with magnitude over π in 2D or in multidimensional unwrapping is called residual. These steps are not possible unwrap id direct way through that steps. One of solutions is sidetracking residual area, this method is called path following, [1]. Method can not be successful in case where no path without residual exists, which is shown of Fig. 1,. Unwrapped image, as shown on Fig. 2 differs from original. Generally, planes area has the same shape, they differs in magnitude. Magnitude difference is step value $k \cdot 2\pi$, where k is whole number. This equivocation can not be successfully solved and all algorithms falls. In that example is clear to see difficulties in 2D unwrapping.

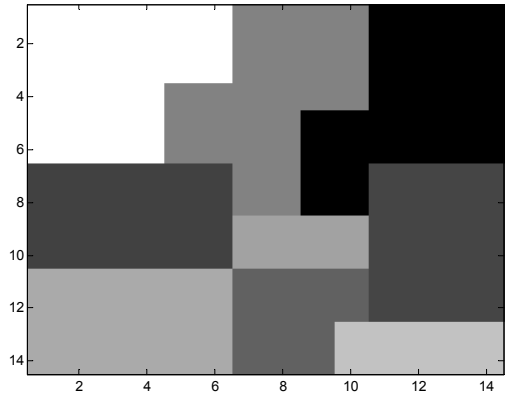

Fig.1: Original image.

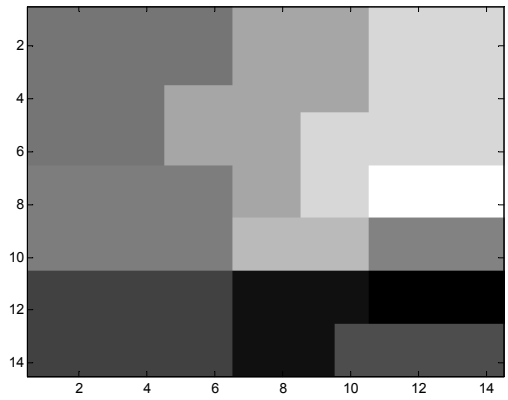

Fig.2: Unwrapped image

2 NOISE IN WRAPED DATA

On Fig. 3 and Fig. 4 is shown original image with no noise. If this free of noise image is submitted to wrapping and consequently unwrapping procedure, no difference occurs. Fig. 5 to Fig 10 shows unwrapped results for different magnitude δ of additional uniform noise. For good visual checking of noise influence, row unwrapping was chose.

With noise magnitude of $\delta = \pi/4$, no residual occur, and resulting images is only noised. For noise magnitude of $\delta = \pi/2$, nine residual degrade rest of lines (no other path was finding). The last example with $\delta = \pi$ shows totally degraded image. Image with so high noise must be denoised before it is submitted to unwrapping.

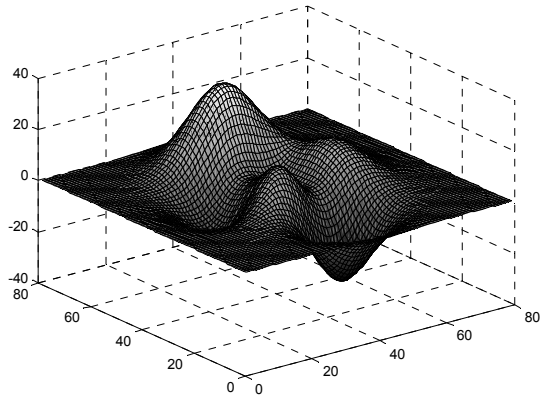

Fig.3: Original image, 3D view.

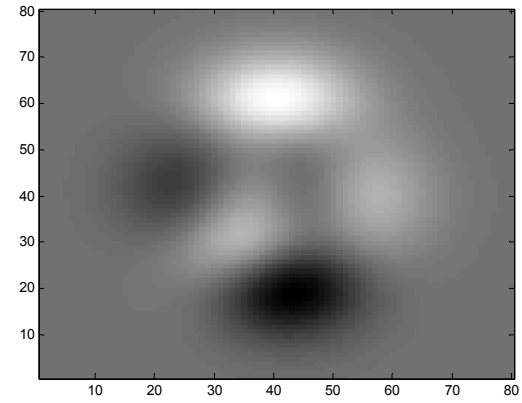

Fig.4: Original image, 2D view.

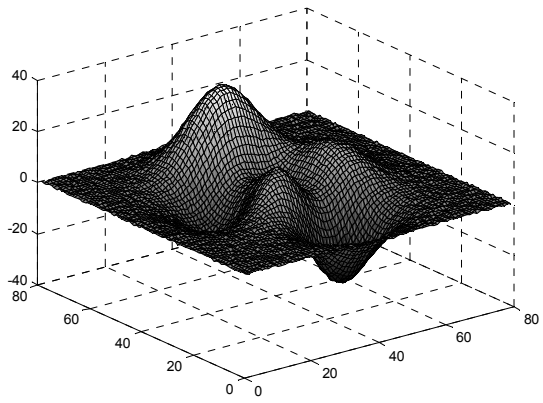

Fig.5: Unwrapped image, $\delta = \pi/4$, 3D view.

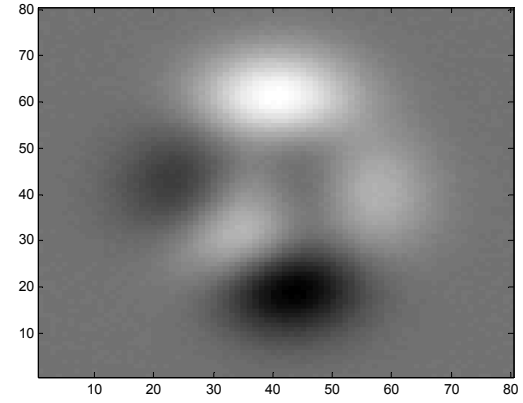

Fig.6: Unwrapped image, $\delta = \pi/4$, 2D view.

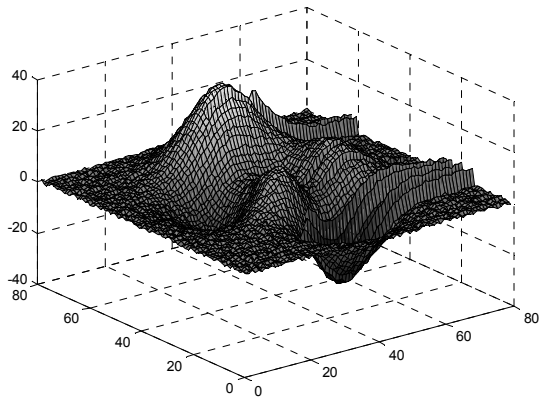

Fig.7: Unwrapped image, $\delta = \pi/2$, 3D view.

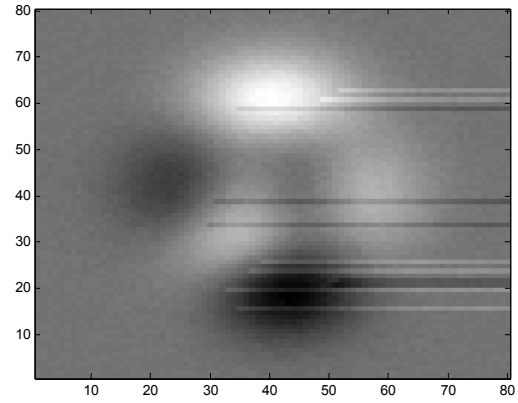

Fig.8: Unwrapped image, $\delta = \pi / 2$, 2D view.

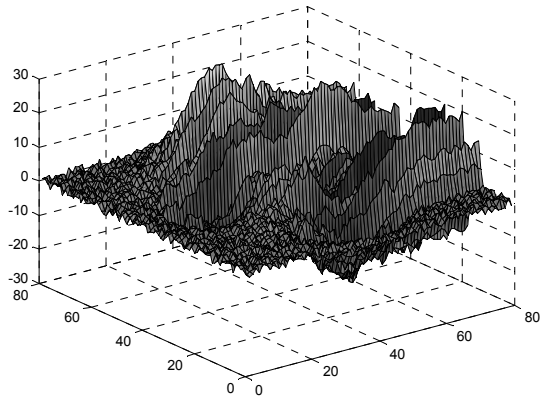

Fig.9: Unwrapped image, $\delta = \pi$, 3D view.

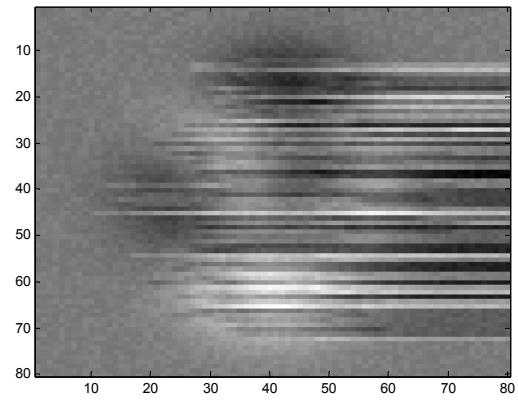

Fig.10: Unwrapped image, $\delta = \pi$, 2D view.

3 CONCLUSION

Paper shows noise influence on 2D unwrapping. For high value of noise in image, denoising techniques are necessary to obtain acceptable result. Wavelet denoising seems to be suitable, but with chance of edge blurring by smoothing effect. Smoothing effect help to unwrapping algorithm, but can be undesired, for example in medical imaging.

4 REFERENCES

[1] D. C. Ghigla, M. D. Pritt: Two-dimensional phase unwrapping, J. Wiley & Sons, N.Y. 1998.
[2] H. C. Enriques, J. V. Ginori: Wavelet based methods for improving signal to noise ratio in phase images, Lecture notes in computer science 3656, pp 247-254, 2005.
[3] R. C. Gonzales, R. E. Woods, S. L. Eddins: Digital image processing using matlab, Prenticehall, N.J. 2004.

ACKNOWLEDGMENTS

The paper was prepared with the support by project 102/07/1086 of the Grant Agency of the Academy of Sciences of the Czech Republic.

Ing. Radek Kubasek, Ph.D.
Brno University of Technology
Dept. of Theoretical and Experimental Electrical Engineering,
Kolejni 2906/4, 612 00 Brno, Czech Republic

E mail: kubasek@feec.vutbr.cz

Martin Kunc
Brno University of Technology
Dept. of Theoretical and Experimental Electrical Engineering,
Kolejni 2906/4, 612 00 Brno, Czech Republic

E mail: xkuncm02@stud.feec.vutbr.cz