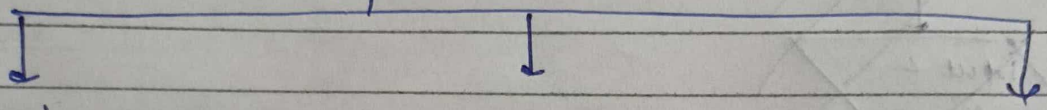
FALL PREVENTION USING A CAMERA BASED LINE LASER OBSTACLE DETECTION SYSTEM.

- When elderly fall, it affects their physical as well as mental state.
- Factors causing fall..



Intrinsic factors
Diseases and reduced physical abilities.

Extrinsic factors
environmental hazards, ie poor light slippery floors, unsuitable footwear

Exposure to risk.
Most inactive and most active people have highest risk of falls

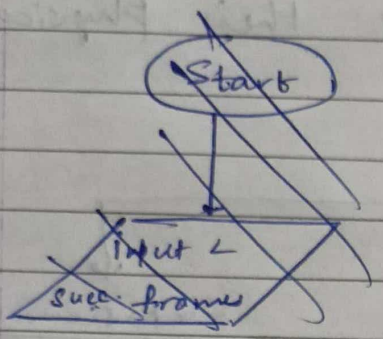
- Until now all the fall detection system detected the falls after they had occurred.
- To overcome the shortcomings of all the previously designed systems we introduce a line laser obstacle detection system which prevents falls in advance.
- Popular range based sensors include ~~the~~ ultrasonic sensors, laser range finders, radar and stereo vision, each has its own shortcomings.

METHOD:

- Config: The line laser is mounted on the side of the ~~the~~ shoes and an RGB camera is fixed but tilted down on the top side of the shoes.

- A blue glass paper is used as a band pass filter to resist unnecessary light from environment

- ~~SOFTWARE FRAMEWORK:~~



- SOFTWARE FRAMEWORK: Initially camera continuously acquires images and the obtained successive frames are compared with each other.
- When the users foot is on the ground and when the foot is at the highest pt., at both these instances obstacle detection events are triggered.
- Otherwise it will keep on comparing successive frames.
- The whole algorithm is summarized in the flowchart pasted in the next page.
- SAD (Sum of Absolute difference)

$$SAD = \sum_{u=0}^{N_{rows}} \sum_{v=0}^{N_{cols}} \frac{|I_p(u,v) - I_c(u,v)|}{N_{rows} N_{cols}}$$

(u, v) → Pixel coordinates
N_{rows} and N_{cols} → pixel nos of image width & height.
I_p and I_c → pixel intensity of the prev & curr frame resp.

- Basically the SAD is used to determine the difference b/w 2 successive frames, and using this diff we're able to judge whether the feet is at ground or at the highest point.

- SAD value is small when the feet is at ground or at the ~~dot~~ highest point and large otherwise.
- This implies that relatively small SAD value happens at the middle and at the end of every swing phase.
- Therefore the obstacle detection ~~is~~ gets ~~triggered~~ triggered when SAD value is small.

- LINE LASER PATTERN ~~EAT~~ EXTRACTION : Once the obstacle detection event is triggered a median filter is then applied to suppress the bad influences coming from the environmental noise.
- After applying the median filter an intensity threshold is set to separate the line laser pattern from the surrounding.
- To increase performance intensity threshold is set over a window rather than a specific pixels.

- LINE LASER PATTERN ~~CL~~ CLUSTERING : To recognize how far and how large the potential obstacles are, a segmentation algorithm is needed after line laser pattern extraction procedure.
- This algorithm classifies each pixel on the line laser pattern into several clusters that are likely denoting the obstacles.

- HOMOGRAPHY TRANSFORMATION : After executing the line laser pattern clustering, the physical distance is needed to be determined by homography transformation.

- The transformation denotes the relationship b/w the image coordinate and the real world coordinate

$$\begin{bmatrix} x_1' \\ x_2' \\ x_3' \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix} \rightarrow (1)$$

real world coordinate | homography matrix | coordinate on the image plane.

$$(x_1', y') = \left(\frac{x_1'}{x_3'}, \frac{x_2'}{x_3'} \right) \rightarrow (2)$$

real world coordinate conv. to real dimension.

- ~~By rewriting the Above (1) and (2) only~~
- $h_{33} = 1$.

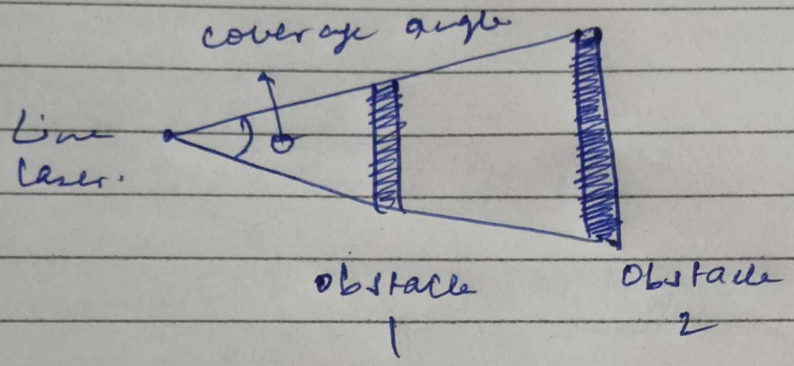
$$\begin{bmatrix} x & y & 1 & 0 & 0 & 0 & -x'x & -x'y \\ 0 & 0 & 0 & x & y & 1 & -y'x & -y'y \end{bmatrix} \begin{bmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \end{bmatrix} = \begin{bmatrix} x' \\ y' \end{bmatrix}$$

- From here the 8 unknown of homography matrix ~~are~~ can be known and $h_{33} = 1$.
∴ We obtain homography matrix.

- In practice the real world coord should be shifted again, due to translation in the basis position.

- OBSTACLE ALARM LEVEL CLASSIFICATION :

- As long as the width and depth of obstacles can be calculated, alarm level can be classified.
- To ~~co~~ cover the aspect of size and distance θ(coverage angle) is coined.



Both of same coverage angle and therefore same alarm level

- ~~Its~~ To avoid unnecessary alarm messages we introduce 4 alarm levels where
  1 → most urgent and loud
  2, 3, 4 → becomes less urgent and weaker.
  ↓
  system will not react.