CHAPTER 4

SYSTEM ANALYSIS

4.1 Existing System

The Nyquist Theorem, also known as the sampling theorem, is a principle that engineers follow in the digitization of analog signals. For analog-to-digital conversion (ADC) to result in a faithful reproduction of the signal, slices, called samples, of the analog waveform must be taken frequently. The number of samples per second is called the sampling rate or sampling frequency.

Any analog signal consists of components at various frequencies. The simplest case is the sine wave, in which all the signal energy is concentrated at one frequency. In practice, analog signals usually have complex waveforms, with components at many frequencies. The highest frequency component in an analog signal determines the bandwidth of that signal. The higher the frequency, the greater is the bandwidth, if all other factors are held constant.

Suppose the highest frequency component, in hertz, for a given analog signal is f_{max}. According to the Nyquist Theorem, the sampling rate must be at least $2f_{max}$, or twice the highest analog frequency component. The sampling in an analog-to-digital converter is actuated by a pulse generator (clock). If the sampling rate is less than $2f_{max}$, some of the highest frequency components in the analog input signal will not be correctly represented in the digitized output. When such a digital signal is converted back to analog form by a digital-to-analog converter, false frequency components appear that were not in the original analog signal. This undesirable condition is a form of distortion called aliasing.

4.2 Proposed System

Compressed Sensing or Compressive Sensing is about acquiring and recovering a sparse signal in the most efficient way possible (sub-sampling) with the help of an incoherent projecting basis. Unlike traditional sampling methods, Compressed Sensing provides a new framework for acquiring sparse signals in a mutiplexed manner. The main theoretical findings in this recent field have mostly centered on how many multiplexed measurements are necessary to reconstruct the original signal and the attendant nonlinear reconstruction techniques needed to demultiplex these signals. Another equally important thrust in the field has been the actual building of sensing hardware that could produce directly the multiplexed signals.

Once a signal is known to be sparse in a specific basis, one of the main challenge is to find a set of measurement tools (producing the compressed measurements) and the attendant nonlinear solver that reconstructs the original full signal. There are theoretical results yielding the minimum number of required measurements needed to produce the original signal given a specific pair of measurement matrices and nonlinear solvers. In all cases, the expected number of compressed measurements is expected to be low relative to traditional Nyquist sampling constraints.

4.3 Proposed System Architecture

System architecture refers to a combination of hardware, software, infrastructure and trained personnel organized to facilitate planning, control, coordination and decision-making in an organization.

A **system architecture** or **systems architecture** is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures of the system.

System architecture can comprise system components, the externally visible properties of those components, the relationships (e.g. the behavior) between them. It can provide a plan from which products can be procured, and systems developed, that will work together to implement the overall system.

The architecture shown in Fig 4.1 describes how the system works.

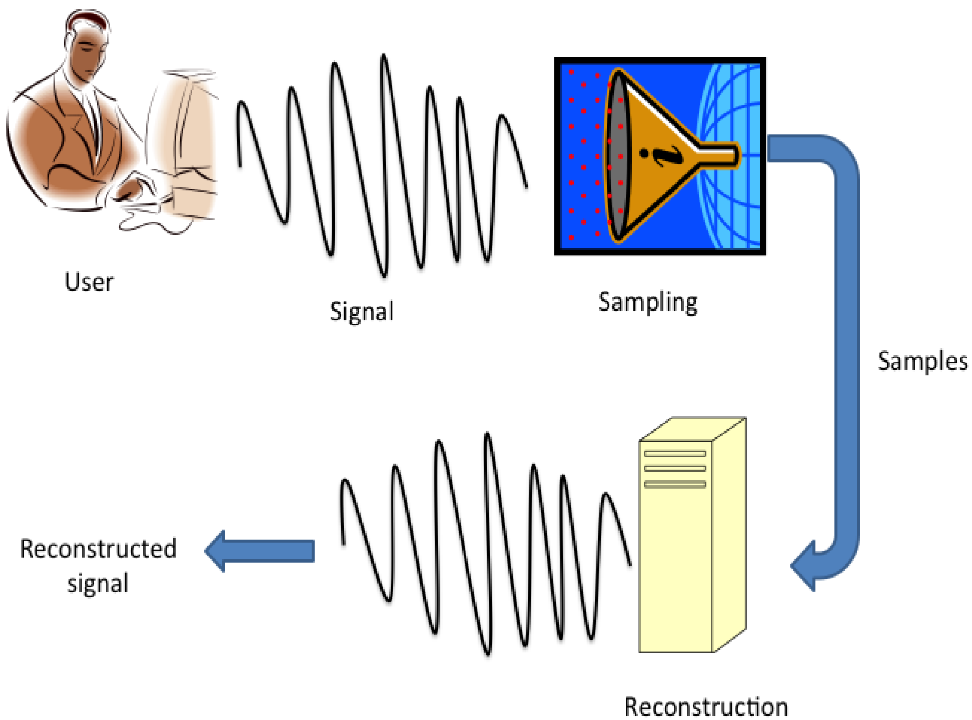

Figure 4.1. Architecture of Signal reconstruction using CS System

The system consists of 2 main modules; one for sampling the input signal and another for reconstruction. The steps are as follows:

1. The user chooses any one of the keys between 0 and 9, for which a signal is generated.
2. The sampling module then takes a certain number of samples of this signal. These samples are written into a file, which is then sent to the reconstruction module.

The reconstruction module attempts the recovery of the signal by using the samples sent to it using one of the 3 algorithms: Orthogonal Matching Pursuit, Approximate Message Passing and Basis Pursuit.