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# COMPUTER VISION IN INDUSTRIAL AUTOMATION FOR SAFETY

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***Abstract:*** **Computer Vision is** no more a buzz word in today's IT and OT world, rather it has become one of the key elementary building blocks of our daily life; be it IT, Industrial segments, Medical segments etc. Computer vision in Industrial safety is trending now due to COVID -19 and the safety guidelines not followed by the individuals in Industries. Every Company i.e. manufacturing or IT, the first priority is Safety. In manufacturing unit safety is maintained by Safety team or HSE team. Safety is individual responsibility but sometime due to ignorance major accident may happen so to avoid such an incidence it is very important to create process and guidelines in place. The Computer Vision with Industrial system makes it easy to implement the process and guidelines.

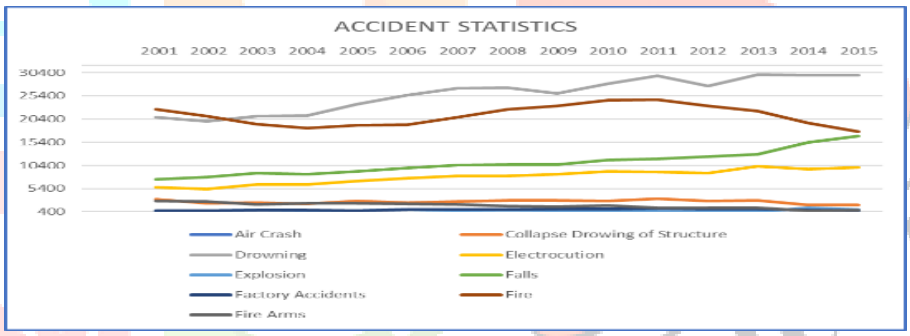



*Fig .1 Accident Statistics of 5 years.*

Source: 'Accidental Deaths and Suicides in India' Report 2016, National Crime Records Bureau, Ministry of Home Affairs.

Fig. 1 explains chart of un-natural deaths. Analysis shows most of problem is due to ignorance, not following proper guidelines or processes. For example, not wearing PPE, Safety jacket, Helmet, Safety shoes, Safety Gloves, Safety glass and so on**.** Present condition is very serious due to COVID-19. If anyone ignore the basic guidelines of COVID-19, then it will impact whole Manufacturing units, Tech park. Guidelines to save our self from Covid-19, Social distance, wearing Mask, temperature check.

Any ignorance in Covid-19 guidelines or HSE will impact huge loss to company with various aspects like as production loss, life loss, company credibility loss. So it is very important to use new feature technology 'Computer vision' which will solve this problem in very efficient manner.

Keywords— Industrial safety, COVID-19, Personal protective equipment, PPE, safety jackets, safety masks, ABB 800xA, ABB Ability™ Genix

## I. INTRODUCTION

Industrial sector is growing vastly to meet demands of growing human population. Examples of Industrial sectors are Solar power generation, oil and natural gas, metal industries, Cement, Vehicle manufacturing and many more. Injuries to working personnel is always a concern and protection against it has been a very challenging task for industrial leaders. There could be many instances where working personnel could harm his life from instances such as falling objects, electric shock, viral infection such as COVID-19. Working personnel must follow safety guidelines to protect themselves from injuries or death but sometimes it is not possible due to negligence, lack of knowledge and skills. Industries already have CCTV based monitoring system but is not very convenient and efficient as humans must manually identify whether working personnel follows safety guidelines or not. So, a proactive automated monitoring and controlling system for safety is required in industrial sectors. Safety systems should be capable of identifying and ensuring that the working personnel have all the safety equipment before attending any work.
Artificial intelligence and computer vision based industrial system will help industries to achieve highest safety standards and are followed by working personnel. If safety guidelines are not followed by working personnel, then a message alert / alarm is delivered to health and safety team (HSE). HSE team could then analyse the message and take necessary action. A person is automatically blocked from entering industry premises, control rooms, machinery equipment area without safety protection equipment. A message alert could consist of a photo copy of working personnel who did not follow safety guidelines along with his bio data.

## II. PORPOSED METHOD FOR ACHIVING SOLUTION

### 1. HOW SOLUTIONS COULD BE ACHIEVED USING 800XA

Utilize existing ABB ability Genix platform along with system 800XA and apply machine learning model to detect safety violations made by the working personnel.

Method: System 800xA DCS Integration

- System 800xa supports integration of CCTV with the inbuilt feature of VideOnet connect as mentioned in the below fig 1.

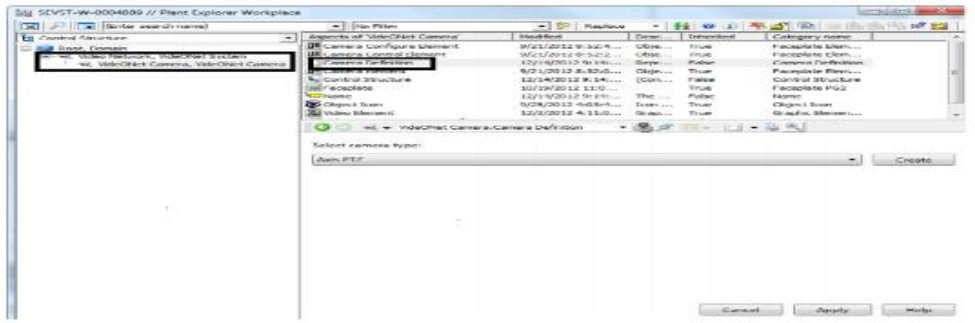


Fig. 1 shows VideOnet connect in System 800xA

System 800xa captures live events from CCTV and streams the live video with the help of VideOnet connect and store in the storage area. It is possible to reuse ABB ability Genix platform with 800xa to collect frames from stored video and apply machine learning and computer vision techniques. To have efficient utilization of bandwidth of ABB ability cloud network, it is advised for Machine learning safety prediction model to be located at ABB Ability Edgenius device. Only safety violation message along with photo of working personnel to be sent to ABB ability cloud for storage and not entire video frames. Working personnel in industrial premises without safety protection equipment will be identified by the proposed safety system and a notification to Health and Safety team is sent through email. The alarm message could contain photo of the work personnel who broke safety guidelines and bio data. HSE team could then take appropriate measures. It is also possible to have computer-controlled gate that could block work personnel without safety equipment from entering control room, construction area, and machinery area. It is also possible to reuse already existing ABB ability Dashboard web based application to monitor the safety of work employees at industry premises. This is very helpful, practically possible to implement and more useful for customers of ABB to have their employees and contractors to be safe at work. This solution helps to have more safe and reliable work environment.

### INDUSTRY 4.0

With the advent of Industry 4.0, digitalization and digital transformation have emerged as core drivers for industry. ABB Ability™ Genix harnesses the power of digitalization to drive key business outcomes - helping improve operational excellence, asset integrity and performance, sustainability, safety, energy efficiency and supply chain optimization, amongst others.
ABB Ability™ Genix has been structured as a platform and suite; and on the principle that data is at the center of digital transformation. It supports industries in unlocking immense value from data by contextualizing and integrating data from a variety of systems spanning across units, plants and even the entire enterprise ecosystem; further using industrial AI and analytics to provide deep, meaningful actionable insights.

We have a very good infrastructure and necessary tools to achieve AI and computer vision based industrial safety system. We could make use of machine learning and deep learning technology for image processing to achieve best results.
TensorFlow, Keras and OpenCV are one of the most useful tools that we could make use of.

CCTVs are used to capture footage or videos and are then utilized by deep learning techniques to automatically monitor and detect working personnel whether they follow safety guidelines. A python-based program will then send message or email to Health and safety team (HSE). HSE team could further take necessary actions.

The AI and computer vision based industrial safety system has two major steps:

1. Creation of a machine learning model to recognize safety equipment in human face.
2. Detect safety equipment, Prediction of safety problem and reporting to HSE team.

Safety equipment recognition machine learning model:

Creation of a machine learning model to detect safety problems.

The model created using below technique will be capable to classify and differentiate human faces with safety equipment and without safety equipment.

To create a machine learning model, it is needed to have set of positive and negative images. Positive images consist of face of a human with all safety protection equipment such as helmet, safety mask, safety eye wear. Negative images consist of a human with missing safety equipment. It is desired to have thousands of such

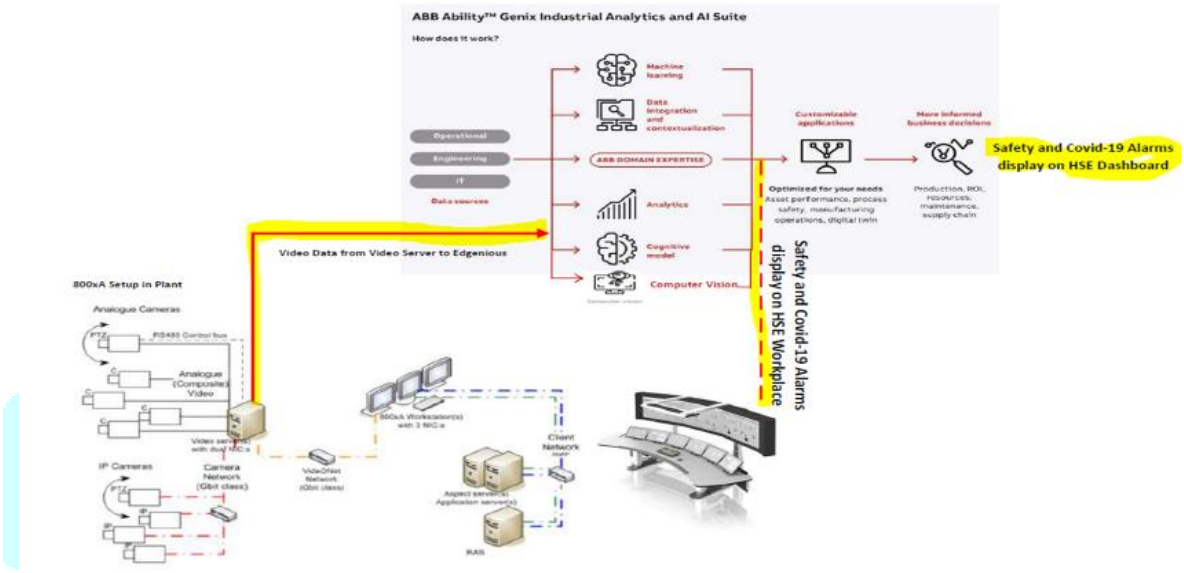



Fig 2: - Shows Integration of Webcam with System 800xA and ABB Ability™ Genix

positive and negative images for a machine learning to have a more accurate prediction. The images are converted to Numpy arrays and then the model shall be trained, and model could be saved as external file. We make use of opensource libraries such as Python, TensorFlow, Keras, Numpy, Scikit learn for building a machine learning model for AI and Computer vision based industrial safety system.

- Creation of Machine learning Model to Detect safety problem:

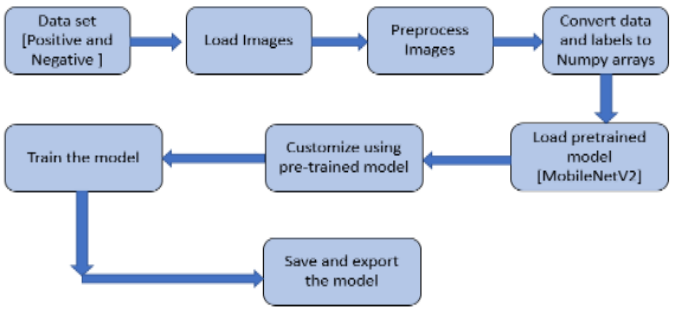



Fig 3: Prediction of safety problem and reporting to HSE team

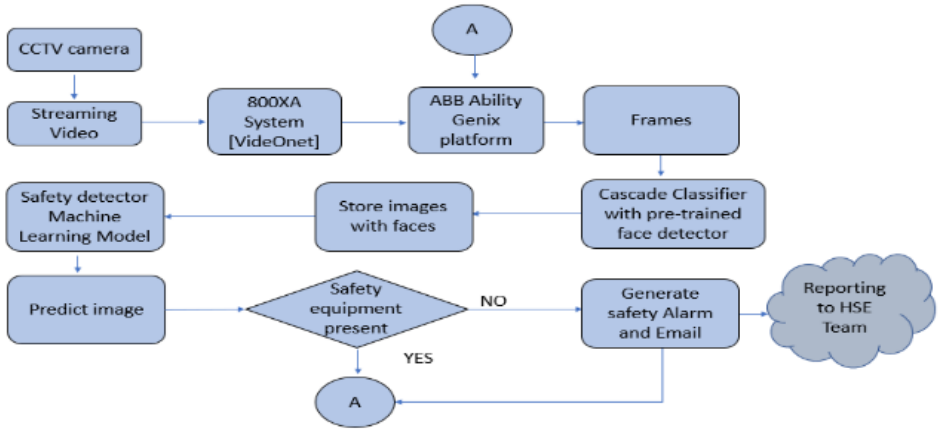
**Computer vision**: It is a field of study which encompasses on how computer see and understand digital images and videos. Computer vision involves seeing or sensing a visual stimulus, make sense of what it has seen and extract complex information that could be used for other machine learning activities.

CCTV camera is a core component here, so it must be ensured that the images captured are clearly visible. Following points to be resolved before proceeding ahead:

1. Indoor CCTV and outdoor CCTV should capture images clearly during night. So, a feasible lighting solution should be provided for it. It could be LED light.
2. If CCTV is located outdoor then it should be ensured to have protection against dust and rain. Preferably cover shielded CCTV to be used.
3. *CCTV settings should ensure that it cover the area of surveillance where safety guidelines have to be monitored.*

*Below is a block diagram that illustrates the workflow*

- Safety problem prediction and reporting – Using System 800xa and ABB ability platform




CCTV footage is captured as streaming live video. We use OpenCV library to capture video from CCTV and then convert to set of images / frames. Each image frame is then analyzed for detection of safety problems. The main objective is to identify human face from an image extracted from video that is captured from CCTV.

OpenCV: OpenCV (Open Source Computer Vision Library) is an open source computer vision and machine learning software library. OpenCV was built to provide a common infrastructure for computer vision applications and to accelerate the use of machine perception.

Feature based approach for face detection using OpenCV. Feature extraction is a technique to extract different feature of an object such as shape, texture, color etc. Human face has several visible organs such as eyes, eye brows, mouth, nose, ear. These visible organs are treated as features. We utilize OpenCV library to extract such features.

**Face detection algorithm**:

We use a popular feature-based approach called as Viola-Jones algorithm which is quite good in real-time face detection but also has its own drawbacks, this algorithm is slow to train and works with only grey scale image. A more sophisticated algorithms are also available today with their own pros and cons.

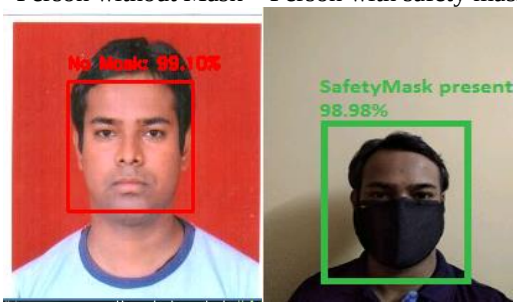
Viola-Jones algorithm is also known as Haar Cascade algorithm. It an effective machine learning object detection algorithm used to identify objects in an image or video. In OpenCV, we have several trained Haar Cascade models which are saved as XML files. Instead of creating and training the model from scratch, we used pre-trained model for front face detection of humans i.e., "haarcascade_frontalface_alt2.xml". Above haarcascase_frontalface_alt2.xml, a pre-trained face detection model is loaded into cascade classifier. Frames are extracted continuously from a live video stream from CCTV using OpenCV library and are converted to grey scale. This grey scale image is then utilized by the cascade classifier and then faces are detected and stored. The stored images ensured to be in RGB scale and are then utilized by model for prediction of safety equipment in working personnel. There are two possible outcomes:

1. Working personnel wearing safety equipment such as helmet, COVID-19 masks, safety eye glass.
2. Working personnel without wearing or missing safety equipment.

Safety reporting to HSE team and blocking working personnel from entering industrial premises:

The result of machine learning model will be observed by the Python program and then if there are any safety problems observed from working personnel, then it is reported to HSE team as an alarm. An email could be sent with details of working personnel such as image and bio data and contract details with that industry. The above safety details are also sent to ABB ability cloud for storage. It is also possible to block the working personnel without necessary safety equipment from entering industry premises by closing automation-controlled gates near entrance to control panel, security gate of company and construction area and so on.

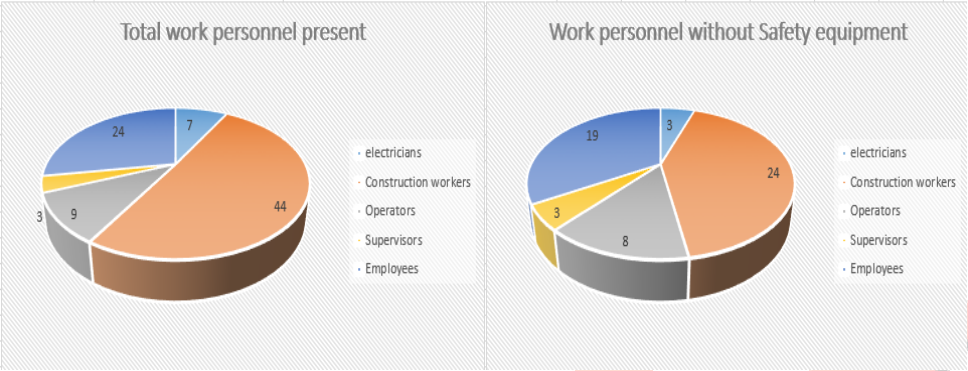
Person without Mask Person with safety mask



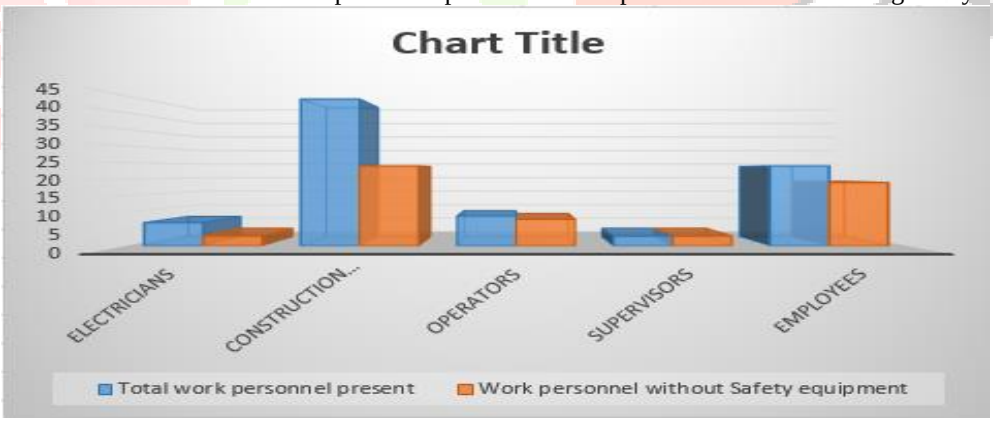

**Reporting in web-based Dashboard portal:**

It is possible to utilize already existing ABB ability Dashboard application to show health status of a factory or industry. A separate Dashboard view could be created to monitor the safety status. Dashboard should be capable of showing number of safety violation alarms, number of working personnel with safety equipment. Below is the sample picture of how safety problems could be captured and viewed in dashboards.

Below two pie charts shows total work personnel present at work location and work personnel in work location without having safety equipment.




Below chart shows Total work personnel present vs work personnel without wearing safety equipment




## III. RESULTS AND DISCUSSION

Chapter 1 discussed various methods following which HSE can be achieved by 800xA, without much changes in current system. Due to safety problems more deaths and injuries are happening in industrial plants. Making safer environment is always a challenge and many industrial leaders are challenged to identify new innovative solutions. Operators, electricians, workers, supervisors of plant sometimes could have fatal injuries / deaths due to overconfidence negligence, lack of skill and knowledge in handling electrical equipment, machinery, materials. There are also new health and safety related problems arising such as COVID-19. These problems could completely shut down business and a potential threat to unemployment and a worldwide recession. Safety policies made by companies are alone not helpful in having safer environment but along with it, a proactive decision-making and controlling system is also needed.

The best solution that an industry could have is a computer vision and Artificial intelligence based industrial safety system.

## IV. REFERENCES

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DECLARATION:

The hacking instances mentioned in the paper are carried out only with intension of verifying the cyber security compliance of those solutions. There were no other intensions\gains\ill-effects intended. All the vulnerabilities found during these activities were reported to concerned or higher authorities.