Components for Embedded Programs

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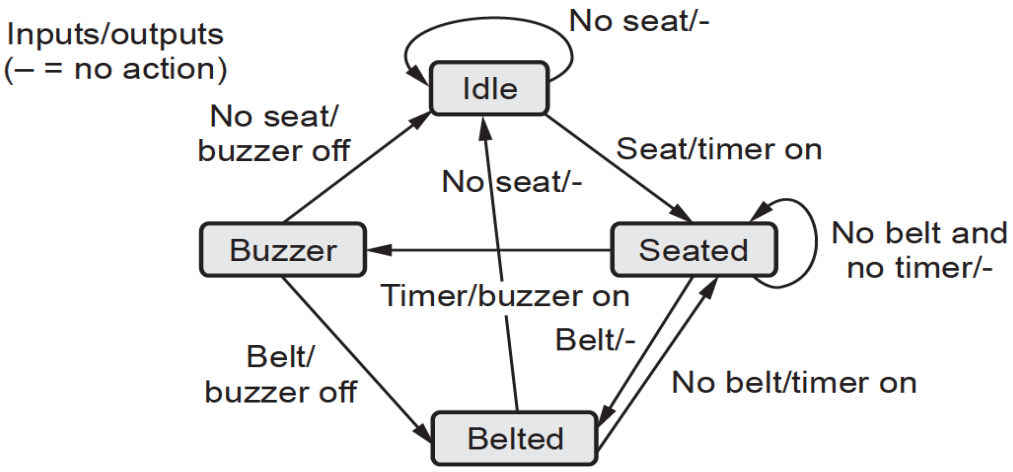
- Embedded software uses three components : State machine, circular buffer and queue.
- State machines are well suited to reactive systems such as user interfaces, circular buffers and queues are useful in digital signal processing.

State Machine

- A state machine is any object that behaves different based on its history and current inputs. Many embedded systems consist of a collection of state machines at various levels of the electronics or software.
- In general, a state machine is any device that stores the status of something at a given time and can operate on input to change the status and/or cause an action or output to take place for any given change.
- In practice, however, state machines are used to develop and describe specific device or program interactions.
  1. A set of states.
  2. An initial state or record of something stored somewhere.
  3. A set of input events.
  4. A set of output events.
  5. A set of actions or output events that maps the states and input to output.
  6. A set of actions or output events that maps the states and inputs to states (which is called a state transition).
- Finite State Automaton (FSA), Finite State Machine (FSM) or State Transition Diagram (STD) is a formal method used in the specification and design of wide range of embedded and real time systems. The system in this case would be represented by a finite number of states.



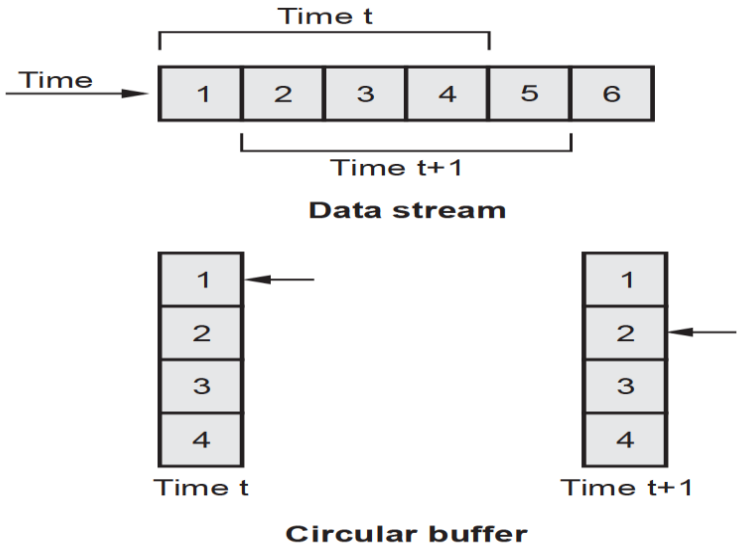
State machine for seat belt controller

- Controllers job is to turn on a buzzer if a person sits in a seat and does not fasten the seat belt within a fixed amount of time. This system has three inputs and one output.
- The inputs are a sensor for the seat to know when a person has sat down, a seat belt sensor that tells when the belt is fastened and a timer that goes off when the required time interval has elapsed. The output is the buzzer.
- The idle state is in force when there is no person in the seat. When the person sits down, the machine goes into the seated state and turns on the timer.
- If the timer goes off before the seat belt is fastened, the machine goes into the buzzer state. If the seat belt goes on first, it enters the belted state. When the person leaves the seat, the machine goes back to idle.

Circular Buffers

- A circular buffer, circular queue, cyclic buffer or ring buffer is a data structure that uses a single, fixed-size buffer as if it were connected end-to-end. This structure lends itself easily to buffering data streams.
- The circular buffer behaviour is ideal for implementing any data structure that is statically allocated and behaves like FIFO.
- Circular buffers are a special type of buffer where the data is circulated around a buffer. In this way they are similar to a single buffer that moves

the next data pointer to the start of the buffer to access the next data. In this way the address pointer circulates around the addresses.



- When a buffer underruns, it indicates that there is no more data in the buffer and that further processing should be stopped. This may indicate an error if the system is designed so that it would never rim out of data.
- If it can happen in normal operation then the data underrun signal indicates a state and not an error. In both cases, a signal is needed to recognise this point.

Queues

- Queues are also used in signal processing and event processing. Queues are used whenever data may arrive and depart at somewhat unpredictable times.
- Queue is also referred to as an elastic buffer. An elastic buffer is a device that helps smooth the data transfer between two similar, but unsynchronized clock domains.
- Linked link is used for building queue.
- For designing the queue, it is declares as follows :

```
#       define Q_SIZE 32
#       define Q_MAX (Q_SIZE-1)
int q[Q_SIZE];              /* array for queue */
int head, tail;             /* position of head and tail in the queue */
```