

Motivation

- ▶ Lifting heavy items is one of the leading causes of injury in the workplace. As per U.S. Bureau of Labor Statistics report:
 - In 2001, over 36 percent of injuries involving missed workdays resulted due to **shoulder and back injuries** in workers.
 - In 2017, **97,990 workers** taking a day away from work involving overexertion in lifting or lowering.
- ▶ Some of the common reasons for workplace injuries:
 - Short term pains in due to accidental events such as worker getting struck by some object.
 - Overexertion during manual heavy object transportation.
- ▶ The weight lifting pains can result in:
 - Inflammation and trauma to the tissue in and around the joints.
 - Wear and tear of the joints and cartilage.
 - Degeneration of the tendons.
 - Early-onset of arthritis.
- ▶ Posture detection and monitoring can loop to serve as an early warning system for the workers to enhance their work efficiency and physical health.
- ▶ **The motivation behind the proposed study is to address the problem of detecting and monitoring body postures in the work place where heavy object lifting is a part of the worker routine.**

Background

- ▶ Real-time pose estimation for a person is a key component in enabling machines to have an understanding of people in images and videos.
- ▶ Papandreou et al. (2017), Cao et al.(2017), Cao et al. (2018) have proposed various approaches for human pose recognition using deep learning.
- ▶ We intend to develop a human pose monitoring system on top of these approaches.
- ▶ We also intend to further predict the behavioral intent of the person using temporal data and recurrent models of neural network in our system.
- ▶ Being aware of good posture is the first step to breaking old poor postural habits and reducing stress and strain on your spine.

Objectives and Task Description

- ▶ The main objective of this project is **detecting and monitoring body postures** in the work place where heavy object lifting is a routine.
- ▶ Specific tasks involved in this project are as follows:
 - Design and development of an Edge Computing based camera feed processing unit to enable real-time posture detection on factory floors.
 - Develop user interface to allow multi-device accessibility and data visualization.
 - System design to allow prediction of workers' behaviors using computer vision and deep learning.

Experimental Design

- ▶ We are using the postural cutoffs defined in REBA (Rapid Entire Body Assessment) standards as a reference for our development.

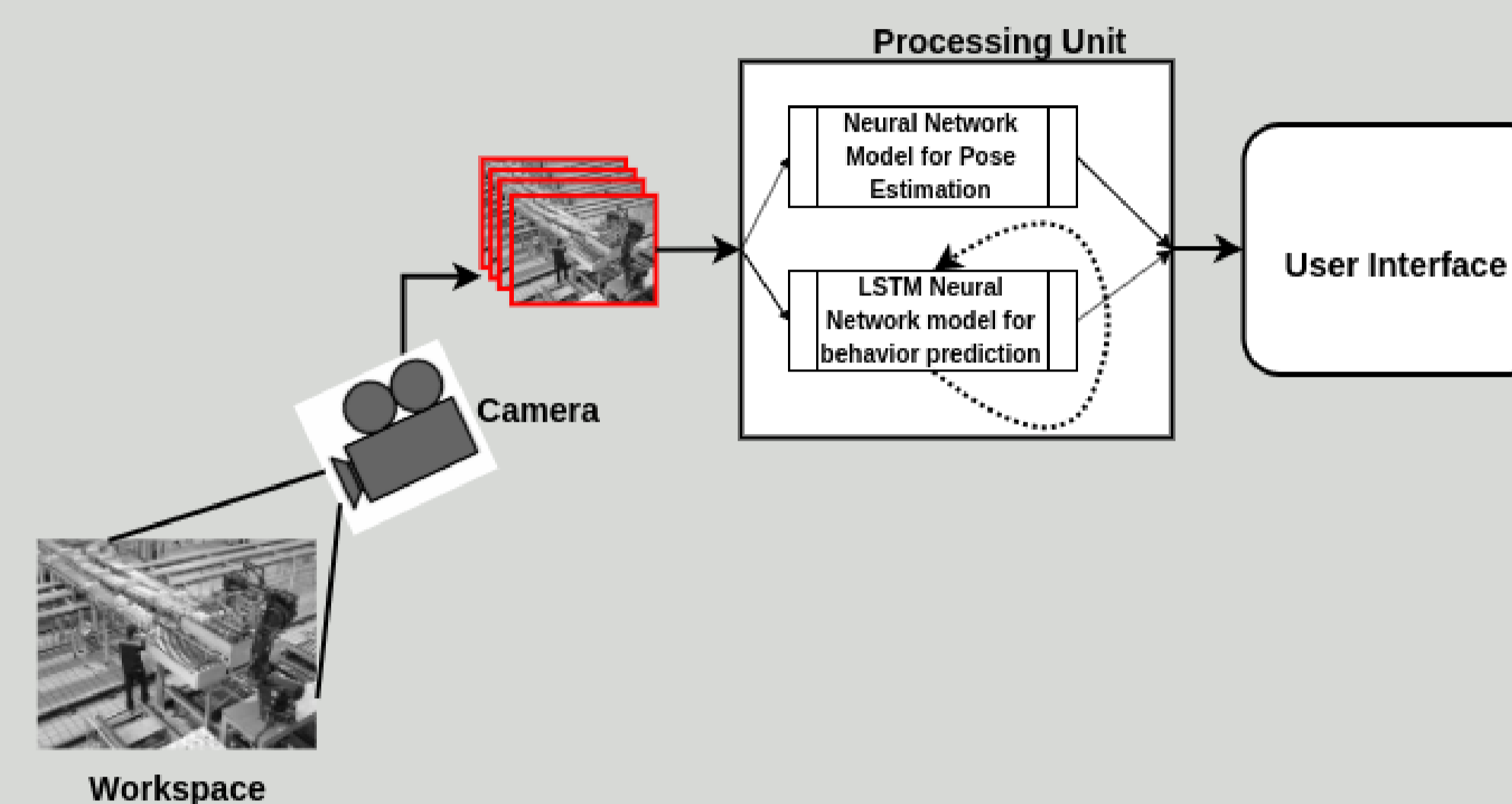


Figure: Schematic of the proposed setup

- ▶ The data-sets of human activity understanding presented by Caba Heilbron et al. (2015) and human pose dataset presented by Andriluka et al. (2014) will be used for this project. No human subjects will be involved in the current phase.

Expected Results

- ▶ An IoT device using **NVIDIA Jetson TX2 board** as the processing unit.
- ▶ The setup will be able to suggest corrective measures based on the detected postures of people.
- ▶ Body posture monitoring will be valuable to formulate requirements for a healthy working environment.
- ▶ Optimization of the manual handling of heavy objects on the factory floor is the primary focus of this research.

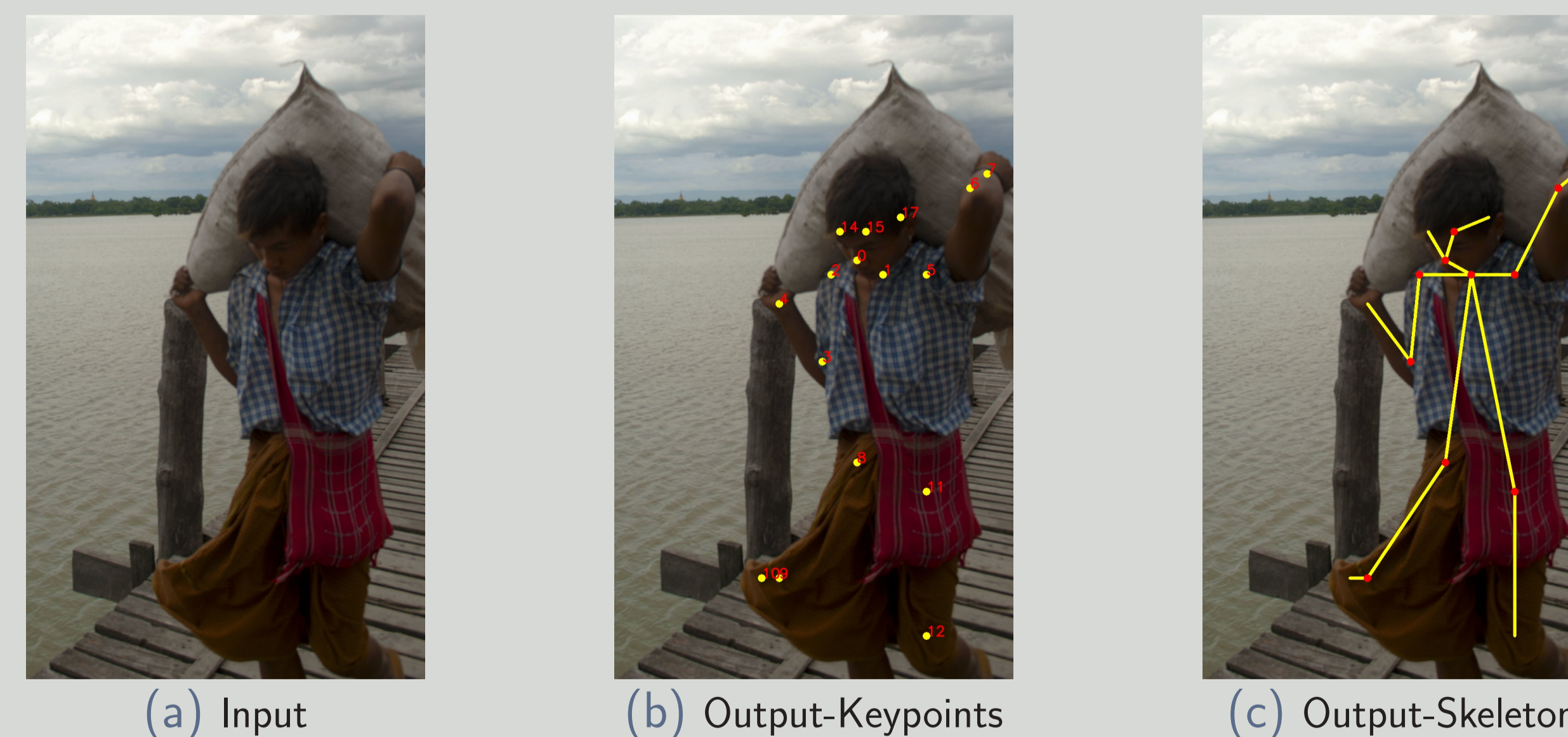


Figure: Detection of People: (a) Worker handling heavy load, (b) Key points on human body and (c) Posture skeleton of the worker.

Image Source of (a): <https://flic.kr/p/9QTZJN>.

The above result was generated by using the work presented by Cao et al. (2018) available at <https://github.com/CMU-Perceptual-Computing-Lab/openpose.git>

Limitations and Future Direction

- ▶ Limitations of this system include:
 - This approach being non-invasive, it can't give the physical information about the environment.
 - Including some wearable devices in addition to video feed for posture monitoring has a potential to improve the accuracy of the system.
 - For wide area coverage at workplace, multiple cameras will be required.
- ▶ Future work towards improvement of this system may include:
 - Incorporating the developed application on cloud platform for accessibility on mobile devices.
 - Data collection and data analytic platform development for the human pose recording and intent analysis.
 - Incorporation of developed pose recognition system in robots may result in:
 - ▶ Development of robust human robot interaction systems allowing robots to take decisions based on predicted human behavior.
 - ▶ This can further ensure safety in case of factory workers working along side manufacturing robots.
 - ▶ This module can also help in ensuring safety of pedestrians if used in self-driving cars.

References

- ▶ Caba Heilbron, F., Escorcia, V., Ghanem, B., Carlos Niebles, J. (2015). Activitynet: A large-scale video benchmark for human activity understanding. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 961-970).
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- ▶ Papandreou, G., Zhu, T., Kanazawa, N., Toshev, A., Tompson, J., Bregler, C., Murphy, K. (2017). Towards accurate multi-person pose estimation in the wild. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (pp. 4903-4911).
- ▶ Cao, Z., Hidalgo, G., Simon, T., Wei, S. E., Sheikh, Y. (2018). OpenPose: realtime multi-person 2D pose estimation using Part Affinity Fields. arXiv preprint arXiv:1812.08008.
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Acknowledgement

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Title	Author	Affiliation
A Lead-Free Carbon-Based Shielding Material to Protect Healthcare Workers	Devika Chauhan	University of Cincinnati Mechanical and Materials Engineering
IoT based AI Application for Posture Recognition to Reduce Workplace Injuries	Aditya Milind Deshpande	University of Cincinnati Mechanical and Materials Engineering
Dual-Functionality Heatable Carbon Nanotube Air Filters for Healthcare Providers	Yanbo Fang	University of Cincinnati Mechanical and Materials Engineering
Designing Next-Generation Solid Electrolyte via a Multiscale Computational Scheme to Avoid Workplace Battery Hazard	Yao Fu (Mengze Ma)	University of Cincinnati Aerospace Engineering and Engineering Mechanics
Neurotoxicity of Polyfluoroalkyl Substance (PFAS) Mixtures in Firefighting Materials	Ola Wasel	Purdue University School of Health Sciences
Heavy Metal Sensor for Construction Workers Based on 3D Graphene	Mahnoosh Khosravifar	University of Cincinnati Mechanical and Materials Engineering
Assessing Volunteer Workers' Exposure to Dust, Metals and Bioaerosol During Equine Assisted Activities/Therapies: An Exploratory Study	Kimberly Tumlin	University of Kentucky Preventative Medicine and Environmental Health
Characterizing Fine and Ultrafine Particle Exposure Among Home Healthcare Workers	Ashley Turner	University of Cincinnati Environmental Health
Role of Firefighting-Associated Chronic Stress Factors in Immune Dysfunction in Mouse Model	Brijesh Yadav	University of Cincinnati Environmental Health
Invited Posters		
Home Health Care Workers' Occupational Exposure to Bioaerosols and Potential Association with Respiratory Health Issues	Yao Addor (Targeted Research Training Poster)	University of Cincinnati Environmental Health

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