Vision Based Intelligent Rescue Operations Bot

Motivation and Context

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People die every day in USA due to household fires.

88%

Of the deaths in fire are caused by is smoke inhalation as opposed to burns

30%

Of the deaths involve the victim being unconscious or asleep during fire.

Source - NFPA and Linkedin.

Incoming Dow

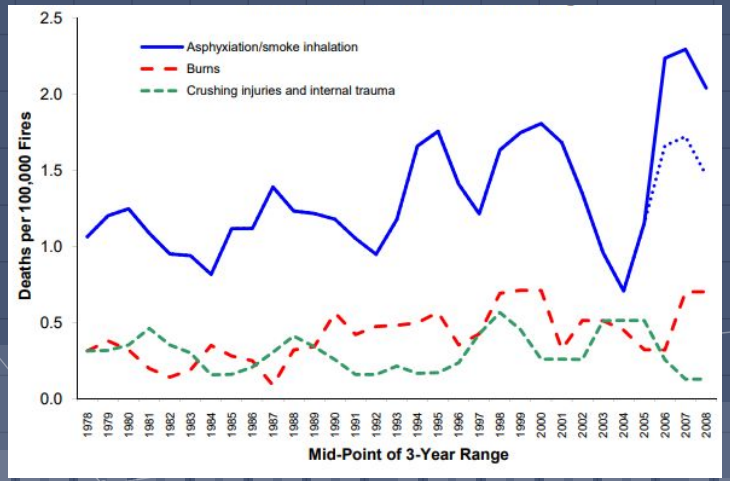
- In 2014, due to rapidly deteriorating fire conditions, a firefighter became trapped in an extremely cluttered apartment on the 19th floor of an apartment building. He died of smoke inhalation and thermal burns.
- In 2007, two firefighters became trapped in ‘maze-like’ conditions in an office building that was being demolished. Both victims died on the 14th floor due to smoke inhalation. In all, 115 firefighters were injured in this incident.

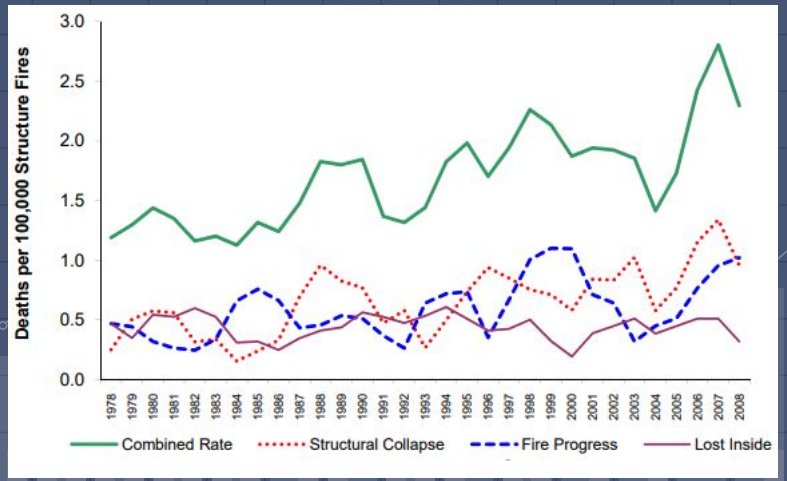
Source - NFPA and Linkedin.

Statistics

- Almost all of the non-cardiac deaths of firefighters inside structure fires over the past 30 years have been due to smoke inhalation.

- Getting lost in the affected area of fire has been among the top four causes of death of firefighters between 1977 to 2009.





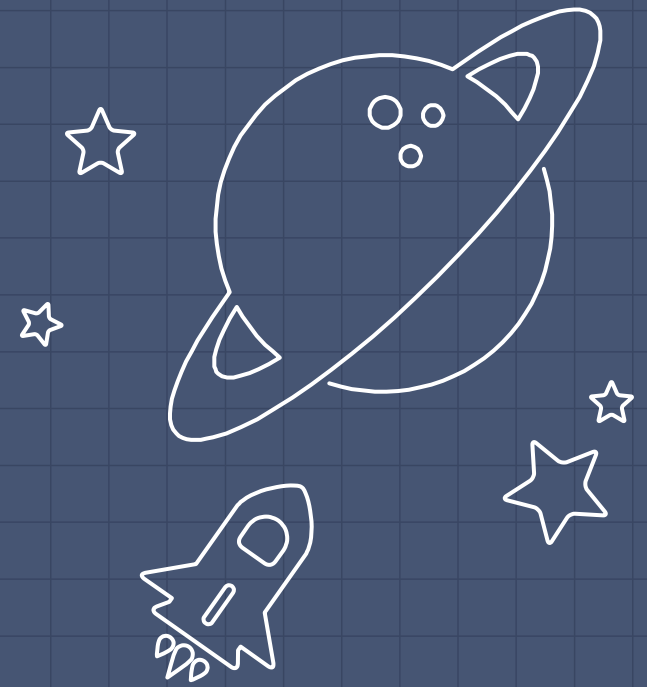
Source - NFPA and Linkedin.

Key Points to consider...

- Majority of the deaths in fire are due to lack of oxygen and excessive smoke inhalation.
- During the search operation firefighters are unaware of the environment causing fatalities.
- Victims are unable to escape the site despite knowing the complete layout of their homes.

Proposed Solution

- Provide a clear wireless video feed of the rescue site to the Ground Station.
- Provide the map of the region of operation to the user.
- Identify key victims in the room.
- Help prioritize the rescue operation by classification of dead or alive.



Presenting the IROB

- Provides good mobility in mildly rough terrain.
- Provides better visual aid to rescuer by dehazing the video from on board camera in mildly smoky/ foggy environments (translucent).
- Identifies potential victims in the room using person detection.
- Declares the unconscious victims as alive or dead using motion magnification approach within a range of 1m.
- A 3-D visualization of the rescue region for indoor conditions with non-plain walls.
- Wireless Local Area Network to transmit video feedback and a web based GUI for easy access of data.

Remotely Operated ATV

Need for an All Terrain Vehicle

- Usually the terrain on which rescue operation is carried out is uneven.
- This can arise from the presence of debris in the situation.
- An all terrain vehicle would thus be needed for thorough inspection.

ATV Specifications

Unbreakable PVC+MDF Chassis	Dimensions 23x28x
High Torque DC geared Motors	300 RPM, 12V, 30kgcm, 800mA NL current
Li-Ion Battery	4400mAh, 2C, 11.1V, 3S2P
Dual DC Motor Driver	For motor rating (6V-18V), 20A continuous current under normal operation
FS-CT6B Rx-Tx	6Ch. 2.4 GHz Type 2 radio controller
Servo Motor	(14-16)kgcm stall torque at (4.8-6)V

Providing Clear Video Feedback via Dehazing

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Need for Clear Video Feedback

- In scenarios involving smoke or haze, there is lack of proper visual feedback for the firefighter.
- Smoke or Haze makes it harder for the rescuer to spot victims, leading to ill-planned rescue operations.

Implementation

- We are using **Iball 20.0HD** webcam for video streaming.
- The streaming is done on **Flask Web Server.**
- We are using the **All-in-One Dehaze Net**, CNN for dehazing the image. We have compared it with a similar implementation DehazeNet.

Results

Input image | DehazeNet Output | AOD-Net Output






Identifying Potential Victims

Need for Person Detection

- Considering the poor quality of visual Feedback, it becomes difficult for rescuers to identify victims.
- There is a possibility of human error i.e, the rescuer misses out a few of the victims.
- Even if the user spots a victim, he has no idea whether he is dead or alive.

Implementation

- The Camera used for Person detection is an **Iball 20.0 HD** webcam.
- The video streaming is done via **x11VNC** server.
- The Intel Movidius Neural Compute Stick is used for inference for the purpose of person detection.
- The Mobile Net SSD algorithm is used for person detection.

Results

Frame rate comparison on frame size : 300x300

Processor Used	AOD-Net	Person-Detection
CPU (Intel(R) Core(TM) i5-6200U CPU with 2.30GHz)	6-7 fps	11-12 fps
UP2	2 fps	2-3 fps
UP2 +Movidus	N/A	8-9 fps

Prioritizing the Rescue

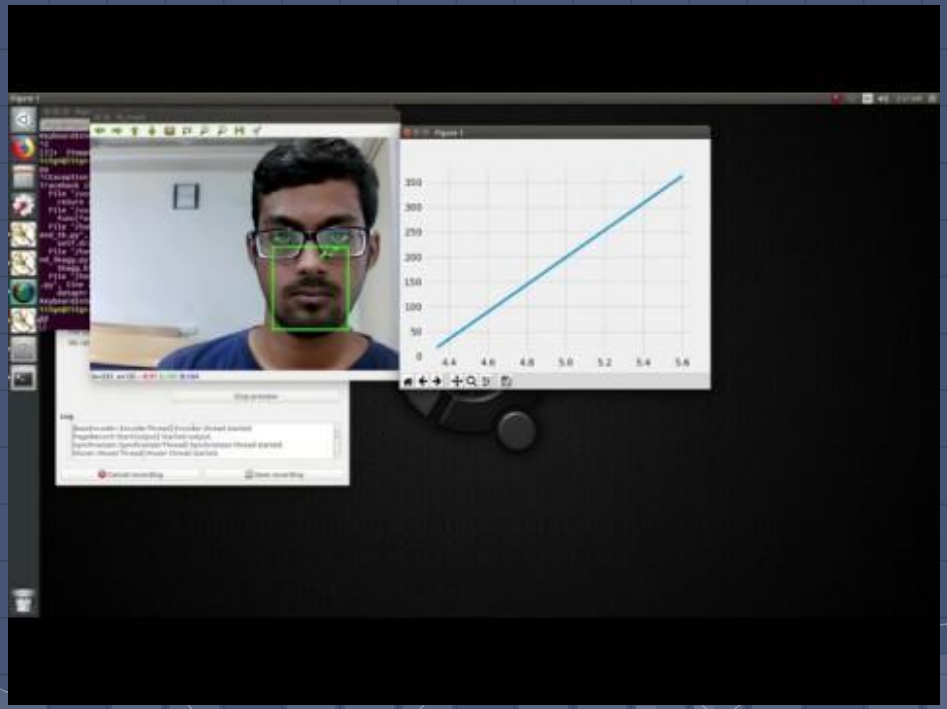
Need for Prioritizing the Rescue

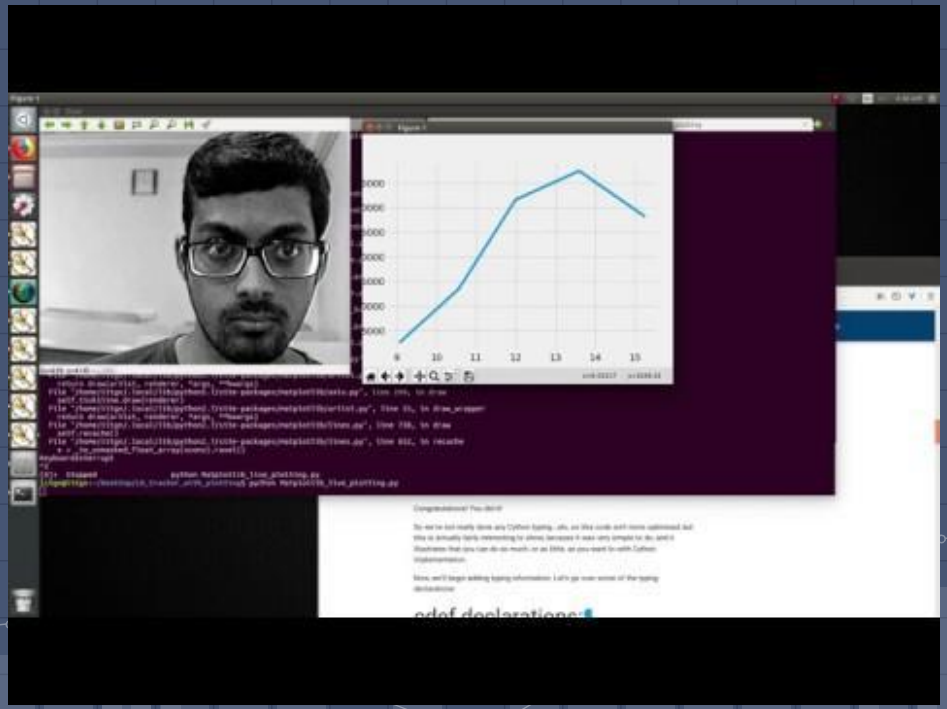
- In disaster scenarios involving life and death, time is of utmost importance.
- Prioritizing by saving those people that have most probability of being alive is key to a successful operation.

Implementation

- First, We apply Eulerian Motion Magnification in order to magnify motion on the person detected frame.
- Secondly, we use Lucas Kanade tracker, to track the motion points and find motion magnitude.
- The person is then classified as Dead or Alive.

Results





Mapping and Localization

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Need for Mapping and Localization

- During search and rescue operations, it is always better to have a good visualisation of the site to be searched specially when the victims get trapped in elusive places.

- Also, being able to remotely monitor the location of the victims would help in a better analysis of the situation and hence device a more robust rescue plan.

Implementation

- IROB is equipped with a Kinect V2 (XBOX One) which has a RGB sensor, and an Infrared (IR) emitter and detector.
- We have made use of the RTAB-Mapping ROS package for generating map and localising the bot.
- RTAB-Map makes use of RGBD-graph based SLAM and Memory management for this purpose.
- The map is wirelessly produced at Ground Station (GS) via **x11VNC** server.

Live Video Feedback on Web Server (Flask)

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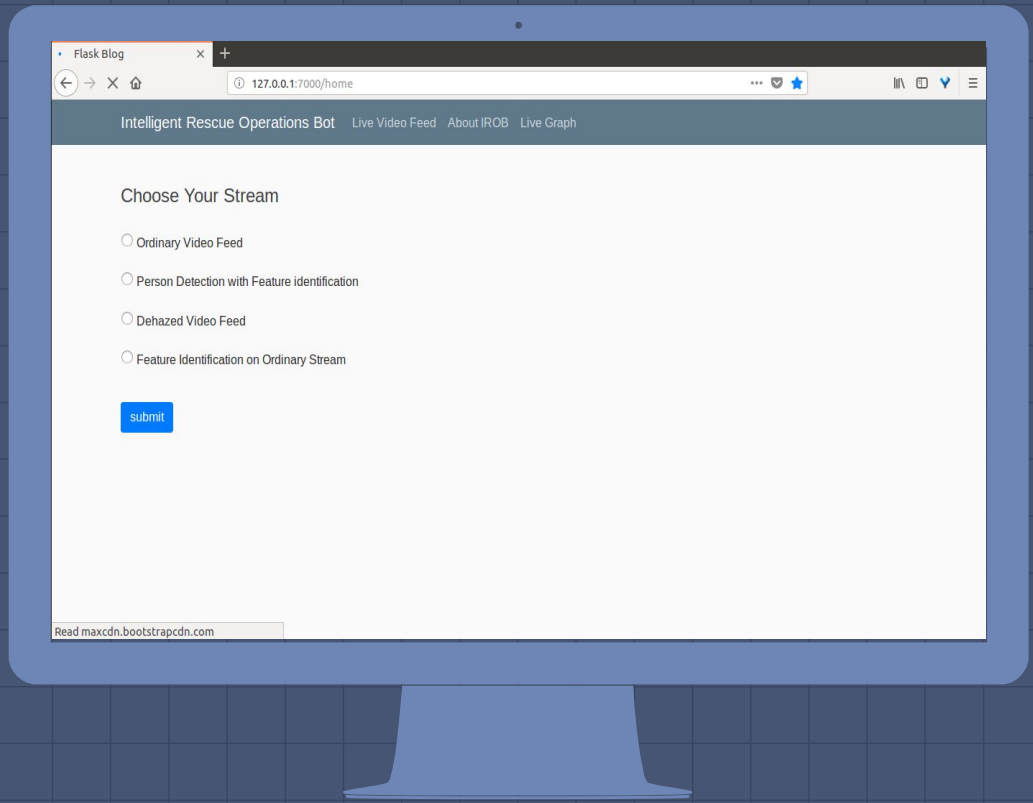
The Flask GUI



Further Applications of IROB's Features

- The AOD-Net algorithm we have used can also be applied to outdoor smoke or haze, which can be used in self-driving cars.
- Our entire model can also be used in situation involving poisonous gases

THANK YOU !

Any questions?

TEAM

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