reliability of the system. For example, the system allows the selective application of real-time processing computing platforms where they are required without burdening other system elements that do not have real-time requirements with the added complexity and costs associated with real-time processing.

[0107] The architecture maximizes the functional capabilities and flexibility of the high throughput system by allowing swift and smooth integration of new or reconfigured electromechanical configurations to the system while at the same time ensuring that overall, the system is not globally effected by the changes in sub-system designs. Additionally, the architecture enhances system reliability by condensing the various system aspects into independent islands of functionality that may monitor and report their own progress to the supervisory layer. The supervisory layer can then coordinate the overall system operation based on the state of the lower layers without being burdened with unnecessary information. Each layer may be conceptually reduced to a finite state machine with well-defined states and transitions thus achieving the robust and deterministic behavior required. This segregation also improves system reliability by ensuring that errors occurring in low level sub-systems do not corrupt the entire throughput process. The supervisory layer can observe such failures and various corrective actions initiated or in the most extreme cases, operation may be gracefully shutdown while appropriate status reports are generated for the human operators.

[0108] System components may include a conveyer belt, sample, substrate and reagent dispensing stations, a microtiter plate handling system, an analyzer interface, an analyzer control system, a database of sample information, a droplet tracking system, a supervisor system, and a user interface. Examples of each of these components follow.

[0109] The conveyor belt may include a narrow and long regularly cogged timing belt, a system of pulleys and tensioning elements, a stepper motor for actuation, and a rotary encoder for feedback. The belt is commanded to maintain a constant velocity during system operation. The encoder is attached to an idler pulley and provides motion state feedback of the belt. Using this encoder the velocity of the belt can be accurately recorded, belt failures or stalls detected, and individual drop positions within the system may be tracked. The rotary encoder tracking belt motion serves as the primary source of synchronization for the various subsystems making up the throughput processing system. Since there is a fixed distance measured along the length of the belt between any two actively controlled system elements that perform an operation on a given drop, the belt encoder provides the most accurate and dependable method for triggering such operations and in preferred embodiments of the invention serves as the primary method of system synchronization.

[0110] A sample library dispensing station may include a multi-axis positioning system actuated by micro-stepper motors outfitted with high-resolution linear encoders to ensure accurate positioning of each axis. The dispensing station moves an array of micro-syringes to the microtiter plate holding the sample to be analyzed, withdraws a volume of sample using an array of micro-syringes and finally dispenses the drops onto the surface of the moving belt. The sample dispensing station is required to keep pace with the desired drop throughput rate by retrieving samples from particular wells of the microtiter plate sample and placing them onto the conveyor belt.

[0111] The substrate and reagent dispensing stations may include a micro-valve(s) for dispensing those fluids and a drop sensing system. These stations wait for a sample drop to arrive, which may be directly sensed using an optical, capacitive or magnetic-based sensor whereupon the valve is actuated adding substrate or reactant to the sample drop. The presence of particular drops placed by the sample dispensing station are thus verified and missing drops are reported. In one embodiment of the invention, a substrate-dispensing valve is placed at the beginning of the belt, which will dispense drops at regularly spaced intervals as triggered by the belt encoder. This ensures that the drops will be accurately spaced on the belt, which is crucial to proper system operation.

[0112] The microtiter plate handling system may include a plate retrieval and stacking robotic system which presents plates of samples to be screened to the dispensing station and removes the plates when no longer needed. Such a system may be software controlled. Additionally, if the plates are equipped with bar codes a bar code scanner may be integrated into the plate handler and used to automate plate identification.

[0113] The analyzer interface system may include a drop sensor and a multi-port fluidic valve that introduces samples to the analyzer. The drop sensor detects the presence of the drop ahead of the input tubing to the multi-port valve. After the drop has been moved by the belt under the tubing orifice, the valve is actuated by a signal from the computer and the drop is drawn into the tube by negative pressure. A second signal from the computer actuates the valve to inject the sampled drop into the input of the analyzer.

[0114] The analyzer control system may include a routine that manages all communications between the throughput system and the analyzer as well as the configuration of the analyzer at run time. This task involves configuring the analyzer appropriately given the sample drops being fed into it and controlling how data is generated and recorded by the device. Configuration changes may include changing the sensitivity of the device, or creating a series of data files recording the results of the scans for example.

[0115] A database of sample information may be created for each screening process in which screening data pertaining to uniquely identified drops is recorded for analysis. Examples of information likely to be recorded include chemical information about the compounds in the library, substrate and reactants added, and analyzer results.

[0116] In various embodiments of the invention, the supervisory task receives high-level commands from the operator interface and manages the automated screening process. The supervisory task may control the execution of the other system tasks, such as the belt task, or the dispensing control tasks, by being responsible for the starting and stopping of these tasks, and querying them for information about their current state. Each sub task may have a finite number of possible execution states, which may be regulated by the supervisor task. A simple table may be maintained by the supervisor task that describes the entire state of the high throughput processing, which may be updated by querying the various sub tasks at some regular interval. Each sub-task managed by the supervisor maintains a data structure accessible in some way by the supervisor task, which will serve as the source of the information for the supervisor task's global state table. The contents of the global state table maintained by the supervisor task in turn dictate what controlling actions should be initiated by it. After querying