A Peer-to-Peer Webcam Network

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Abstract: Today, most peer-to-peer networks are specialised for sharing files, mostly video and audio files. In this paper we describe a peer-to-peer network we are currently implementing. It connects webcams and allows users to search for online pictures and video-/audiostreams by keyword and by location. Peer-to-peer technology is used for the self-organising network so that no central service provider is needed. Research challenges include efficiency and scalabilty aspects and the support for location based search.

1 Introduction & Motivation

Today, the most common peer-to-peer networks are specialised for sharing files, mostly video and audio files. However, the peer-to-peer communication paradigm [1] can be used for other applications, too. In this paper, we describe a new application for peer-to-peer technology that we are currently developing as a research project: It connects webcams to a peer-to-peer network offering their pictures respectively videostreams. Users can search for online pictures and video-/audiostreams by keyword and/or by location information. Fuzzy search ("all cameras around of Darmstadt") is also supported.

A user that operates a public webcam today typically has to put his pictures the camera takes on a web server in regular intervals. From that server the pictures can be downloaded by users. Users can find cameras and metainformation describing them for example in directories like www.onlinecamera.com. With our peer-to-peer based webcam network the use of web servers and centralised directories is not necessary. Users need very little technical knowledge to connect their webcam to the network and to allow others to find it. The network is self-organising and does not depend on centralised components or (potentially commercial) providers.

The webcam network allows us to investigate the potential use of the peer-to-peer paradigm for applications that are plain filesharing applications and avoid their special legal "issues".

The rest of this paper is structured as follows: In the next section, we describe the basic functionality of the webcam network. The development of the network is work in progress; therefore, we present in Section 3 the research challenges we identified so far, before giving a summary and outlook in Section 4.

2 Functionality

The webcam network consists of two different types of nodes that are described next before we list the functionality planned for the network.

2.1 Application Types

The webcam network is a structured peer-to-peer network formed by two types of nodes:

- Consumer nodes are nodes that are searching for cameras and that download pictures from the found cameras.
- Producer nodes offer images/videos from webcams. Although the main goal is to display live pictures from a webcam, for the application a webcam is only one possible image source. Other sources can easily be used, e.g. an image archive. The image archive is not only a potential producer node, it should also be able to store local or remote images and thus act as an additional consumer at the same time.
  Beside webcams and an archive, digital cameras, e.g. build into a mobile phone, could also be an interesting image source. The mobile client is logged into the network and updates its actual coordinates regularly. If an image is requested via the network, the client could show a message to the user asking him to take a photo.

2.2 Basic Features

The application supports the following features:

- Search for webcams based on keywords and/or by location (GPS coordinates or city names). A fuzzy search ("in the area of") is also supported.
- Access found webcams to download images, trigger taking a new picture and to stream video.

Advanced features considered for later versions include:

- Some webcam offer a control channel, e.g. for turning the camera or zooming. The control of the camera could thus be handed to remote peers.
- Event based search: People might be interested in searching for pictures of a specific event. An event maps to a specific location and time. Various ways exist to build an event database within the network. There could be an external event database - or more preferably, the database could be distributed over the P2P network, administered by the users of the network.

Figure 1: Prototype of the Consumer Application (Screenshot)

- Anonymity: As it is possible to track the location of mobile nodes it is necessary for mobile clients to be able to log into the network anonymously. Therefore they could generate a random user ID every time they log in.

2.3 Realisation

The first prototype of our application runs under Linux and Windows. It is written in Java and based on JXTA [2]. Other peer-to-peer frameworks like e.g. [3] will be considered to a later state of the development too, depending on the performance evaluation of the prototype.

A screenshot of the consumer user interface as implemented in the current prototype is shown in Figure 1.

3 Challenges

One research challenge is to structure the peer-to-peer network in a way that efficiently allows fuzzy location based search. At the same time, a text-based keyword search with wildcards must be supported. We plan to use GPS coordinates for the location and to support a decentral lookup-service where users can map city names etc. to GPS coordinates, so that no central server or database is necessary.

A flexible metadata scheme is necessary to describe the cameras, their positions, what they are pointing at. Figure 2 shows the Webcam Advertisement of the current JXTA-based implementation. It includes description fields that can contain XML documents to describe further details in a structured manner.

```
<?xml version="1.0"?>
<!DOCTYPE jxta:WebcamAdvertisement>
<jxta:WebcamAdvertisement2 xmlns:jxta="http://jxta.org">
    <Peer>
        <PeerID>
            urn:jxta:uuid-59616261646162...
        </PeerID>
        <PeerGroupID>
            urn:jxta:jxta-NetGroup
        </PeerGroupID>
        <PeerName>
            Nico
        </PeerName>
        <PeerOS>
            WindowsXP Pro
        </PeerOS>
        <PeerWebcam>
            Logitech Quickcam Zoom
        </PeerWebcam>
    </Peer>
    <Location>
        <LocationGPS>
            GPS
        </LocationGPS>
        <LocationCountry>
            Germany
        </LocationCountry>
        <LocationRegion>
            Rhein-Main
        </LocationRegion>
        <LocationCity>
            Darmstadt
        </LocationCity>
    ...
```

```
    ...
        <LocationZipCode>
            64283
        </LocationZipCode>
        <LocationStreet>
            Schlossgartenstr.
        </LocationStreet>
        <LocationStreetNo>
            2
        </LocationStreetNo>
        <LocationDescription>
            View over Herrengarten
        </LocationDescription>
    </Location>
    <WebcamServices>
        <ServicePictureFormat>
            jpg
        </ServicePictureFormat>
        <ServicePicResolution>
            640,400,24
        </ServicePicResolution>
        <ServiceRCSnapshot>
            0
        </ServiceRCSnapshot>
        <ServiceRCZoom>
            0
        </ServiceRCZoom>
        <ServiceRCMovement>
            0
        </ServiceRCMovement>
    </WebcamServices>
</jxta:WebcamAdvertisement>
```

Figure 2: WebcamAdvertisement of JXTA-based implementation

Resource management at the producer nodes is necessary to flexibly control the amount of bandwidth used by the application – especially when connected to a DSL connection with a low upload bandwidth. Trust, privacy, and security issues have to be considered, too.

4 Summary and Outlook

In this paper, we describe a peer-to-peer application that is connecting webcams in a decentralised self-organising network, allowing users to search for and access these webcams. Location and keyword based search is supported and offers interesting research issues. The presented application is work in progress and planned to be made open source under a suitable license in 2005.

References

[1] R. Steinmetz, K. Wehrle: Peer-to-Peer-Networking and -Computing. Informatik Spektrum, 27(1):51-54, February 2004.

[2] JXTA P2P Framework; http://www.jxta.org

[3] MMAPPS - Market Managed Peer-to-Peer Services; http://www.mmapps.org