

Bicycle Theft Detection

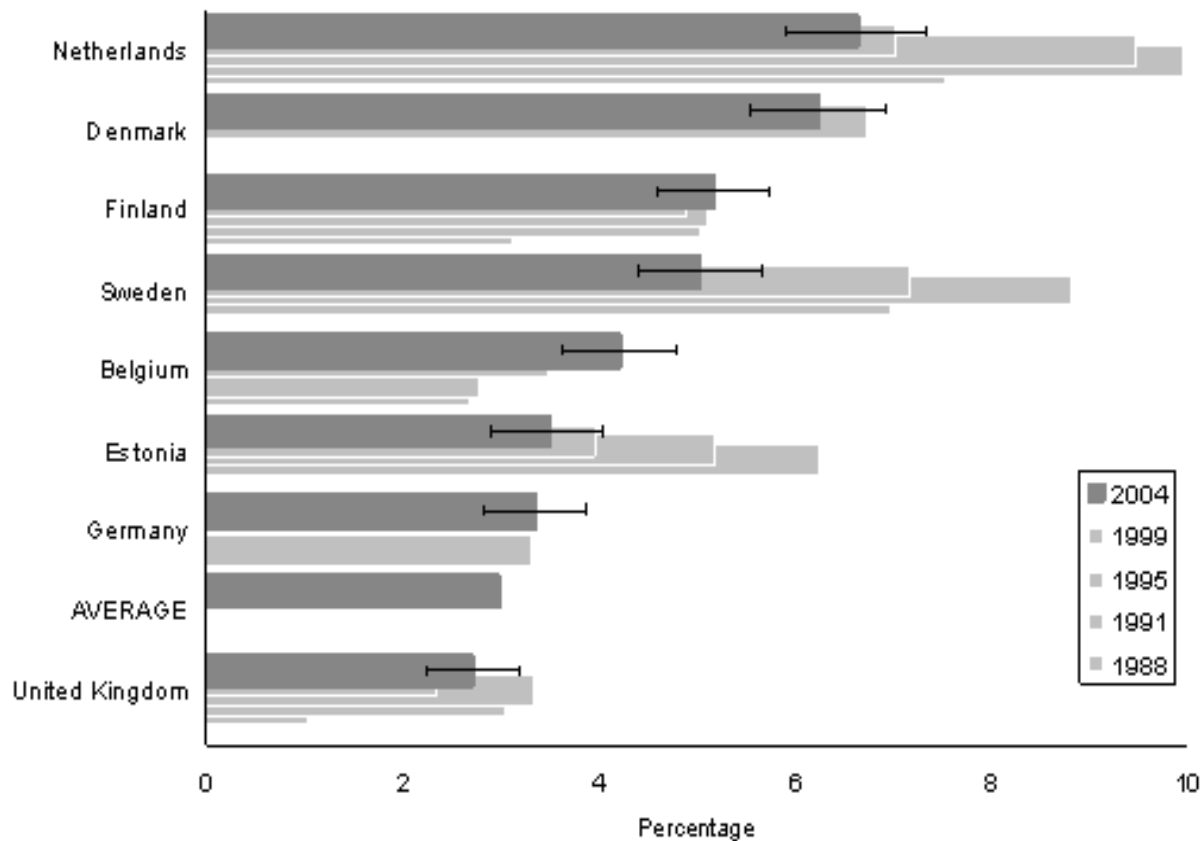
Motivation and Prototype

Dima Damen and David Hogg
Computer Vision Group

Facts

- 500,000 Bicycles stolen annually in the UK
- 21,236 bicycles stolen in London (2006/7).
- 5% of the stolen bicycles returned to their owners. (2005)
- Highest rate of bicycle thefts in: the Netherlands, Sweden, Japan, Canada, New Zealand, England, Finland and South Africa

Facts



Source: EUICS report, The Burden of Crime in the EU, A Comparative Analysis of the European Survey of Crime and Safety (EU ICS) 2005

From the news...

- 7/6/2007: York (290 bicycle thefts during May 2007) city sets up CCTV cameras over bicycle racks.
- 22/6/2007: Oxford (1800 bicycle thefts during the last year) city sets up CCTV cameras over bicycle racks.



The screenshot shows the homepage of 'THE Press' website. At the top, there is a logo for 'THE Press' and a red banner for 'national-lottery.' with the text 'Players must be 16 or over. Games Rules and Proceeds'. Below the logo, there is a navigation bar with links for 'News', 'Newsletter', 'Site Map', and a search box. The 'News' link is highlighted. On the left side, there is a sidebar with a list of categories: 'Local news', 'Announcements', 'Blogs', 'Business', 'Campaigns and appeals', 'Columnists', 'Comment', 'Community Pride', 'Consumer matters', and 'Diary on the loose'. The main content area displays a news article titled 'CCTV cameras at bike racks' by Helen Gabriel. The article text reads: 'POLICE are set to put up spy cameras over York's bike racks in a bid to catch thieves. The small CCTV cameras will be set up to watch over cycle storage facilities in the city centre in the latest bid to slash the increasing number of bike thefts. The moveable cameras are the latest in a series of measures being used by police in a bid to reduce bike thefts, with between five bikes being stolen every day in the city.'

From the news...

- 23/5/2007 – Catching Daniel Westrop...
“have been stealing commuters' cycles, often two a day, for the past three years”!!



What can Computer Vision offer?

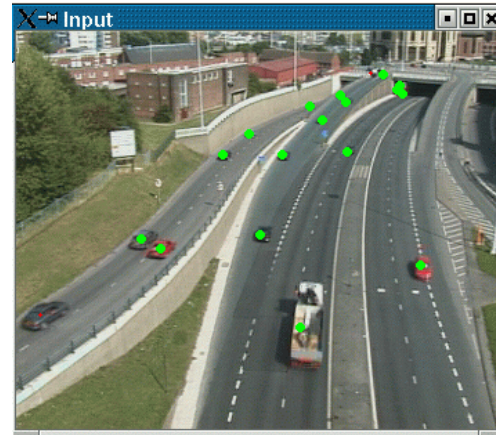
- Tracking
- Object Detection
- Change Detection
- Colour analysis

We still Can't do

- Behaviour Analysis
- Night tracking

Computer Vision at University of Leeds

- Over 15 years



Associating Drop-offs with Pick-ups



The approach...

Identifying Sequences of Events...

Drop off → Pick up

Associating Drop-offs with Pick-ups

1. **Tracking People**
2. Detecting Bicycles
3. Deciding on drop-off and pick-up actions.
4. Comparing colour information
5. Raising warnings



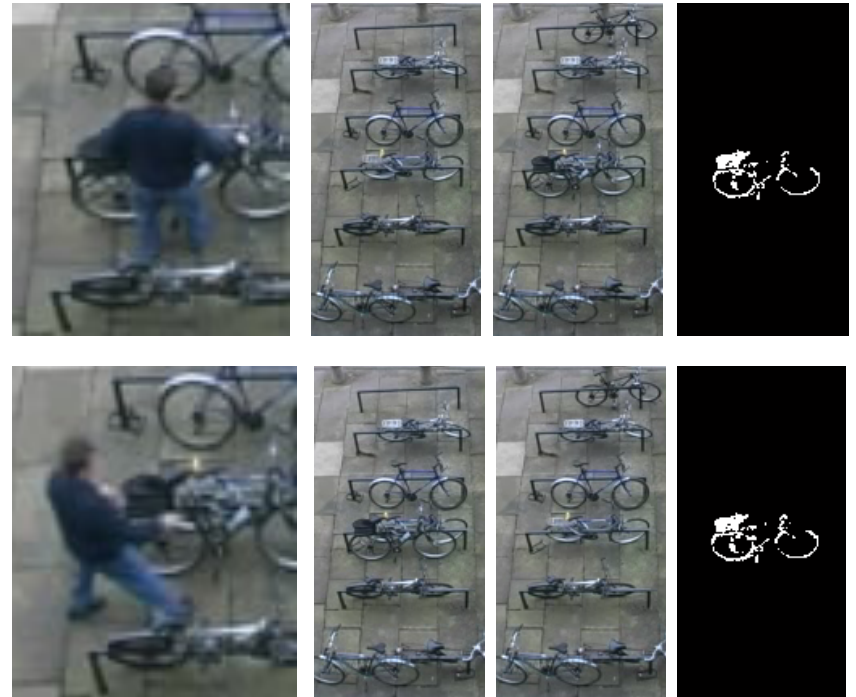
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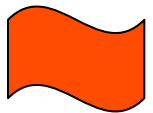
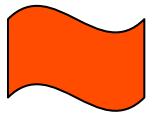
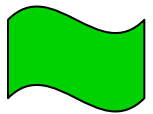
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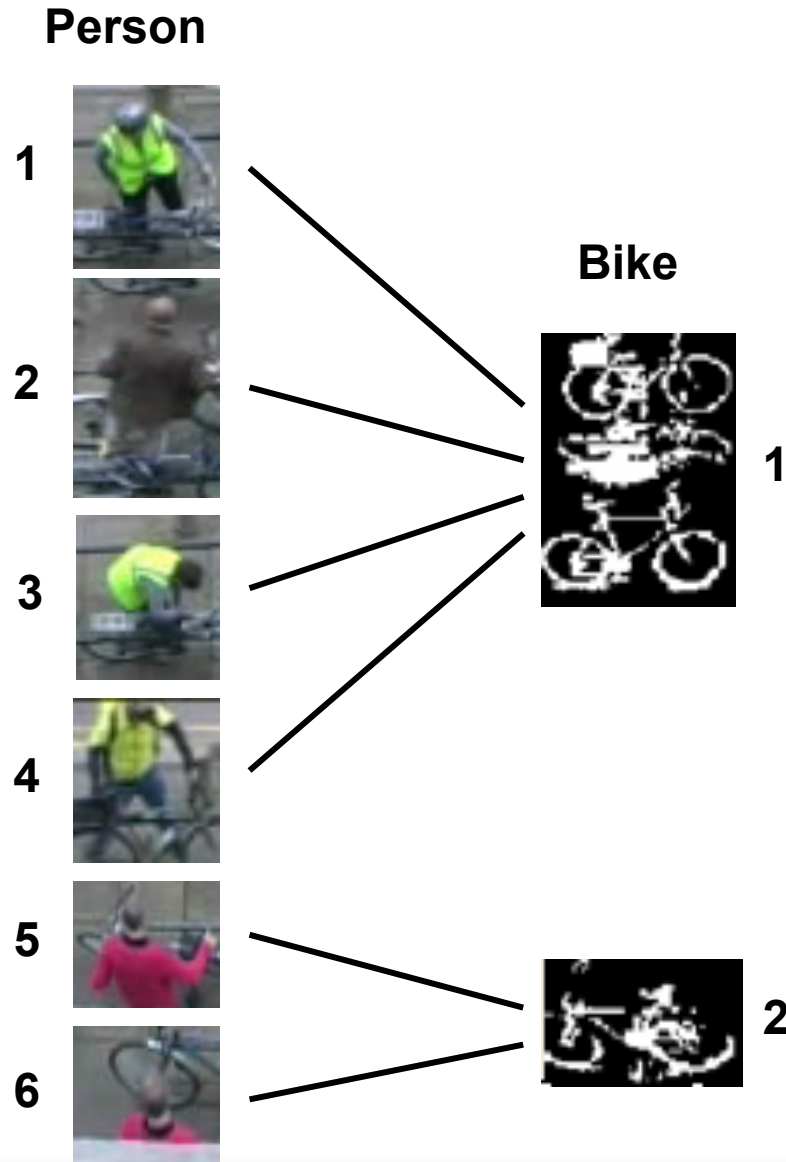


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5. **Raising warnings**



Resolving Ambiguities



Resolving Ambiguities

- Deferred Logic
- MHT
- MCMCDA

Experiments & Results

- 3 experiments
 - 1 hour (45 events)
 - 50 minutes (22 events)
 - Full day (9 hours and 30mins) (40 events)

Application to bicycle theft detection

	Predicted	
	Thief	Non-Thief
Actual		
Thief	11	2
Non-Thief	17	183

Strengths & Weaknesses

Strengths:

- Decrease in required monitoring time.

Weaknesses

Recorded time: 11 hours and 30 minutes
Warning time: 13 minutes

Strengths & Weaknesses

Strengths:

- Decrease in required monitoring time.
- Raises warning, no action taken.

Weaknesses

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- Person changing clothing.

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Strengths & Weaknesses

Strengths:

- Decrease in required monitoring time.
- Raises warning, no action taken.

Weaknesses

- Person changing clothing.
- Does not detect suspicious behaviour.
- Warning is raised after the bicycle is removed.

System's Failure Cases

1. The thief wears the same clothing as the owner.



System's Failure Cases

2. The thief drops another bicycle and picks a better one at the same time.
3. The tracker loses track of people as they pause
4. Theft cases of parts of the bicycle

We actually caught thieves!!



Conclusion

- 77% theft detection rate.
- 8.5% false negative rate.
- 1.9% of required monitoring time.

Publications

Damen, Dima and Hogg, David (Sept 2007). Associating People Dropping off and Picking up Objects. British Machine Vision Conference (BMVC 07).

Damen, Dima and Hogg, David (July 2007). Bicycle Theft Detection. International Crime Science Conference. (CS2 07)

<http://www.comp.leeds.ac.uk/dima>