

Analyzing and predicting the use of public spaces from image data

Presented by
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Problem:

Many public spaces (such as Gurula) have constant camera monitoring, but the data isn't really utilized for more than security purposes. How can we analyze the people's activity in certain areas using only webcam images as input? What if we could use the picture data to extract useful data for the visitors and administrators of the spaces?

Solution:

We came up with a solution for this problem. Our case study area was Gurula, the club room for computer science student which is situated in the University of Helsinki's Exactum building. It has two webcams which provides real time images of two rooms using web service. We have built a real time activity monitoring in the Gurula room by comparing the current images with the image of an empty gurula room. Visitors can monitor the activity level during the weekdays, weekends and also can find the peak hour when it's more crowded by taking a glance at the visualization plots in our web page.

Data: sources, wrangling, management:

We used the images provided by <http://gurula.wtf/cams/> to provide real-time information in gurula such as: how much movement there is, activity by hours, activity by daysn activity trend line along with the real images. We have done this by comparing the current images with the image of an empty gurula room. The main challenge was the reliability of the data extraction, because even primitive estimates will give valuable data on trends that occur in gurula room. From the activity trendline we have given predictions to the gurula visitors and administrators via our web interface: <http://gurula.joo.pe/>

Data analysis:

We use real datasets from the images to understand the crowd. The extracted data were stored on a web server database along with the timestamp. Because the cameras are stationary and lighting stays the same, we can create composite image showing what parts of the room has changed by diffing the two images. The change in the images depicts the movement and activity level in the room. From the extracted data we analyzed the correlation of time and crowdedness, tried to discover patterns and used them to predict the change in the environment in the trend line. Crude comparison of the pixel data provided us enough data to estimate the crowdedness of the space, and visualize the most popular parts of the area.

Communication of results: summarization and visualization:

- First four figures show real time "forecasts" related to the space and the areas related to that for visitors.
- Heat map showing the layout of the room and crowdedness in different colors
- Bar plot for average activity(movement) by weekdays: It depicts that there are less activity on the weekends and more in the weekdays. We can observe from the plots there are more crowd on the first day of week(Monday) in both of the rooms.
- Bar plot for average activity(movement) by hours: It depicts that there are minimum activity at the midnight(2.00-3.00) and more in the daytime. We can observe from the plots, most of the movements occur in between 10.00-18.00 in both of the rooms and the peak hour is at 15.00.
- The activity trend line predicts the trend of the movement with corresponding hours by using locally weighted linear regression model.
- After comparing each of the cases for room 1 and room 2, we observed that room 2 is always more popular among the students than room 1.

Operationalization:

- **Ideation and scope:** The idea was new for the Gurula visitors obviously because there was no existing system before this. The idea is very useful and can be implemented in other use case scenarios as well just by replacing the real time images from other places. So the system can be implemented in other applications at the same time.
- **Actionability and deliverability:**
Users of Gurula will be able to see when and where it's most likely to be crowded in the room. As well as, we can use the system pipeline somewhere else as well in future. It's interactive for the users as they can see the data representation as plots and maps. The webpage we provided can stand alone itself only. It provides visitors an insight of the data with a summarization of weekdays and hours. This is very easy to understand and follow because all the complexities are hidden abstractly.
- **Adding value and end user point of view:**
The real time forecasts provides a lot of detail of the area and use of the place. For example users can get an idea when it is perfect time to go to gurula to have a coffee or just to study or for taking a nap, when it's not crowdy. So the visitors could simply visit a webpage to see the current status. It will be surely adding value to the gurula visitors and in other use cases as well if implemented.

The system is useful for the administrators as well. They could visualize what parts of the room are most popular and when. So they can improve the space accordingly by improving the facilities in the sitting areas such as, is there more sitting arrangement needed or if there are more students after 19.00 then they might need some snacks from the cafe which closes at 18.00 usually.

Finally, gurula motion crowd detection system according to time and place can give us insight of where the students hang out or study mostly at which time. So if someone wants to study somewhere quiet then they can look over the data and choose some place to sit. As well as if, if the system can use the other indoor cameras then we can come up with any indoor activity detection in consideration with time and place.

Challenges:

- The main challenge was estimating the activity level from the images and integrating all of the technical concepts together.
- Transforming the image data to 2D heatmap was a challenges well, because we had to somehow map the field of view of the camera to 2D plane.
- We could have better results if there was no angle in the webcams. If we could get the bird's eye view of the room from top then there would be no overlapping of the moving objects in the heat map. Then heat map would stand out clearly and we could count the no of people in the room as well.

➤ Link to our web interface: <http://gurula.joo.pe/>