INTRODUCTION
Throughout the history of the construction industry, many fatalities and injuries have occurred in construction sites. One of the major causes of accidents is unsafe site conditions; basically, this is due to inadequate supervision. To improve upon the traditional supervision approach, this study proposes a ‘Framework Development for Construction Safety Visualization’ approach. In addition to this, a computer vision Edge Detection Algorithm was developed and tested to convert construction site still images into edges of the objects in the images. The framework development of this study uses computer vision, robot vision, image compression, pattern recognition, internet transmission, network communication, and image processing.

ALGORITHMS
1. **Edge Detection Algorithm:**
   - Compute Luma component-get color intensity value from an image.
   - Find 2nd order partial derivatives with respect to x and y then Laplace transform-the max differences of pixels Eq. (1).
   - Compute histogram from the values Eq.(1) - arrangement of pixel values in descending order.
   - All the values for which the area of the histogram to the right is less than 2.5% are edges, less than 10% are possible edges, and if any of the neighbors of a possible edge is an edge then the possible edge is an edge.

   \[
   \Delta f(x,y) = \nabla^2 I(x,y) = \frac{I(x-1,y) + I(x+1,y) + I(x,y-1) + I(x,y+1) - 4I(x,y)}{2}
   \]  
   Eq. (1)

2. **Proposed Segmentation Algorithm:**
   - Divide the scene into Video Object Planes (VOPs).
   - Separate the VOPs according to the people in the scene.
   - Focus on the part of the VOP of a person between the base of the neck and the upper end.
   - The sub-video object plane of the hard hat consists of two orthogonal semicircles.
   - The cord line joining the ends of the top semicircle forms an angle with the x-axis of the screen. This angle \(\theta\) can be determined by taking the dot product of the cord line row vector with the row vector (1, 0). If the dot product is one, the cord is parallel to the screen coordinate x-axis and the person is standing straight up, in this case, there is a possibility of the head tilting. This possibility can be resolved using more than one camera. If the dot product is between -1 and 1, then the hard hat can be rotated by \(- \arccos \theta\).

APPLICATIONS OF FRAMEWORK DEVELOPMENT
This study developed a framework for hard hat detection from the real time images transferred from the construction sites. This framework is prepared to warn safety personnel if the workers are not wearing hard hats. A big concern to some may be to know how the framework detects and dispatches a message that one or more are not wearing hard hats on their heads.

Fig. 1 shows a flowchart that describes the steps involved to detect a hard hat on a worker’s head at the site.

APPLICATIONS OF EDGE DETECTION ALGORITHMS

**CONCLUSIONS**
This study developed a framework for hard hat detection from the real time images transferred from the construction site. This framework is prepared to alert safety personnel if the workers are not wearing hard hats. One of the major steps of this framework is to develop Edge Detection algorithm which has been completed in this research. This algorithm changes a still image into a line diagram of the objects in the image. Segmentation algorithm that has been proposed in this framework is not developed. After Segmentation algorithm is developed, the combination of these two algorithms can be used to identify the hard hats. This novel approach will reduce the fatality and injuries at the construction sites and will help to achieve zero fatality.

**RECOMMENDATIONS**
To complete the framework, the proposed Segmentation algorithm needs to be developed as well as an algorithm to split a video into a number of images. In addition to this, we need to implement file servers, database management, imbedded systems, internet software, network software, and internet security. We further recommend extending the hard hat detection to other personal protective equipment (PPEs).