Expose

Design of a visual module for ergonomics assessment in human robotic collaborative applications

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Introduction and problem definition

In human robot collaboration, operations of worker are neccessary and significant. Work-related Musculoskeletal Disorders(WMSDs) are common in industries and harmful to workers' health, which reduce production effiency. Moreover, financial losses are also essential when remedying to MSDs[1]. Therefore, it is meaningful to estimate human pose and assess it in terms of ergonomics in real-time while a worker is performing a task with robot. Based on the risk level, improvement is proposed and applied if the operation is at risk. The improved design would be assessed again to make sure that the risk level is reduced.

There are different methods to measure ergonomics, such as Rapid Upper Limb Assessment (RULA), Novel Ergonomic Postural Assessment Method (NERPA) and Loading on the Upper Body Assessment(LUBA)[1]. Although each method has its advantages and disadvantages, RULA is the most widely used method in industries[3].

In addtion, the developed visual module shall be intergrated into Manufacturing Execution System(MES), so that it could be applied in Small Medium Enterprises (SMEs). An approach is to establish a central database, in order to exchange data between MES and other components[4].

Aim of your research and research questions

Commonly, human pose is assesed with simulation and interview. However, those tools are not always precise. Therefore, in this research internship human pose will be detected from images of workers while doing tasks, and a convolutional neural network(CNN) could be implemented to estimate it. Besides, a proper ergonomic assessment method should be chosen to realize an acceptable accurancy of risk level evaluation. Furthermore, the integration of ergonomics data in MES systems is to be considered.

Methodology and planned procedure

Deep neural network has been widely applied in human pose estimation nowadays besides classic methods such as Feature Presentation and Pictorial Structure Model. A bottom-up method, Realtime Multi-Person 2D Pose Estimation Method using Part Affinity Fields[2], will be implemented. Figure 1[2] illustrates a two-branches convolutional neural network. Firstly, a set of feature maps F is generated by a convolution neural network VGG19[5] which is input to the twe-branches neural network. The top branch in beige, predicts the Confidence Maps, which detect parts of huamn. For example, neck, waist, foot, etc. The bottom branch in blue, predicts Part Affinity Fields (PAFs) to find optimal connections between parts, which will later be used to calculate angles and perform an ergonomic evaluation. The output of the two branches at each stage will be the input of next stage along with the feature maps F.

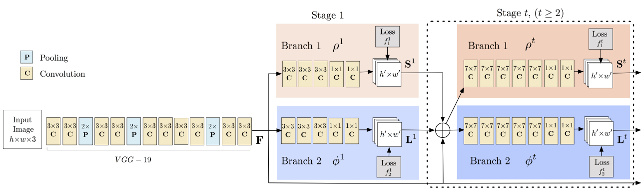

Figure 1: Network Architecture

RULA is capable of identifing high-risk positions, but not good at detecting low risk positions[1]. NERPA is modified RULA, of which some strict criteria of RULA are modified while assessment structure remains the same, so that NEARPA performs better in low risk conditions[3]. Besides, there is significant difference of ergonomic assessment results between RULA and NERPA[1]. The score and risk level of RULA does not decrease in most instances after improvement proposals have been applied, whereras NERPA could detect improvements better and reduce scores[3]. Moreover, the result of LUBA is not significantly different from that of RULA. Therefore, it is reasonble to use a method of combination of RULA and NERPA to improve the ergonomic assessment accurancy in both high risk and low risk conditions.

First of all, The above mentioned CNN will be used with public datesets, e.g., Common Objects in Context(COCO)[6] and Max Planck Institute Informatics(MPII) Human Pose Dataset[7] to estimate the pose information. Secondly, the results should be evaluated by RULA and NERPA. Afterwards, the developed framework is to be tested and evaluated. Finally, the ergonomics asessment data will be applied in MES.

Work plan

The research internship starts at 07. September 2020. The work plan is listed in Table 1 by week. Three presentations are colored in blue.

Week	Task
1	Read literature
2	Write expose, prepare for initial presentation
29. Sept.	Initial presentation
3 - 5	Inplemention of an neural network module for human position estimation
6 - 8	Implementation of ergonomics measure with human position
8	Write intermidiate report, prepare for intermidiate presentation
tbd.	Intermidiate presentation
9 - 10	Testing and evaluating the developed framework
11 - 13	Intergration to MES system
13	Write final report, prepare for final presentation
8. Dec.	Final presentation

Table 1: Work Plan

References

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