CHALLENGING ASSIGNMENT

EMBEDDED SYSTEMS

ITE305

Submitted By:

Mukul Dev

13BIT0269

Submitted To:

Dr. Balaji Raman

ITE305 Mentor

Cyber-Physical Systems (CPS) is integrations of computation, networking, and physical processes. The technology builds on the older (but still very young) discipline of embedded systems, computers and software embedded in devices whose principle mission is not computation, such as cars, toys, medical devices, and scientific instruments. Embedded computers and networks monitors control the physical processes, usually with feedback loops where physical processes affect computations and vice versa. As an intellectual challenge, CPS is about the intersection, not the union, of the physical and the cyber. It is not sufficient to separately understand the physical components and the computational components. We must instead understand their interaction. CPS integrates the dynamics of the physical processes with those of the software and networking, providing abstractions and modeling, design, and analysis techniques for the integrated whole. Models imitate the system and reflect properties of the system. Models specify what a system does. Design is the structured creation of artifacts. It specifies how a system does what it does. Analysis is the process of gaining a deeper understanding of a system through dissection. It specifies why a system does what it does (or fails to do what a model says it should do).

As a discipline, CPS is an engineering discipline, focused on technology, with a strong foundation in mathematical abstractions. The key technical challenge is to conjoin abstractions that have evolved over centuries for modeling physical processes (differential equations, stochastic processes, etc.) with abstractions that have evolved over decades in computer science (algorithms and programs, which provide a "procedural epistemology" [Abelson and Sussman]).

MODEL: We define a system to be simply a combination of parts that is considered as a whole. A physical system is one realized in matter, in contrast to a conceptual or logical system such as software and algorithms. The dynamics of a system is its evolution in time: how its state changes. A model of a physical system is a description of certain aspects of the system that is intended to yield insight into properties of the system.

DESIGN: It refers to implement systems while thinking across traditional abstraction layers — e.g., hardware and software, computation and physical processes. While such cross-layer thinking is valuable in implementing systems in general, it is particularly essential in embedded systems given their heterogeneous nature.

ANALYSIS: It focuses on precise specifications of properties, on techniques for comparing specifications, and on techniques for analyzing specifications and the resulting designs.

CPSs can be deployed in many different contexts and application areas. Here are some examples:

- Monitoring safety and movements of passengers in a public transport system, or of vehicles on a road network.
- Improving efficiency and safety in homes and offices, for example by monitoring and controlling heat and humidity.
- Optimizing crop yield and reducing pesticide/fertilizer use, by using CPSs to identify and deliver them only where they are needed.
- Supporting elderly people living alone, for example by detecting problems (such as illness or accidents) and raising the alarm automatically, using non-intrusive wearable sensors or detectors installed in the house.