EXECUTIVE SUMMARY

During the last few years, the dependency on alternate energy has been growing with steady pace and significance; thereby providing an abundant scope for deploying new technological solutions to growing problems like pollution, adulteration and corruption. It is a well-known fact that additives added to any liquid fuel directly affects the performance and efficiency of any automobile. The same fact applies to adulteration in common commodities like milk, curd and soft drinks. The various physical properties that govern the nature of fluids include viscosity, concentration, boiling point, melting point, etc. The additives and other adulterants produce a change in these properties. Therefore, developing a sensor based on the physical properties of such fluids can provide a reliable and effective solution for detection and monitoring of adulterants. There are a host of devices available in the market for measuring adulteration in fluids. Most of them are either complex or need a huge lab space with a trained instructor for the operation. This makes it challenging for a common man to measure adulteration at ground level.

This thesis describes the designing, fabrication, theoretical modeling and experimental validation of a 3D printed lab-on-chip microfluidic device which measures adulteration by analyzing the variations in dynamic viscosity of a fluid in a palm-sized variant without the need of an experienced operator. The working principle in this device is viscosity dependent width capture by two immiscible fluids flowing into a rectangular microchannel at the same flow rate. The theoretical model of the device has been based on the modified Hagen-Poiseuille flow equation with emphasis on flow rate, sample volume and viscosity as major parameters. The dynamic viscosity of various samples have been tested w.r.t a reference solution and the test results have been verified using a standard rheometer. The tests were conducted for three types of sample groups. The first group comprised of several blending ratios of diesel with biodiesel. The second group was a sample galore of various commonly mixed adulterants (of different ratios) in milk. The third and final group consisted of samples formed by a mixture of three conventional fuels namely petrol, diesel and kerosene. The design and fabrication of the device using the conventional micromachining and the advanced 3D printing technology has been discussed in detail. This optical microviscometer has many advantages over other devices like simple design, quick 3D fabrication, low cost, low sample volume, excellent insulation, transparency, durability and accuracy. The simple and versatile device design offers the advantage of being compatible for many other applications like food adulteration, haemoglobin detection, PT-INR measurement, etc.