Real Time Systems1

Real Time systems Concepts

Lecture1

Real Time systems Definition

▸ **Real-time systems** are computing systems that must react within precise time constraints to events in the environment.

▸ As a consequence, the correct behavior of these systems depends not only on the value of the computation but also on the time at which the results are produced

Real Time examples

- 1. Chemical and nuclear plant control,
- 2. control of complex production processes,
- 3. railway switching systems,
- 4. automotive applications,
- 5. flight control systems,
- 6. environmental acquisition and monitoring,
- 7. telecommunication systems,
- 8. medical systems,
- 9. industrial automation,
- 10. robotics,
- 11. military systems,
- 12. space missions,
- 13. consumer electronic devices,
- 14. multimedia systems,
- 15. smart toys, and
- 16. virtual reality.

Embedded Systems

▸ In many cases, the real-time computer running the application is embedded into the system to be controlled. Embedded systems span from small portable devices (e.g., cellular phones, cameras, navigators, ECG Holter devices, smart toys) to larger systems (e.g., industrial robots, cars, aircrafts).

▸ A high percentage of accidents that occur in nuclear power plants, space missions, or defense systems are often caused by software bugs in the control system

WHAT DOES REAL TIME MEAN?/ THE CONCEPT OF TIME.

▸ The word *time* means that the correctness of the system depends not only on the logical result of the computation but also on the time at which the results are produced.

▸ ان كلمة time لا تعتمد على النتيجة المنطقية للحساب ولكن أيضًا على الوقت اللازم الذي يتم فيه إنتاج النتائج.

WHAT DOES REAL TIME MEAN?/ THE CONCEPT OF TIME.

The word *real* indicates that the reaction of the systems to external events must occur *during* their evolution.

As a consequence, the system time (internal time) must be measured using the same time scale used for measuring the time in the controlled environment (external time).

تشير كلمة "حقيقي" إلى أن تفاعل الأنظمة مع الأحداث الخارجية يجب أن يحدث أثناء تطورها ، وعليه, يجب قياس وقت النظام (الوقت الداخلي) باستخدام نفس مقياس الوقت المستخدم لقياس الوقت في البيئة الخاضعة للرقابة (الوقت الخارجي).

Real time system <> fast system.

- the objective of fast computing is to minimize the average response time of a given set of tasks, the objective of real-time computing is to meet the individual timing requirement of each task.

الهدف من الحوسبة السريعة هو تقليل متوسط وقت الاستجابة لمجموعة معينة من المهام ، والهدف من الحوسبة في الوقت الحقيقي هو تلبية متطلبات التوقيت الفردية لكل مهمة

Real time system <> fast system.

- The environment is always an essential component of any real-time system.
- Figure 1 shows a block diagram of a typical real-time architecture for controlling a physical system. Rather than being fast, a real-time computing system should be predictable.

- And one safe way to achieve predictability is to investigate and employ new methodologies at every stage of the development of an application, from design to testing.

Figure 1 Block diagram of a generic real-time control system
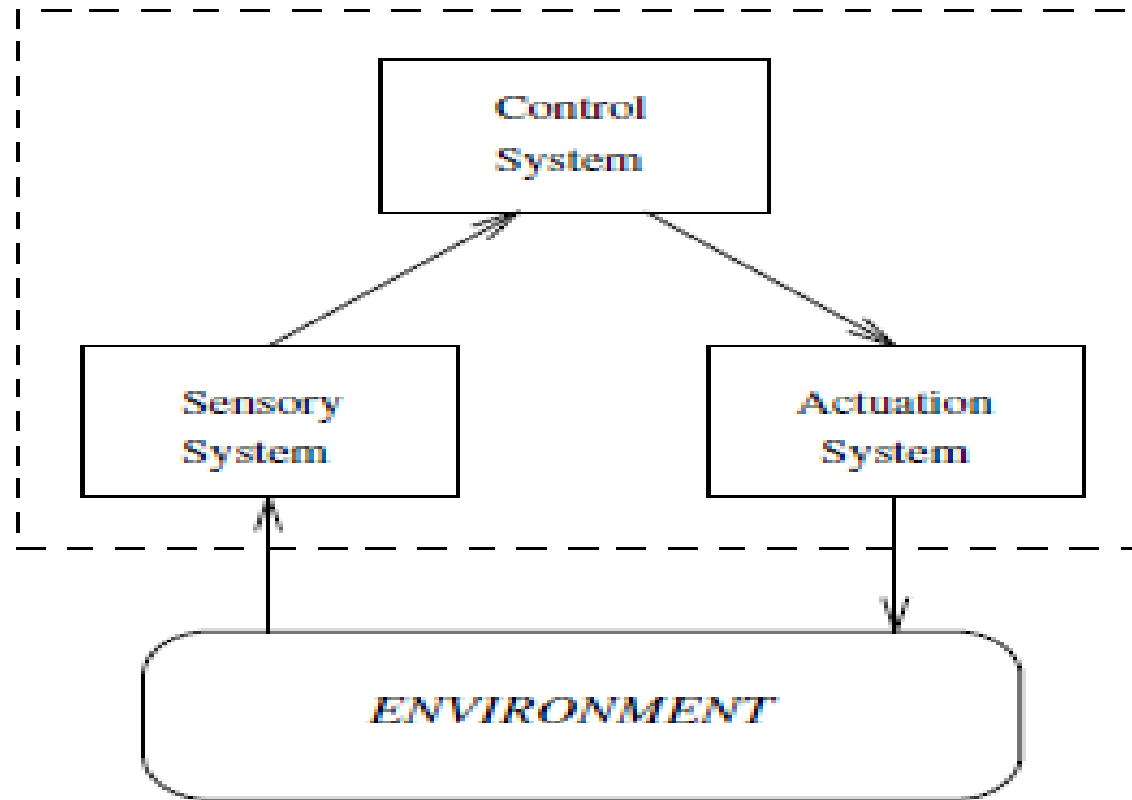
Figure 1.2 Block diagram of a generic real-time control system.

Deadlines

- At the process level, the main difference between a real-time and a non-real time task is that a real-time task is characterized by **a *deadline*, which is the**

- **maximum time within which it must complete its execution**. In critical applications, a result produced after the deadline is not only late but wrong!

Kinds of Real Time systems

▸ Depending on the consequences that may occur because of a missed deadline, a real time task can be distinguished in three categories:

▸ Hard
▸ Firm
▸ Soft

Kinds of Real Time systems

- **Hard**: A real-time task is said to be *hard* if producing the results after its deadline may cause catastrophic consequences on the system under control.

- E.g. Sensory data acquisition; data filtering and prediction; detection of critical conditions; data fusion and image processing; actuator servoing; low level control of critical system components; and action planning for systems that tightly interact with the environment

Kinds of Real Time systems

▸ **Firm**: A real-time task is said to be *firm* if producing the results after its deadline is useless for the system, but does not cause any damage. E.g. Video playing; audio/video encoding and decoding; on-line image processing; sensory data transmission in distributed systems.

Kinds of Real Time systems

▸ **Soft**: A real-time task is said to be *soft* if producing the results after its deadline has still some utility for the system, although causing a performance degradation .

▸ **e.g.** The command interpreter of the user interface; handling input data from the keyboard; displaying messages on the screen; representation of system state variables; graphical activities; and saving report data.