SAN JOSÉ STATE UNIVERSITY

PROJECT REPORT

SmartCams

Project Team-3

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1. Introduction

In recent times, we have witnessed a great amount of growth in technology especially in the field of Machine learning and Artificial Intelligence. The scope of this field is huge, ranging from text to speech conversions to predictive analysis. One very interesting area this could be used in is in emulating *visual recognition* abilities in a machine. This is not just an interesting area but also an area with great scope for making an impact, be it for security purposes or for understanding trends visually. Visual recognition combined with analytical tools could provide us with extremely useful insights.

Smart Cams is a software product that leverages visual recognition services and provides customised solutions to end users. The camera is empowered with visual recognition abilities that could identify the presence of a person and estimate their age range, gender and number of people at a particular time. It can also identify objects within a frame.

The information pertaining to people could be extremely helpful to store/restaurant owners looking for in-store analytics that could help them assess the demographics of the crowd over a period of time. Smart Cams can also be used for home security to alert the owner in case someone unexpectedly turns up at his or her door.

2. Need for Smart Cams

2.1. In-store analytics

Understanding the impact of marketing and store management on in-store sales is complicated. Not only has the shoppers behaviour changed, but the retail landscape has rapidly evolved. With the explosion of online retail stores, retail analytics helps brick and mortar stores to maintain their competitive edge by gaining meaningful insight into customer behaviour and shopping patterns.

This insight can be used by the management to make informed business decisions.

Smart Cams allows users to collect, analyze and interpret the data in real time. Smart Cams collect the demographic data(gender, age, proximity) of customers. This allows the users of Smart Cams to gain meaningful insight into customer behaviour patterns, which can be used to improve store performance, pricing and promotion of products, predictive analytics, and workforce/stores streamlining. This insight helps the users to improve their sales, customer experience while lower their overheads.

2.2. Home Security

In today's world, we need to actively think about our privacy and security. As crime rates are increasing and burglaries are on becoming more sophisticated, protecting ourselves and our loved ones should be our top priority. We can never know what tragedy might occur in any of our lives. We cannot possibly know what the future holds for us, but we can definitely put up safeguards to prevent it or at least minimize its effect.

Smart Cams can be configured to be activated based on motion sensors. They can be installed around the house to monitor the surroundings. Wifi enabled Smart Cams can live stream video of the surroundings, which can be accessed from remote locations. Smart cams can also be configured to recognize people's faces, and profile them. These cameras can send alerts to the users about suspicious/unfamiliar people around the house. This allows the users to keep themselves, the family members and property safe from burglars, thieves and criminals.

3. Working of Smart Cams

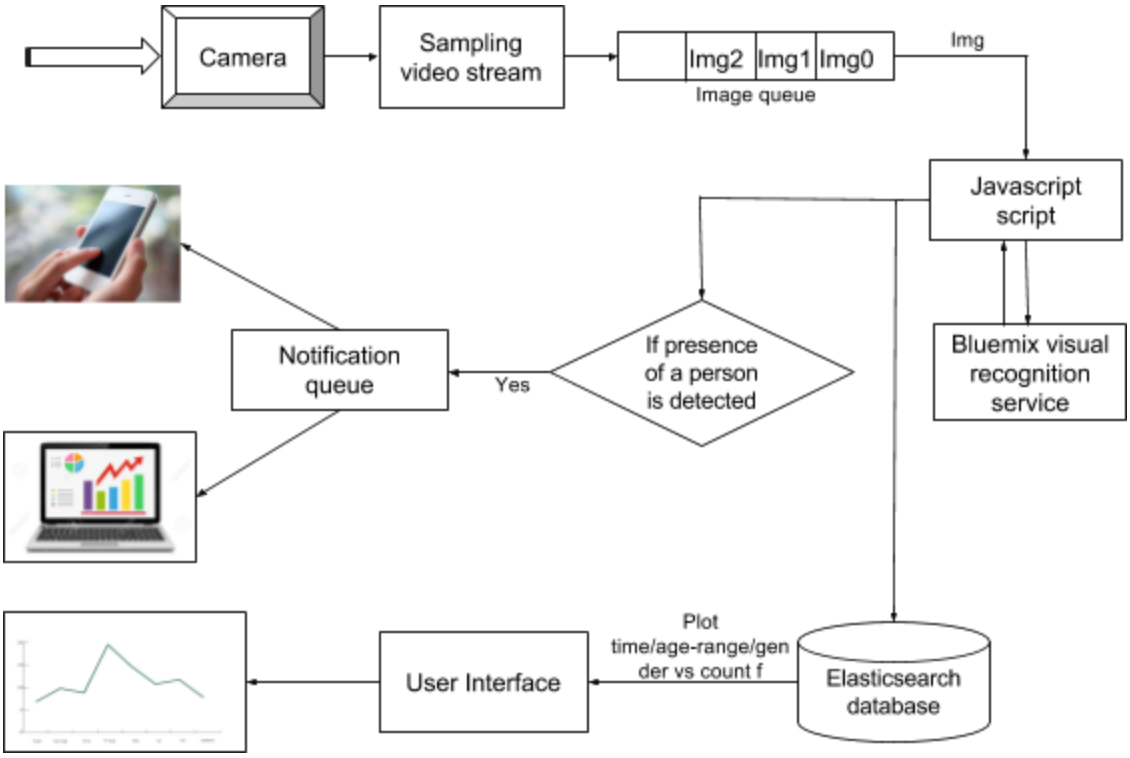


Figure: Flow diagram

3.1. Image Recognition

The fundamental step of a visual recognition application is image acquisition which is defined as the action of retrieving an image from some source, generally a hardware-based source. The image which is acquired by hardware source is completely unprocessed. Here, it is even more challenging since the source being used is a video recording camera.

In order to be able to run visual recognition services on it, the streamed video undergoes sampling at a predetermined optimal frequency. The Smart Cams then samples the video stream at an interval of 3 seconds and uploads the sampled data to a locally run server. The server in turn uses **IBM Bluemix visual recognition** APIs to analyze the sampled images and get a response from the bluemix system.

The response received contains a JSON object containing names of objects present in the image(based on how the service has been trained) and confidence scores associated with each object if it's greater than 0.5.


```
"images": [
  {
    "faces": [
      {
        "age": {
          "max": 24,
          "min": 18,
          "score": 0.494174
        },
        "face_location": {
          "height": 113,
          "left": 241,
          "top": 139,
          "width": 88
        },
        "gender": {
          "gender": "FEMALE",
          "score": 0.0179862
        }
      }
    ],
    "image": "dl.png"
  }
],
"images_processed": 1
```


Figure-1: JSON response from IBM Visual Recognition service

Based on customer requirements, the subscribers receive alerts either on their mailbox or as an SMS. The response is also stored in an elasticsearch database, so that the data can be used to later run data analytics. The data is represented using different info graphs, charts and tables.

3.1. Data Analytics

3.2.1 Elastic Search

Elasticsearch is an open source full-text search engine written in Java that is designed to be distributed, scalable, and near real-time capable. Real-time means that although documents are indexed immediately after they are successfully added to an index, they will not appear in the search results until the index is refreshed. The Elasticsearch server does not refresh indices after each update, instead it uses a specified fixed refresh interval to perform this operation.

This response specifies details pertaining to a person like age and gender. Now as the server predicts approximate information, we get an age_range, that is, maximum possible and minimum possible ages.

JSON response displayed in **Figure-1** is pushed to Elasticsearch index as a document.

3.2.2. Kibana

Kibana is an amazing visualization powerhouse for Elasticsearch data. Kibana is great at creating graphical visualization with a useful plugin infrastructure. Using Kibana, we can create multiple data visualizations, like pie charts, line graphs and bar graphs.

We have used this software to create a dashboard that displays number of people visiting a store/restaurant along with their gender, age group, and the time at which they are visiting. Here, we get near real time data. This visualization provides a better understanding on data. Dashboards are specific for each business. Visualizations are modified after each fixed refresh interval (custom).

These visualizations are helpful for deciding criteria like where a business should focus most, how to attract more people for improving the business, what the peak days for business are, so that they can prepare beforehand to handle various circumstances like increase in workload etc.

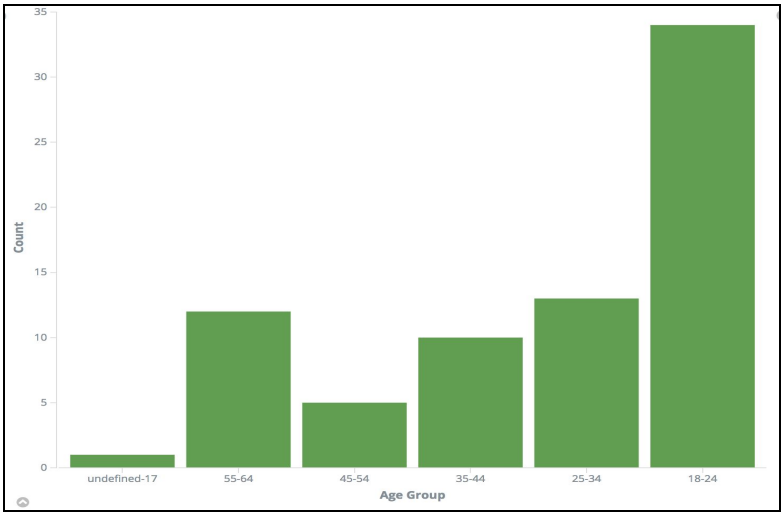
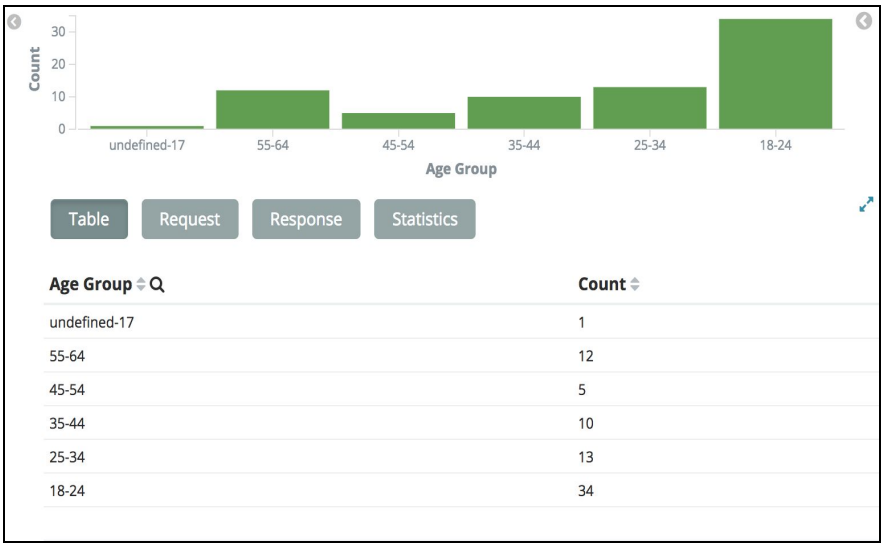


Figure-2: Data represented in Graphical format

Above graph specifies age groups of people entering a store/restaurant. From the graph, it is clear that people of age range between 18-24 are the most frequent visitors. By hovering on the specific bar other details can be seen. Following is the same visualization with a table containing details.



Age Group	Count
undefined-17	1
55-64	12
45-54	5
35-44	10
25-34	13
18-24	34

Figure-3: Data visualization with details included

Some more graphs that help in data analytics can be shown as follows:

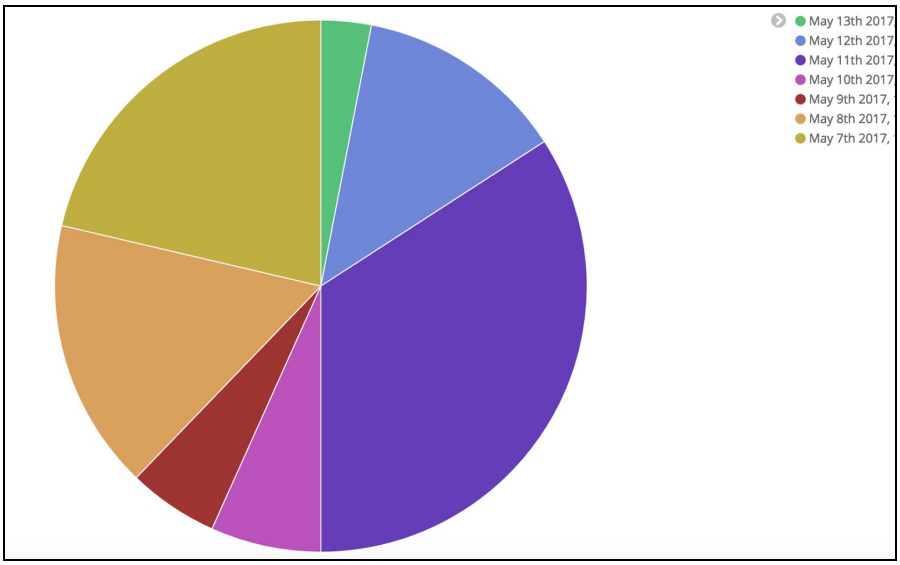


Figure-4: Graph showing number of people visiting a store on a particular day.

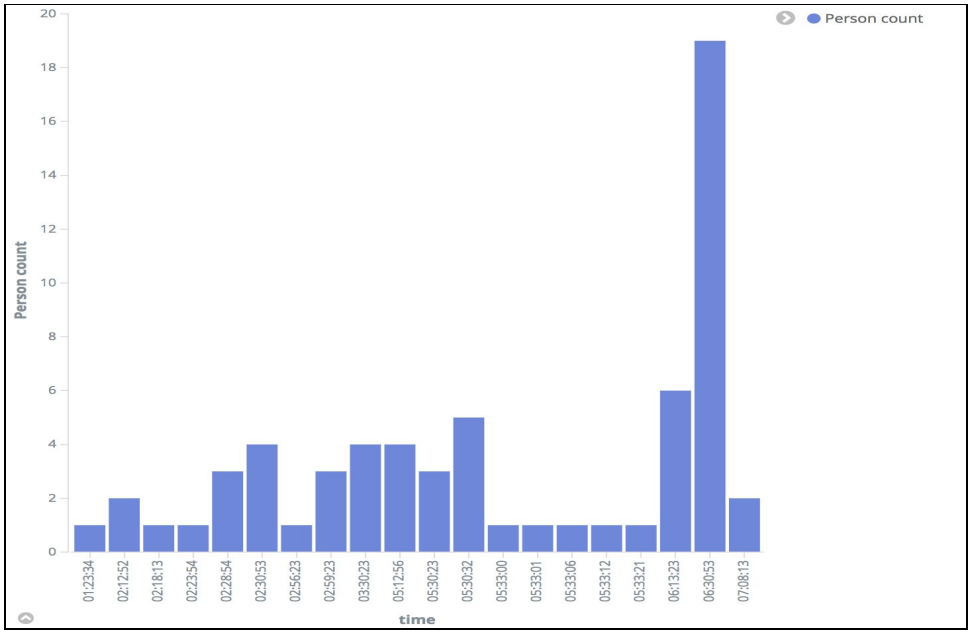


Figure-5: Graph showing person count at particular time

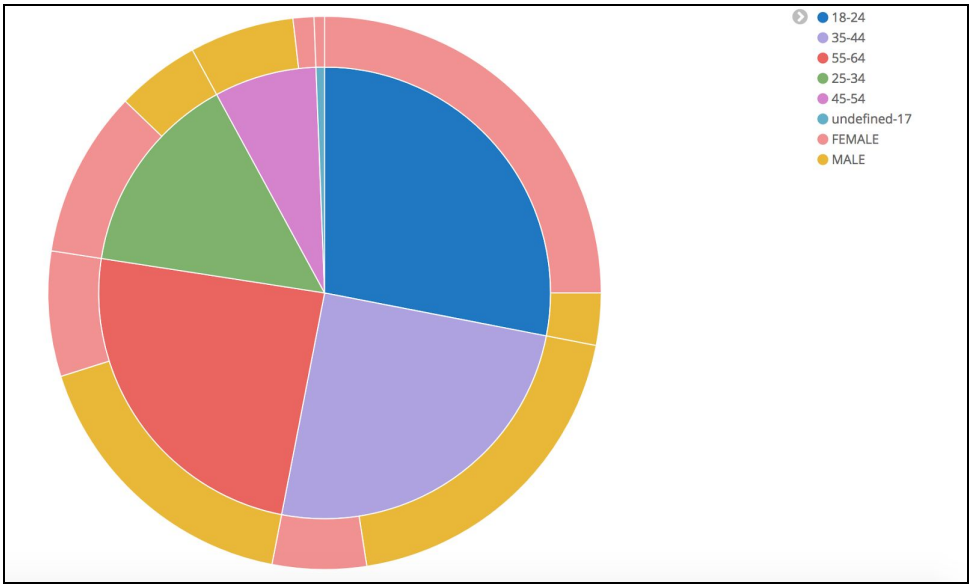


Figure-6: Pie-chart showing people count along with gender and age-group

3.3. Notification System

Amazon Web Services (AWS) has a Simple Notification Service (SNS) that allows one to create Topics. The system wanting to send a message to others is called the publisher. Systems/People wanting to receive notifications published to a certain topic are the Subscribers.

A topic was created on SNS to alert the subscribers in case of an impending danger to home security (The Notification System only applies to Customers who have availed the product for Home Security and not for Shop/restaurant owners interested in In-store analytics).

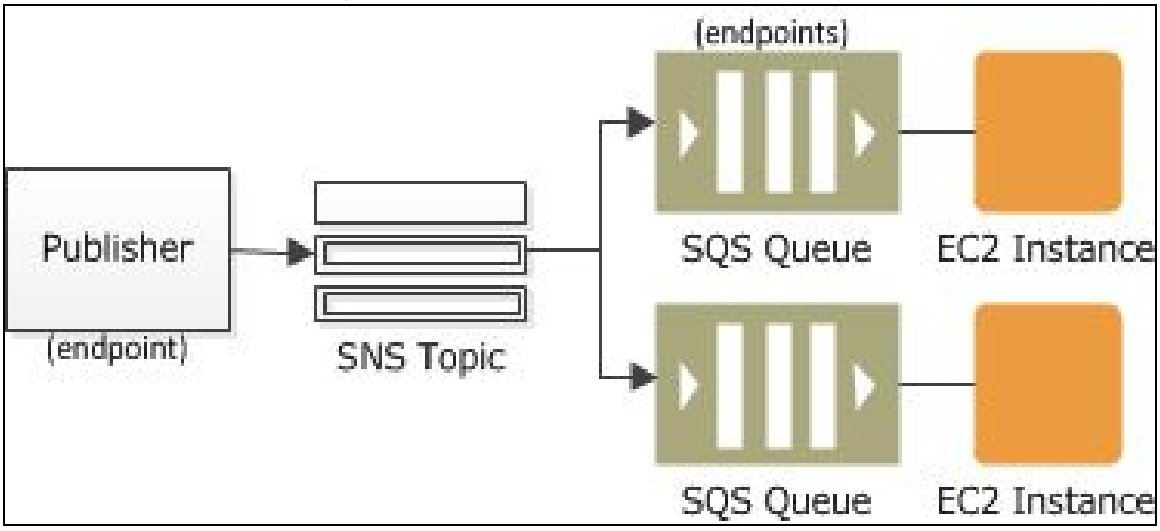


Figure-7: Notification System

3.4. User Interface

Smart Cams is built on MEAN (MongoDB Express AngularJS NodeJS) stack. A new user can Sign up and save his details. These details are then stored in mongodb. Once he logs in, he can view a kibana dashboard with all kinds of statistics associated with the people captured by the camera.

Figure-8: Home page of User Interface

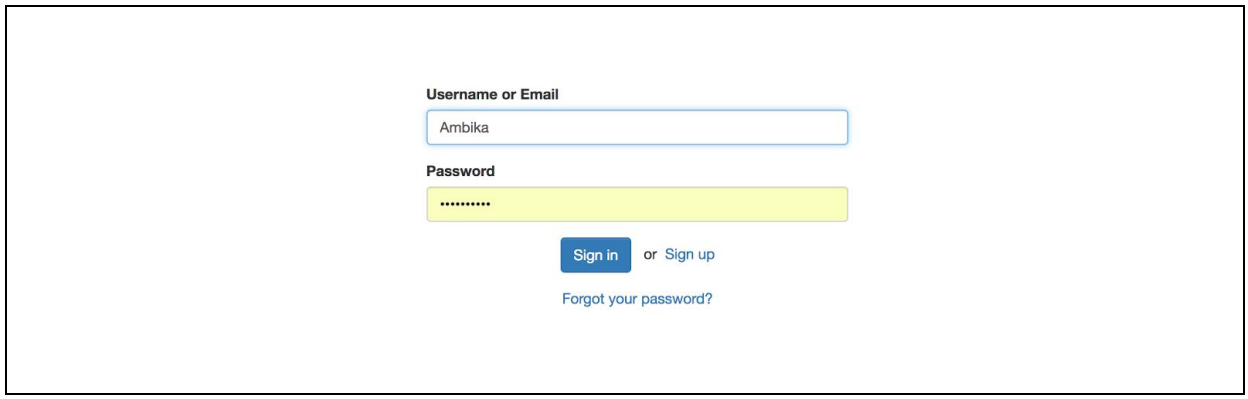


Figure-9: Sign-in page

As the user signs in, a dashboard having multiple visualizations will be opened.

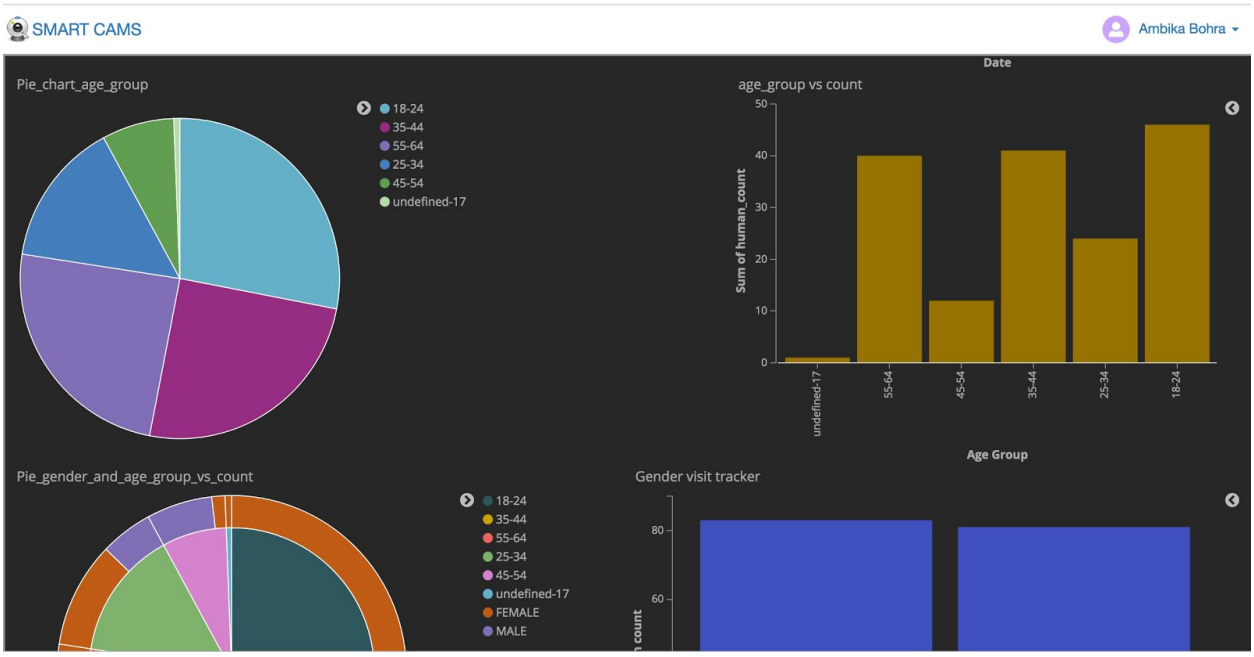


Figure-10: Kibana dashboard visualization

3.5. Hosting On Cloud

The Smart Cams Web application is hosted on an EC2 instance of Amazon's Web Services.

Website URL is:

http://ec2-52-41-107-173.us-west-2.compute.amazonaws.com/

In order to modularize the running of the app, two docker containers, one running User Interface and the other running mongodb have been deployed on the EC2 instance. The docker container running UI runs on port 8080 by default and has to be mapped to the mongoDB docker container's port which is 3000. This way the connection is established and both run in unison.

4. Conclusion and Future Scope

Smart cams can help retailers to keep track of customer behaviour and gain a competitive edge in retail field. They help retailers to understand their customers better, targets them with better offers and deals. This enables them to increase

their sales volume, profitability, and customer satisfaction. The analytical data can also be used to organize and streamline retailers work force and stores.

Smart cams can also be used for home security. It can be used to monitor and keep track of people around the house. The smart cams can be configured to notify the users about suspicious people around the house, This allows the users to keep themselves, the family members and property safe from burglars, thieves and criminals.

Visual recognition is a multifaceted field with still a lot of untapped potential in terms of it applications.Smart Cams for now has been trained to work for detecting faces, making an estimate on their gender and age range. This could be extended to recognize other objects like weaponry (eg. guns, knives etc) and criminals. This could be extremely useful in predicting potential crime scenes. It could also be used in areas of quarantine to examine if a person is not properly or adequately geared to enter the premises based on visual scanning. These applications however warrant a great deal of training the visual recognition services.

5. Technologies Used

- IBM BlueMix
- Amazon Web Services
- ElasticSearch
- Kibana
- Angular JS
- Mongodb
- Express.js
- Docker

6. References

- https://www.compose.com/articles/getting-started-with-elasticsearch-and-node/
- https://momentjs.com/docs/
- https://www.elastic.co/guide/en/kibana/current/tutorial-visualizing.html
- https://www.ibm.com/watson/developercloud/doc/visual-recognition/index.html
- https://blog.codeship.com/running-mean-web-application-docker-containers-aws