disclosed above. Amplifying the target nucleic acids prior to the processing in the magnetic microchannel allows a more efficient capturing by the channel. On the other hand, enriching the nucleic acids by the magnetic microchannel prior to an amplification reaction provides more rapid and more accurate templatedirected synthesis by the polymerase. The use of such in vitro amplification methods is optional in the methods of the invention, which makes the present invention advantageous. A target nucleic acid sequence that is rare in the sample normally requires an amplification step to generate sufficient signal to be detected. The amplification methods, such as PCR, typically produces errors in the target nucleic acid sequence, thus raises problems when the sequences of the target nucleic acids are to be accurately determined. The magnetic microchannel processing allows a fast and specific enrichment of the target nucleic acids, thus allows a detection of the target sequence without amplification.

[0317] When target nucleic acids are amplified prior to the processing in the magnetic microchannel, the primers that are used in the amplification reaction can be labeled with magnetic labels, so that the amplification products are automatically labeled in the amplification reaction. Alternatively, the amplification products are subsequently labeled in a separate labeling reaction. The labeled nucleic acids are then introduced to and captured in the magnetic microchannel.

[0318] In a preferred embodiment, the nucleic acid that are captured in the channel are amplified inside the magnetic channel. The amplified products are then allowed to flow out of the magnetic microchannel. In this embodiment, a thermal unit is placed properly next to the magnetic microchannel, so that the channel chamber can serve as a reaction chamber for amplification reactions. Alternatively, the eluted target nucleic acids, released from the magnetic label if necessary, can also be subsequently amplified in a reaction module.

[0319] In a preferred embodiment, the target nucleic acids are detected while they are captured in the microchannel. For example, the targets may be simultaneously labeled by a detection label and a magnetic label, as described above for "sandwich" type assays. Similarly, the target nucleic acids can labeled inside the magnetic channel. Labeled target nucleic acid can then be detected by a detection device.

[0320] In a preferred embodiment, the microfluidic devices of the invention are used to detect a target protein. In this embodiment, target proteins are labeled by magnetic labels that contain specific binding ligands such as antibodies specific for the target protein, or other proteins, peptides, or small molecules that can be specifically recognized by the target proteins, as fully outlined above. The labeled proteins can then be captured by the magnetic microchannel and separated from the rest of the sample.

[0321] As outlined above for the detection of cells, proteins can be simultaneously labeled by another detection label so that they can be detected while captured in the channel or immediately after they are eluted from the channel. For example, two monoclonal antibodies recognizing two different epitopes on the protein can be used for the two kinds of labels. The addition of a detection label can either be done in a reaction module or a labeling chamber prior to the processing in the magnetic microchannel, or inside the channel. In some cases, when the protein can be detected without a detection label, for instance when the protein is a GFP protein or a GFP fusion protein, the addition of a detection label would not be necessary.

[0322] In a preferred embodiment, antibodies or fragments of antibodies are used as detection label. The labeling can be done under conditions well known in the art. (similar to immunoassay)

[0323] In a preferred embodiment when the protein is an enzyme, an enzymatic reaction can be carried out inside the magnetic microchannel by introducing its substrate into the channel. The reaction products can then be detected within the channel. Alternatively, the reaction product can be allowed to flow through the magnetic microchannel and detected afterwards, for instance by a spectrometer directly linked to the sample outlet port.

[0324] In a preferred embodiment, the proteins that are processed in the magnetic microchannel are further subjected to separation. For example, the target protein may be labeled by some ubiquitous label and processed in the magnetic microchannel. The processed protein sample is then subjected to another round of magnetic labeling and processing. Alternatively, the processed protein sample are further processed by a separation module, such as electrophoresis.

[0325] In a preferred embodiment, the eluted target proteins are modified or cleaved in a reaction module before they are detected. For example, target proteins may be cleaved into peptide fragments by CNBr, or hydrolyzed by enzymes. The peptide fragments are then subjected to mass-spectrometry analysis, as described above. The modification or cleavage reactions can also be carried out in the magnetic microchannel, while the proteins are captured in the channel.

[0326] In a preferred embodiment, the biological sample is "cleaned up" by going through the magnetic microchannel, i.e., some undesired components, rather than target analytes, are labeled by magnetic labels and retained by the magnetic channel. Generally but not necessarily, a relatively nonspecific binding ligand is used to capture the undesired components. For example, when some kind of bacteria need to be removed from a biological sample, a mixture of antibodies for the bacteria to be removed can be used as binding ligands.

[0327] When the samples are introduced into the magnetic channel, the labeled components will be retained in the channel, while the rest of the sample, including the target analytes will pass through. The then "cleaned-up" sample can be subjected to subsequent processing, which may include another round of magnetic labeling and processing of either the target analyte or other components. Alternatively, the target analytes are further processed in the separation module and reaction modules before they are detected.

[0328] The above-described "clean up" steps can be repeated several rounds in a single processing event. This can be done by subjecting the flow-though portion of the sample to the same magnetic microchannel. Alternatively, the sample can be "cleaned up" by going through several consecutively linked magnetic microchannel.

[0329] The following examples serve to more fully describe the manner of using the above-described invention,