Chapter 6
Summary of Results and Future Scope for Work

6.1 Summary

Holography is a technique pioneered by Dennis Gabor in 1948, in which interference and diffraction phenomena are employed to record and retrieve the full information. Holography has an indispensable role in science and industry. Principle of holography has opened up completely new possibilities in three dimensional displays, holographic cameras, interferometers for non destructive analysis, archival data storage systems, diffractive optical systems, invariant pattern recognition, optical fuzzy logic control, and embossed display hologram for security.

The first chapter provides an introduction to the development of holography and reviews the recording and read-out geometries, and recording materials. A brief mathematical basic is also included. Special emphasis is given to explain some important application of the recording materials. They include the theory of grating, design and fabrication of grating based on the simulation result obtained. The different techniques used for the optical characterisation are also discussed.

Chapter 2 deals with the simulation of VPGs using the design parameters and grating are fabricated on silver halide, photopolymer and photoresist materials.
Diffraction efficiency of these gratings are measured and plotted. Among the three materials used, grating formed in silver halide showed the highest efficiency followed by photoresist. Grating fabricated on photopolymer showed lowest diffraction efficiency.

In the first part of the chapter 3, optical characterisations are done by UV-Vis spectroscopy and AFM techniques. The UV-Vis spectra shows better transmittance for grating fabricated on silver halide compared to that fabricated on photopolymer and photoresist. This indicates the suitability of the grating formed on silver halide films for use in the transmission mode and the gratings formed on photopolymer and photoresist films in the reflective mode. Effect of polarization is also examined in the case of silver halide. The UV-Vis spectra of the silver halide for different polarization angles reveal that good grating are formed at polarizing angles of $10^\circ$ and $30^\circ$. AFM analysis reveals better relief patterns for the gratings formed on photoresist and its metal shim.

Second part of third chapter testifies the fabrication of a three way coupler fabricated on different holographic gratings. The behavior of the optocoupler is interpreted. The optocoupler fabricated on silver halide and photopolymer are superior to that fabricated on photoresist materials.

Phase conjugated waves are generated on dye sensitized silver halide plates using DWFM. Dyes such as lissamine green B, toluidine blue O and methyl red used for sensitizing the plates. The PC signal power produced in these materials is also evaluated. It showed that PC power generated in lissamine green B is high, trailed by toluidine blue O and then by methyl red. The general nature of all graphs (drawn PC signal versus time) showed that the PC signal first increases attain a maximum value.
and then decreases. The decrease of the PC signal power after reaching the maximum value can be due to the photo bleaching of the dye molecules at the excitation wavelength.

The search for a holographic storage material fulfilling all application requirements is still in progress. Here, the ability of the recording materials in the field of emerging data storage field is testified by developing a low cost SLM. A holographic data storage set up was designed and implemented. With the developed data storage setup, data is encoded and holographically recorded. The recorded data is successfully retrieved and correlated using a joint transform correlator.

6.2 Future Scope for Work

One of the futuristic applications of gratings would be development of complex grating structures for astronomical applications. Holographic gratings can be stacked together to make a variety of complex grating structures. A single grating assembly might contain a second grating with the fringes perpendicular to the first in order to provide cross-dispersion. A second concept is a double grating which disperses light of two different wavelengths into the same angle of diffraction. A third concept would be a dual grating that divides the light at different wavelengths into different paths to function as a dispersive beam splitter.

Aberration correction can be directly incorporated into VP holographic gratings used in military head-up displays.

The nature of the VP grating raises the possibility that a single grating can have a range of performance characteristics depending on the configuration of the
spectrograph in which it is used. Such versatility from a single grating is not available with surface-relief gratings. With VP grating technology, it is possible to think of a spectrograph in which the peak efficiency and dispersive power that can be tuned to the desired wavelength of interest with a simple change in both the grating angle and the angle between the collimator and the camera.

Nonlinear property of the dye sensitized holographic materials can be utilized in developing optical logic gates.

There is a huge competition to keep up with the continuing demand for more capacity, more density, and faster readout rates. Improvements in conventional memory technologies like magnetic hard disk drives, optical disks, and semiconductor memories have managed to keep pace with the demand for bigger and faster memories. However, these two-dimensional surface storage technologies are approaching fundamental limits. An alternative approach for next generation memories is to store data in three dimensions. 3D memories can be achieved by superimposing many holograms within the same recording material. The current study has demonstrated a prototype of holographic storage system. These systems with desirable properties, engineered at a competitive cost, will be the next challenging task for scientist and engineers to optimize the storage media.