Ad Hoc Networking
And its Security Applications

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Abstract.
Ad Hoc Networking has been an area of active research recently due to its numerous and appealing applications. Ad Hoc Networks can be used in military applications, rescue missions, business meetings among other applications where infrastructure is not necessary. There are many aspects of Ad Hoc Networking that require a lot of in-depth studies before they are able to be implemented efficiently. However, ad hoc networks suffer from great limitations and problems; infrastructure networks do not have. There have been many protocols to improve their efficiency; however, almost every aspect is inversely proportional to another aspect. This research project focuses on streaming video from a network camera; the camera streams the video to a computer which broadcasts the frame packets to the nodes in the network. The nodes receive the packets and reassemble the frame and display it.

For this purpose, we utilize a motion detection algorithm that sends the frames when it detects movement until the background image converges. The computer that receives the webcam stream then transmits the frame data to the nodes. Currently, the motion algorithm efficiently detects movement and the packets are all sent and received correctly. Tests in a wireless network and multicast will be required.

Materials.
1. Microsoft Visual Studio 2005 C#
2. Motion Detection Algorithm by Andrew Kirillov
3. Computer Network Hardware
4. Ethereal

Process.
The motion detector works by detecting the motion by "moving" the new background towards the old background. As it is moved, the new background detects that there is a change in the old background and therefore boxes the object in question. Where there is a big box, or multiple boxes add up to more than the pixels changed threshold, the motion detector throws an alarm event, indicating that motion transition is greater than the threshold motion level value. The motion level threshold is given by:

\[ \text{motion level} = \frac{\text{pixelsChanged}}{\text{width} \times \text{height}} \]

There are two motion detectors. One calculates the amount of white pixels and assigns numbers to those objects that affected motion level significantly. We utilize the motion detector that calculates the pixels changed based in the bytes of the current frame against those in the background frame. In Figure 1, we see the interface of the motion detection algorithm. Since it just started, it does not detect movement. But when a pen is dropped into the scene (Figure 2), it detects it and encases it in a red box. The red box marks the area that has changed since last frame.

Once the motion level exceeds threshold value, the socket with the frame data is sent in packets) to the node and then reassembled to form the frames in Figure 3 and Figure 4.

Figure 1. Motion Detection at Start. No motion has been detected.
Figure 2. Motion Detector after dropping a pen into the frame.

Discussion.
While video displayed in Laptop 1 worked and displayed correctly on screen, video on Laptop 2 suffered from data loss. Figure 6 shows that the average rate of bytes transmitted per second from the PC to Laptop 1 was approximately 12,000 bytes and the average rate of packets per second was 103 packets. The data indicates that about half of the packets sent from the motion detection algorithm to laptop 1 are sent to Laptop 2. The drops in the graph symbolize those moments were the camera did not detect any movement, thus packet traffic stopped to a halt. This shows that the motion algorithm works correctly for a dynamic environment setting. More tests need to be made and more data retrieved in a full wireless environment.

Future Work.
• Utilize a wireless router so that a computer can connect remotely to the camera, thus eliminating the need for Ethernet connections.
• Field testing. Testing the throughput as the nodes are moving apart from one another.
• Protocol testing. Testing how much video can be sent using different Ad hoc routing protocols.
• Improve the motion detection algorithm with HMM models so that it can capture specific events and act accordingly to each one.
• Use of better packet header information and better packet validation data.

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References:

Figure 3.& Figure 4. The received frame after motion detector sent the frame packets to a node. The event is triggered by the hand’s appearance and subsequently results in the jar being taken out.
Figure 5. The computer network is set up of a camera connected by a router to a PC, the PC captures sends the video frames to Laptop 1 though the switch connection, which sends it to Laptop 2 through Wireless Network.

The PC broadcasts the image where the camera detects motion to all computers connected to the router, then those computers send the data to the computers connected wirelessly to them. The laptops are 18 feet away from each other.

Figure 6a. The traffic flow of UDP bytes and packets:
(A) Sent by PC. (B) Received by Laptop 1. (C) Sent by Laptop 1. (D) Received by Laptop 2.

Figure 6b. The packets per second graph:
(A) Sent by PC. (B) Received by Laptop 1. (C) Sent by Laptop 1. (D) Received by Laptop 2.

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