Faculty of Manufacturing Engineering

COMPUTER VISION SYSTEM FOR MONITORING BODY DISCOMFORT IN MANUFACTURING ENVIRONMENT

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Master of Science in Manufacturing Engineering

2016

COMPUTER VISION SYSTEM FOR MONITORING BODY DISCOMFORT IN MANUFACTURING ENVIRONMENT

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A thesis submitted
in fulfillment of the requirements for the degree of Master of Science
in Manufacturing Engineering

Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

DECLARATION

I declare that this thesis entitled “Computer Vision System For Monitoring Body Discomfort in Manufacturing Environment” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this thesis and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Science in Manufacturing Engineering.

Signature :…….....

Supervisor Name :…….....

Date :…….....

DEDICATION

To my father Ramdan Razali, my mother Wan Maseri and all my siblings, I love you.

ABSTRACT

Manual handling is one of the primary causes of body discomfort. If motions are repeated frequently, such as every few seconds, and for prolonged periods such as an eight-hour shift, fatigue and muscle strain can happen. Body discomfort can occur in every part of the body, such as the neck, arms, waist, spine, legs, and feet. To reduce body discomfort among manual workers, many researchers have carried out studies on body discomfort. Previous studies usually used the traditional method, which is by carrying out surveys of manual workers using specific questionnaires. A questionnaire that is often used is the Nordic Musculoskeletal Questionnaire (NMQ). The questionnaire is designed to find out about discomfort that occurs in all parts of the subject's body. The traditional method cannot detect body discomfort automatically because no automatic system is used. Furthermore, the Closed-Circuit Television (CCTV) used in factories nowadays is used for security purposes, not for ergonomic purposes. Therefore, the goal of this research is to design a vision system that monitors body discomfort in manual workers. It is done by using a new method, the image histogram. The methodology proposed is the development of a vision system using Python and SimpleCV software for recording images and image analysis. The output of the image analysis is a red-green-blue (RGB) histogram which shows the pixels of the gray scale color distribution. The image analysis is done every three minutes for 30 minutes. The results show that when the worker is moving in order to carry out his or her work, the RGB histogram also changes. When the histogram is changing throughout the period of 30 minutes, it is found that the person is likely to feel body discomfort regardless of which part of the body is involved. By also referring to the image frame, it is proven that the worker is experiencing body discomfort within the 30 minutes. To support and strengthen the results, NMQ analysis is also used. The experiments are done by conducting three types of experiments on the fitting process, milling process, and turning process. Nine subjects participated in these experiments. The results show that seven of the subjects experienced body discomfort in the range of the hypothesized limit time. From all the results, including the histograms, it is shown that the system can monitor body discomfort successfully.

Key words: Manual handling, body discomfort, image histogram.

ABSTRAK

Pengendalian manual adalah salah satu punca utama ketidakselesaan badan. Jika diulang dengan kerap, seperti setiap beberapa saat dan untuk tempoh yang lama seperti syif lapan jam, keletihan dan ketegangan otot boleh berlaku. Ketidakselesaan badan boleh berlaku dalam setiap bahagian badan seperti leher, lengan, pinggang, tulang belakang, dan bahagian kaki. Kajian sebelum ini biasanya menggunakan kaedah tradisional, iaitu dengan melakukan kaji selidik ke atas pekerja dengan menggunakan cara soal selidik yang tertentu. Tambahan pula, Televisyen Litar Tertutup yang digunakan di kilang pada masa kini adalah untuk tujuan keselamatan, bukan untuk tujuan ergonomik. Oleh itu, matlamat kajian ini adalah untuk mereka bentuk sistem visi yang memantau ketidakselesaan badan pada pekerja manual. Ia dilakukan dengan menggunakan kaedah baru iaitu histogram imej. Kaedah yang dicadangkan adalah dengan membangunkan sistem visi menggunakan Python dan perisian SimpleCV untuk rakaman imej dan analisis imej. Output analisis imej adalah histogram merah-hijau-biru (RGB) yang menunjukkan piksel pengagihan warna skala kelabu. Analisis imej dilakukan setiap tiga minit, selama 30 minit. Keputusan menunjukkan bahawa apabila pekerja bergerak untuk melakukan kerja mereka, histogram RGB juga berubah. Apabila histogram sentiasa berubah dalam tempoh 30 minit, pekerja itu mungkin mengalami ketidakselesaan badan tanpa mengira mana-mana bahagian badan .Dengan juga merujuk kepada sesuatu imej, ia membuktikan bahawa pekerja yang mengalami ketidakselesaan badan dalam tempoh 30 minit. Untuk menyokong dan mengukuhkan keputusan, analisis NMQ juga digunakan. Eksperimen dilakukan dengan menjalankan tiga jenis eksperimen iaitu; proses pemasangan, proses pengisaran dan proses perubahan. Sembilan subjek telah dipilih untuk menyelesaikan eksperimen ini. Setiap subjek mempunyai rekod kesihatan yang berbeza. Keputusan menunjukkan bahawa tujuh daripada sembilan subjek mengalami ketidakselesaan badan dalam lingkungan masa hipotesis. Keseluruhan keputusan menunjukkan bahawa sistem tersebut boleh memantau ketidakselesaan badan dengan jayanya.

***Kata kunci**: Manual pengendalian, ketidakselesaan badan, histogram imej.*

ACKNOWLEDGEMENTS

I would like to thank to my Supervisor Dr. Ahmad Yusairi Bin Bani Hashim, my co-Supervisor, Dr. Seri Rahayu Binti Kamat and Dr. Siti Azirah Binti Asmai who has led me along the journey to complete this research. I also want to thank Universiti Teknikal Malaysia Melaka for the support by providing the research grant with identification number PJP/2013/FKP(5D)/S01173 and MyBrain UTeM scheme for two years.

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LIST OF SYMBOLS, ABBREVIATIONS AND NOMENCLATURE

ABBREVIATIONS

LBP	-	Lower back pain
sEMG	-	Surface electromyography
CCTV	-	Closed-circuit television
WRMSDs	-	Work-related musculoskeletal disorders
eiLBP	-	Exercise-induced lower back pain
WBV	-	Whole-body vibration
RGB	-	Red-Green-Blue
AVI	-	Audio Video Interleaved
MIG	-	Metal inert gas
SimpleCV	-	Simple Computer Vision
OpenCV	-	Open Computer Vision
NMQ	-	Nordic Musculoskeletal Questionnaire
STS	-	Sit-to-stand
ICF	-	International Category of Functioning Disability and Health
VAS	-	Visual Analog Scale
ODI	-	Oswestry Disability Index
TFA	-	Trans-femoral amputation
WBV	-	Whole-body vibration
LTA	-	Leisure-time activities
2D	-	Two- dimensional
3D	-	Three- dimensional
GDP	-	Gross domestic product
UK	-	United Kingdom

MRI	-	Magnetic Resonance Imaging
CT	-	Computed tomography
MHI	-	Motion History Image
DADCG	-	Detection of Abnormal Behaviour in Dynamic Crowded Gatherings
OF	-	Optical flow
IP	-	Internet Protocol
MIG	-	Metal Inert Gas
D	-	Diameter
JPEG	-	Joint Photographic Experts Group

NOMENCLATURE

EQ5D	-	A standardised instrument for use as a measure of health outcome
Trimata	-	Name of the vision system
H	-	Unit of Motion History Image
Img	-	Image (Python code)
Len	-	Length (Python code)
Matplotlib	-	Plot module (Python code)
CAM 1	-	Camera 1
CAM 2	-	Camera 2
CAM 3	-	Camera 3
P0-P9	-	Point 0 to Point 9

SYMBOLS

τ	-	constant 255 corresponding to 8 bit pixel representation
Δ	-	Delta
x	-	x-axis
y	-	y-axis
t	-	Time