CORRECTION OF ENDOSCOPIC IMAGES AND MEASUREMENT OF LESION AREA

林志鴻、劉仁俊

E-mail: 9019014@mail.dyu.edu.tw

ABSTRACT

THE MEASUREMENT OF LESION SIZE USING ENDOSCOPIC IMAGES IS IMPORTANT IN PERFORMING CLINICAL TRIAL. ENDOSCOPES ARE CONSTRUCTED USING WIDE-ANGLE LENSES IN ORDER TO INCREASE THE FIELD OF VIEW. HOWEVER, THE DISPLAYED IMAGES ARE SERIOUSLY DISTORTED. THE DISTORTION GETS EVEN MORE SERIOUS AS THE OBJECTS EXTEND OUTWARD FROM THE CENTER OF THE LENS IN RADIAL. IN CONSEQUENCE, THE MEASUREMENT OF LESION SIZE IS A DIFFICULT TASK. THE TRADITIONAL MEASURING-BY-EYE METHOD WILL CREATE SIGNIFICANT ERROR. THIS PROJECT WILL DISCUSS THE EFFECT OF IMAGE DISTORTION AND CORRECT THE EFFECT. A MORE ACCURATE SIZE-MEASURING ALGORITHM WILL BE DEVELOPED AND COMPARED TO THOSE OF TRADITIONAL APPROACHES. WE WILL PROVE THAT IT IS EASIER TO ANALYZE THE EFFECT OF RADIAL DISTORTION IN POLAR COORDINATE. THE DISTORTED AND CORRECTED IMAGES CAN BE MAPPED BY TWO COORDINATE SYSTEMS. THEY CAN BE TRANSFORMED TO EACH OTHER BY A SPECIAL ORTHOGONAL POLYNOMIAL. THE PROPOSED METHOD IS VERY EFFECTIVE TO PLANE IMAGES. THE ACCURACY IS HIGH. TO MEASURE LESION SIZE, GRAPHIC USER INTERFACE (GUI) IS USED. THE NUMBER OF PIXELS OF LESION IS FIRST CALCULATED USING THE METHOD OF REGION GROWING. THE AREA IS THEN COMPUTED BASED UPON THE RATIO TO THE ENTIRE IMAGE. IN CONDUCTING SIMULATIONS, WE WILL FIRST ANALYZE THE LENSES ON THE ENDOSCOPE. THE APPROACH IS THEN VERIFIED ON IMAGES WITH GRIDS. FINALLY, THE SYSTEM WILL BE APPLIED TO IMAGES OF REAL HUMAN ORGANS.

Keywords : LESION SIZE, ENDOSCOPE, MEDICAL IMAGING, ORTHOGONAL POLYNOMIAL, COORDINATE TRANSFORMATION.

Table of Contents

REFERENCES

[1] SONNENBERG A, GIGER M, KERN L, ET AL.: "HOW RELIABLE IS DETERMINATION OF ULCER SIZE BY ENDOSCOPY?" BR. MED. J., VOL. 2: PP.1322-1324, 1979.

[2] MARGULIES C, KREVSKY B, CATALANO M: "HOW ACCURATE ARE ENDOSCOPIC ESTIMATES OF SIZE?" GASTROINTEST ENDOSC., VOL. 40: PP. 174-177, 1994.

[3] VAKIL N, SMITH W, BOURGEOIS K, ET AL.: "ENDOSCOPIC MEASUREMENT OF LESION SIZE: IMPROVED ACCURACY WITH IMAGE PROCESSING," GASTROINTEST ENDOSCOPE, VOL. 40: PP. 178-183.1994.

[4] VAKIL N: "MEASUREMENT OF LESIONS BY ENDOSCOPY: AN OVERVIEW," ENDOSCOPY, VOL. 27: PP. 694-697, 1995.

[5] SAKITA T, OGURO Y: "MEASUREMENTS OF THE LESION SIZE UNDER DIRECT VISION WITH THE OPTICAL FIBERSCOPE," GASTROINTEST ENDOSCOPE, VOL. 15: PP.456-464, 1973.

[6] MURAYAMA M, ICHIOKA S, TAKEMOTO T, ET AL.: "A CLINICAL TRIAL OF A GASTROFIBERSCOPE WITH SCALE," GASTROENTEROL ENDOSCOPE, VOL 13: PP. 49-57, 1971.

[7] MARGULIES C, KREVSKY B, CATALANO M: "HOW ACCURATE ARE ENDOSCOPIC ESTIMATES OF SIZE?" GASTROINTEST ENDOSCOPE, VOL 40: PP. 174-177, 1994.

[8] VAKIL N, SMITH W, BOURGEOIS K, ET AL.: "ENDOSCOPIC MEASUREMENT OF LESION SIZE: IMPROVED ACCURACY WITH IMAGE PROCESSING," GASTROINTEST ENDOSCOPE, VOL. 40: PP. 178-183, 1994.
[9] YAMAGUCHI M, OKAZAKI Y, YANAI H, ET AL.: "THREE-DIMENSIONAL DETERMINATION OF GASTRIC ULCER SIZE WITH LASER ENDOSCOPY," ENDOSCOPY, VOL. 20: PP. 263-266, 1998 .
[10] CATALANO MF, VANDAM J, BEDFORD R, ET AL.: "PRELIMINARY EVALUATION OF THE PROTOTYPE STEREOSCOPIC ENDOSCOPE: PRECISE THREE-DIMENSIONAL MEASUREMENT SYSTEM," GASTROINTEST ENDOSCOPE, VOL. 39: PP. 23-28, 1993.
[11] WAKABAYASHI T, NAKAZAWA S, YOSHINO J, ET AL.: "A NEW METHOD OF REAL-TIME ENDOSCOPIC MEASUREMENT WITH AN ELECTRIC CATHETER," ENDOSCOPY, VOL. 26: PP.466-469, 1994.
[12] SMITH WE, VAKIL N, MAISLIN SA: "CORRECTION OF DISTORTION IN ENDOSCOPE IMAGES," IEEE TRANS MED. IMAGE, VOL. 11: PP. 117-122, 1992.
[13] H. HANEISH, AND Y. MIYAKE, "DISTORTION COMPENSATION OF ELECTRONIC ENDOSCOPE IMAGE," IEEE CONF. REC. MED. IMAGE CONF. SAN FRANCISC, VOL. 3: PP.1717-1721, 1994.
[14] H. HIDEAKI, Y. YAGIHASHI AND Y. MIYAKE, "A NEW METHOD FOR DISTORTIONCORRECTION OF ELECTRONIC ENDOSCOPE IMAGES," IEEE TRANS. MED. IMAGING, VOL. 14: PP. 548-555, SEPT, 1995.
[15] KV. ASARI, S. KUMAR , AND D. RADHAKRISHNAN, "A NEW APPROACH FOR NONLINEAR DISTORTION CORRECTION IN ENDOSCOPIC IMAGES BASED ON LEAST SQUARES ESTIMATION," IEEE TRANS MED, IMAGE VOL 18: PP. 345-354, APRIL, 1999.
[16] RY. TSAI, "AN EFFICIENT AND ACCURATE CAMERA CALIBRATION TECHNIQUE FOR 3D MACHINE VISION," IN PROC. IEEE COMPUTER VISION PATTERN RECOGNI-TION, MIAMI, FL, PP. 364-374, JUNE 1986.
[17] Y. NOMURA, M. SAGARA, H. NARUSE, AND A. IDE, "SIMPLE CALIBRAT -IONALGORITHM FOR HIGH-DISTORTION -LENS CAMERA," IEEE TRANS. PATTERN ANAL. MACHINE INTEL., VOL.14: PP. 1095-1099, NOV. 1992.
[18] J. WENG, P. COHEN, AND M. HERNIOU, "CAMERA CALIBRATION WITH DISTORTION MODELS AND ACCURACY EVALUATION," IEEE TRANS. PATTERN ANAL. MACHINE INTEL., VOL: 14, PP. 965-980, OCT. 1992.
[19] H. KATO AND J. P. BARRON, "ELECTRONIC VIDEOENDOSCOPY," SWITZERLAND:HARWOOD, 1993.
[20] M. LI AND L. JEAN-MARC, "SOME ASPECTS OF ZOOM LENS CAMERA CALIBRATION," IEEE TRANS. PATTERN ANAL. MACHINE INTELL., VOL.18, PP. 1105-1110, NOV. 1996.
[21] H. DANCYGIER, D. WURBS AND M. CLASSEN, "NEW METHOD FOR ENDOSCOPE DETERMINATION OF ULCERSIZE," GUT, VOL 21, PP. A895-A931, 1980.
[22] S. YOSHIKAZU, Y. HIRONAO, AND TOSHIHIKO UEDA , "A WIDE ANGLE VISION SENSOR WITH FOVEA DESIGN OF DISTORTION LENS AND SIMULATED IMAGES," IEEE CONF., PP.1770-1773,1993.
[23] Y. ONODERA AND K. KANATANI, "GEOMETRIC CORRECTION OF IMAGE WITHOUT CAMERA REGISTRA -TION," TRANS IEICE, VOL J75 DII, PP.1009-1013, 1992.
[24] L. BERTHOUZE, S. ROUGEAUX, F. CHAVAND AND Y. KUNIYOSHI, "CALIBRATION OF A FOVEATED WIDE-ANGLE LENS ON AN ACTIVE VISION HEAD," IN PROCEEDINGS OF CVPR'96,PP.183-188,1996.
[25] H. HANEISH, K. GONO, H. YAGUCHI, AND Y. MIYAKE, "FEATURE EXTRACYION FROM GASTRIC MUCOSA IMAGES AND ITS APPLICATION TO DIAGNOSIS," IEICE TRANS., VOL. J76-DII, PP. 325-333, 1993.
[26] M . CLASSEN, H. DANCYGIER , AND D. WURBS , "NEW METHOD OF ENDOSCOPIC DETERM -INATION OF ULCER SIZE," GUT., VOL . 21, P.895, 1980.
[27] H.OKABE, M.OHIDA, N. OKADA, T.MITSUHASHI, T.KATSUMATA, K.SAIGENGI, AND K. A. NAKA -HASHI, "NEW DISC METHODFOR THE ENDOSCOPIC DETERMINATION OF GASTRIC ULCER AREA," GASTROINTEST ENDOSCOPE VOL . 32, PP 20-24,1986 [28] J.YOSHINO, S. NAKAZAWA, K.YAMAO , K.INUI , N.TODA , K.WATARAI , T.WAKABAYASHI, N.ASKURA, T.MORI, AND Y. SUZUKI, "A STUDY OF MEASUREMENT OF GASTRIC LESIONS WITH A NEW ELECTRONIC ENDOSCOPE," IN PROC. WORLD CONG. GASTROENTEROL., SYDENY AUSTRALIA; POSTER #467. 1990 [29] H. HANEISHI, T.OGURA, AND Y.MIYAKE, "PROFILOMETRY OF GASTRO-INTESTINAL SURFACE USING AN ENDOSCOPE WITH LASER BEAM PROJECTION," OPTICS LETT., VOL.19 ,PP 601- 603 , 1994 [30] Y.HATADA, S.IWANE, H.TOHNO , T.BABA, A.MUNAKATA, AND Y.YOSHIDA, "A NEW METHOD FOR THE MEASUREMENT OF GASTRIC AND COLONIC LESIONSWITH AN ELECTRONIC ENDOSCOPY" , VOL.37 P.275 1991.
[31] Q.MAOLIN AND S.DE MA, "PARAMETRIC AND NONPARAMETRIC APPROACHES FOR CAMERA CALIBRATION : ANALYSIS OF IMAGEING ERRORS AND THEIR COMPENSATION ,"IN PROC .SEC. ASIAN CONF . COMPUTER VISION SINGAPORE, 1995, PP.II 205-II 209.
[32] M.LI AND L. JEAN-MARC, "SOME ASPECTS OF ZOOM LENS CAMERA CALIBRATION," IEEE TRANS. PATTEN ANAL. MACHINE INTELL., VOL. 18 ,PP. 1105-1110, NOV. 1996 [33] R.Y. TSAI, "AN EFFICIENT AND ACCURATE CAMERA

CALIBRATION TECHNIQUE FOR 3D MACHINE VISION," IN PROC. IEEE COMPUTER VISIO PATTERN RECOGNITION, MIAMI, FL , JUNE 1986 , PP. 364-374 [34] D.C.BROWN, "DECENTERING DISTORTION OF LENSES," PHOTOGRAMM. ENG. REMOTE SENSING , MAY 1966, PP. 444-462 [35] S.M.KRISHAN , K.V.ASARI , C.J.YAP , AND P.M.Y.GOH, "QUANTITATIVE CHARACTERZATION OF COLON BY FUZZY BASED IMAGE ANALYSIS," IN PROC. ISIRS 98, JAN. 1998 ,PP. 53-55 [36] D.H. BALLARD, "ANIMATE VISION", ARTIFICIAL INTELLIGENCE, VOL. 48 , PP.57-86,1991 [37] Y.KUNIYOSHI , N.KITA , S.ROUGEAUX , AND T.SUEHIRO, "ACTIVE STERO VISION SYSTEM WITH FOVEATED. WIDE ANGLE LENSES" , 2ND ASIAN CONFERENCE ON COMPUTER VISION, SINGAPORE , VOL. I,PP.359-363, 1995 [38] R.S WALLACE, B.B.BEDERSON, AND E.L.SCHWARTZ, "A MINIATURIZED ACTIVE VISION SYSTEM", INTERNATIONAL CONFERENCEON PATTERN RECOGNITION, PP 58-61 1992.
[39] G.SANDINI AND V.TAGLIASO, "AN ANTHROPOMORPHIC RETINA-LINK STRUCTURE FOR SENCE ANALYSIS",COMPUTER GRAPHICS AND IMAGE PROCESSING, VOL. 14,NO. 3, PP. 365-372,1980 [40] A.BASU AND S.LICARDIE, "MODELING FISH-EYE LENSES", INTERNATIONAL CONFERENCE ON INTELLIGENT ROBOTS AND SYSTEMS, YOKOHAMA, JAPAN , PP. 1822-1828, JULY 26-30,1993 [41] R.G.WILLSON AND S.A.SHAFER, "WHAT IS THE CENTER OF THE IMAGE ?" , CMU-CS-93- 122, CARNEGIE MELLON UNIVERSITY , PITTSBURGH, USA,1993 [42] D.W.MARQUARDT, "JOURNAL OF THE SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS," VOL. 11, PP.431-441, 1963.
[43] H.A.MARTINS, J.R.BIRK, AND R.B.KELLE, "CAMERA MODELS BASED ON DATA FROM TEO CALIBRA TION PLANES", COMPUTER GRAPHICS AND IMAGE PROCESSING, VOL. 17 , PP 173 1981.
[44] L.BERTHOUZE AND F.CHAVAND, "A NEW CAMERA CALIBRATION METHOD USING NEURAL NETWORKS" , 3RD FRENCH ISRAELI SYMPOSIUM ON ROBOTICS, HERZLIYYA, ISRAEL, PP.45-50 , MAY 22-23 1995.
[45] BUTLER , D.A., PIERSON, P.K., "A DISTORTION CORRECTION SCHEME FOR INDYUSTRIAL MACHINE VISION APPLICATION," IEEE TRANSACTIONS ON ROBOTICS AND AUTOMATION. 7: PP. 546-551, 1991 [46] GONZALEZ,RAFAEL C.,WOODS,RICHAED E.,DIGITAL IMAGE PROCESSING, ADDISON WESLEY 1993: PP413-478 [47] SCOTT E UMBAUGH ., COMPUTER VISION AND IMAGE PROCESSING: APRACTICAL APPROACH USING CVIPTOOLS, PTR PH 1998,P.26 [48] SCHALKOFF, R.J. DIGITAL IMAGE PROCESSING AND COMPUTER VISION , JOHN WILEY & SONS, INC., 1989 [49] RON LARSON , BRUCE H .EDWARDS., ELEMENTARY LINEAR ALGEBRA , HOUGHTON MIFFLIN 2000, P.27 [50] HANDBOOK OF MATHMATICAL FUNCTION, M.ABRAMOWITZ AND I.A.STEGUN,EDS. NEW YORK : DOVER, 1972, P.791 [51] S.G.NASH AND A.SOFER, LINEAR AND NONLINEAR PROGRAMMING . SINGAPORE : MCGRAW - HILL, 1996 ,P.312 [52] 連國珍， "數位影像處理"， 儒林1993 年三月 [53] 繆紹綱， "數位影像處理一活用MATLAB" 全華1999 年三月 [54] 張智星， "MATLAB 程式設計與應用" 清蔚科技2000