LITERATURE REVIEW

2.1 **ARAI** (2001) has published this standard which prescribes the requirements of Rear view mirrors. This standard clearly emphasizes that Rear view mirrors and field of vision provided by them is a safety requirement. This standard specifies the general method of reflectance measurement and in Annexure 3 of this standard it also specifies the general method of radius of curvature measurement. Through this standard, the requirements i.e. the ranges of values of these parameters of rear view mirrors for satisfactory quality are also known.

2.2 **A. GAMBARDELLA AND R. GALLEANO** (2011) have talked about use of CCD camera for measurement of solar radial energy distribution and have considered the uncertainty components of optical and other CCD specific sources such as CCD linearity, background noise, blooming, lens aberration, exposure time linearity and quantization error and concluded that 0.94% ($k = 2$) combined expanded uncertainty on the solar radial energy distribution can be assumed. This paper also endorses the use of CCD camera for measurement of Reflectance which is similar to radial energy.

2.3 **BIS IS 14210** (1994) standard for rear view mirrors for automobile vehicles has specified the method for measurement of Distortion Factor of Rear view mirrors. The standard also specifies the range of values for different types of rear view mirrors for which the mirrors are certified as satisfactory.

2.4 **CARLOS B. ROUNDY, GREGORY E. SLOBODZIAN AND KURT JENSEN** (1995) have patented the method and apparatus for improving dimensional measurements made with video cameras. This invention clearly specifies the use of CCD cameras for making spatial measurements which is in line with our approach. The patent also talks about the
inherent drawbacks of the CCD cameras such as low signal to noise ratio, baseline offset error etc. It also talks about how to remove these drawbacks.

2.5 **D.K. MISHRA AND M. CHANDWANI** (1993) have presented an automatic CCD camera vision based measurement system having capabilities to measure dimensional parameters. In this paper the author have mentioned that the CCD camera measures the dimensions of the object with an accuracy which is same as that of a Computer Numerical Controlled machines (CNC) and provides co-ordinates to the computer for the movement of machine tools. The review of this paper has made our selection of CCD camera for the accurate dimension measurements which will be done by us in the Distortion Factor measurement.

2.6 **D. ROD WHITE, PETER SAUNDERS, STUART J. BONSEY, JOHN VAN DE VEN, AND HAMISH EDGAR** (1998) have described a fully automatic four axis gonioreflectometer. The method discussed here is similar to our set up for reflectance measurement and it uses a source of light and a light detector to detect the incident as well as reflected light and measure both these lights subsequently. In our reflectance measurement set up also, we are planning to use a light source and a CCD camera for detecting as well as measuring the light incident on a white screen directly at the first time and then measuring the light reflected from the rear view mirror on the same screen.

2.7 **DAVE BAIOCCHI AND J. H. BURGE** (2000) Future space and ground telescopes will have apertures that are increasingly larger in size. The primary mirrors for these telescopes will be so large that they cannot be fabricated, transported, and/or launched as a single entity. One solution is to build a large mirror out of smaller segments. The biggest challenge in fabricating segmented mirrors is matching the individual pieces so they form a
single, continuous surface. This requirement means that the radii of curvature must all match. They presented a technique for matching the relative radii of curvature for segmented mirrors.

2.8 **EDWARD STEVENS JR., MARTIN COHEN AND PEREGRIN SPIELHOLZ** (2009) Legislation and product development in the USA has prompted an interest in mirror-use by traffic flaggers to improve awareness of vehicles approaching from behind. Helmet- and flagpole-mounted configurations were studied using a graphical approach with field verification studies by comparing fields of view, object magnifications, and human factors considerations. Plane and convex mirrors with different radii of curvature were investigated. Results found image formation on helmet-mounted convex mirrors occurs too close to the mirror. A 0.038 m helmet-mounted plane mirror performed similarly to a 0.076 m diameter, 0.508 m radius of curvature convex mirror. Fields of view and image information between helmet-mounted plane mirrors and flagpole-mounted convex mirrors were compared. Issues of image perception, practical use, and attention were identified; they pose serious issues for use as a primary safety device. Additional investigation is needed to determine the requirements and applicability of mirror-use for flagging in work zones.

2.9 **HAISHAN ZENG, STEPHEN LAM, BRANKO MIHAEL PALCIC** (2004) have patented methods and apparatus for fluorescence and reflectance imaging and spectroscopy. The authors have pointed out that white light source is to be used for the reflectance measurement. It also mentions that the white light should be in NIR wavelength band.

2.10 **HANG CAO, XIAOMEI CHEN, K.T.V. GRATTAN AND YUJIU SUN** (2002) have used a CCD camera based system for micro dimension measurement. In fact they have used
a similar set up which is same as our set up of CCD camera, a Frame grabber card (same as Image acquisition card), mechanical and lighting arrangement (Optical and mechanical units), a computer system. So review of this paper has confirmed that our approach is in the right direction i.e. a general purpose analog CCD camera can be used for accurate dimension measurement and that the required accuracy can be achieved by selecting the camera of proper resolution, selecting Frame grabber card of proper resolution and a proper selection of lens for CCD camera.

2.11 J. A. FISHER AND I. A. R. GALER (2007) Two experimental techniques are explored for laboratory investigation of the effect of reducing the radius of curvature of externally mounted rear-view mirrors, using filmed stimulus material prepared to maintain the ecological validity of the changing information display at the mirror surface. One method is concerned with the effect upon the ‘minimum safety margin’ which drivers are prepared to leave in committing themselves to an offside lane change maneuver in front of a vehicle approaching from the rear. The second method is concerned with providing a continuous record of differences in the change over time in visual sensation caused by viewing the approach of a target vehicle through mirrors of different radii.

2.12 JAMES ERIC LLOYD (2006) under the capacity of minister of local Government, Territories & roads, Australia, has laid down similar specifications for rear view mirrors and from these specifications also it is clear that the safety requirement for rear view mirrors is equally important in Australia.

2.13 LUN KE (1999) in his thesis submitted for the partial fulfillment of the requirements for the Masters of Science degree in Computer science from British Columbia University has used CCD camera for Reflectance measurement. In this Thesis, the author talks about
calibrating the CCD camera and using it as a light measuring device. In our set up also we plan to use the CCD camera in a similar fashion i.e. calibrating it initially and then using it as a light measuring device to measure the incident light from a light source and reflected light from the Rear view mirror and then finding out the reflectance which is nothing but the ratio of Reflected light measured and incident light of the light source and this parameter is expressed in terms of percentage. The author even concludes that CCD camera can be used to measure light reflectance properties and is relatively fast and convenient and that is exactly what we have proposed.

2.14 McCORD (1984), in his U.S. patent no. 4449786 has described rear view mirrors in detail i.e. their definition, construction, types, specifications etc. which is a very useful information since the subject matter of our topic is Rear view mirror.

2.15 MASAHIKO SASAKI AND MASAAKI KANEKO (1996) in their patent have discussed the apparatus for making dimensional measurements of objects. i.e. how lighting arrangement has to be done, how the CCD camera has to be placed and what focal lens is to be used etc. They have also discussed about the selection of lens playing a major role in deciding the accuracy of the measurement. Selection of lens decides the magnification which is being carried out by the CCD camera. This magnification along with the resolution of the CCD camera decide the physical dimension of one pixel which is the minimum unit of measurement i.e. least count.

2.16 NIALL R. LYNAM AND JOHN O. LINDAHL (2010) have patented a video mirror system for vehicle. This patent invention relates to automobile lighting i.e. lighted mirrors for a vehicle. This patent talks about the use of Light Emitting Diodes (LEDs) as one of the light sources for vehicle lighting along with incandescent light source. So the authors
endorse our choice of using LED light source for reflectance measurement.

2.17 ROUNDY ET. AL. (1995) have patented for the method and apparatus for increasing the accuracy of dimensional measurements made using video cameras. In this patent, the authors talk about the drawbacks of CCD cameras such as baseline offset error, shading error, pixel to pixel fixed pattern offsets and poor signal to noise ratio. This patent substantiates our claim that video cameras can very well be used for dimensional measurements with desirable accuracy. This patent review also gives the guidelines of what care is to be taken while using CCD camera for dimensional measurement. One such guideline is that the signal the CCD camera should be used in such a manner that the signal produced by the camera is very closed to saturation.

2.18 ROSER, M. (2010) proposes a novel framework for road reflectivity classification in cluttered traffic scenarios by measuring the bidirectional reflectance distribution function of road surfaces from inside of a vehicle. The predominant restrictions in his application are a strongly limited field of observations and a weakly defined illumination environment. To overcome these problems, he estimated the parameters of an extended Oren-Nayar model that considers the diffuse and specular behavior of real-world surfaces and extrapolate the surface reflectivity measurements to unobservable angle combinations. The effectiveness of his approach is demonstrated by a successful classification of the road surface reflectance of expressway scenes with low error rates.

2.19 S.B. DWORKIN, T.J. NYE (2006) have presented a Image processing based Machine vision measurement of hot formed parts. In this method also they have endorsed the use of CCD camera for dimension measurement. This paper talks about the importance of work space illumination and some image processing techniques in the machine vision system.
which is similar to our set up. The review of this paper endorses our selection of lighting arrangement for proper illumination of the work space and also selection of some image processing techniques which will be subsequently used in our software to carry out the measurement of Distortion Factor of Rear view mirrors.

2.20 TONI KUPARINEN, OLEG RODIONOV, PEKKA TOIVANEN, JARNO MIELIKAINEN, VLADIMIR BOCHKO, ATE KORKALAINEN, JUHA PARVIAINEN AND ERIK VARTIAINEN (2005) have presented method for optical paper surface roughness measurement, which overcomes the disadvantages of the traditional methods. In this method also a CCD camera based dimension measurement is done which further endorses our selection of CCD camera for Distortion Factor measurement where distance between concentric circles will be measured accurately.

2.21 VROOMEN (2007) in his patent discusses the method for measuring dimensions by means of a digital camera and certifies the use of CCD camera for such applications. The patent clarifies that the accuracy of the measurement depends on the number of pixels (picture elements) of the image. It also says that measurement of the distance between two points i.e. length can be done by finding out the co-ordinates of the end points and then calculating the distance by the formula. The author further states that to increase the accuracy of the measurement one should use higher resolution camera (in terms of number of pixels) so that the accuracy can be increased. The other alternative method to increase the accuracy is to zoom in the camera i.e. increase the magnification of the camera by using a different lens of suitable focal length.