

# Chapter 17

## A Tool for Automatic Hammersmith Infant Neurological Examination

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### ABSTRACT

*Hammersmith Infant Neurological Examination (HINE) is a popular method to estimate the neurological development of infants aged less than two years. Using HINE, especially for preterm or premature babies, the risk of neural disorder can be minimized through proper preventive measures. This paper presents the design of a semi-automatic application that can be used as an aid to doctors for efficiently conducting the examinations listed in the Hammersmith chart. The user friendly version of the examination interface provides a platform for quantitative neurological assessment of the infants. It includes various simplified video and image based schemes that are suited to inexperienced staff. It provides an interface to go through the previous records of patients. Ten examinations are enlisted in the Hammersmith chart for neonatal babies. This paper examines a semi-automatic approach for posture estimation examination. For post neonatal infants, a follow-up management interface is designed that can be used to fetch / consult past records of the patients for better diagnosis. The application is currently in operation at Neonatal Intensive Care Unit (NICU) of Institute of Post-Graduate Medical Education & Research (IPGME & R) and Seth Sukhlal Karnani Memorial (SSKM) Hospital, Kolkata, India.*

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## INTRODUCTION

Application of computer vision to improve the efficacy of telemedicine and healthcare systems is being considered as a good alternative to the conventional approaches. Advancement in image and video processing technology has accelerated its usage for the betterment of healthcare services. Such schemes are gaining popularity even in various infant care management systems. For example, the application developed using safe, compact and non-invasive sensors to record the movements of a baby with a client / server based approach by Singh and Hsiao (2003), is a telemonitoring system that is being used for remote surveillance of infants. Similar kinds of applications are also found in healthcare domain that adopts computer vision based techniques (Nishida et al., 2004).

Similarly, intensive medical care performed in Neonatal Intensive Care Units (NICU) can be benefited using image and video based monitoring modules. Survival rate of very low birth weight and preterm newborns can be increased with the help of such sophisticated technologies. Romeo and Guzzetta (2008) have reported in their survey that an early prediction based on the outcome of various examinations conducted while the infant is admitted in NICU is clinically useful to counsel families.

Several schemes have been proposed in collaboration with scientists and medical professionals to minimize the error in predictions. One such popular method that has been developed by Dubowitz et al. (1981) is known as Hammersmith Infant Neurological Examination (HINE). The method has successfully been adopted for assessment of preterm and term infants to identify patients with higher risk of neurological abnormalities during later stage of their lives (Haataja & Mercuri, 1999). In addition to that, Romeo et al. (2008) has reported in their work that the HINE scores can be correlated with the levels of Gross Motor Function Classification System (GMFCS). Particularly, infants with Intra-Ventricular Hemorrhage (IVH) or

Peri-Ventricular Leukomalacia (PVL) which is the most common ischemic brain injury in premature infants, an increasing prevalence of Cerebral Palsy (CP) can occur (Majnemer, 2000). Thus, HINE is considered as a preventive measure that can detect neural disorder at an early stage.

It is a quantitative scorable method for assessing neurological development of infants between 2 and 24 months of gestational age. The examinations include assessment of cranial nerve functions, posture, movements, tone, reflexes, etc. While examinations are being carried out, postures and reactions of the infant under consideration are recorded. An overall score that quantifies the neurological development index at the time of experiment is assigned to the infant. For post neonatal babies, the examinations are carried out repetitively at the ages of 3, 6, 9, 12 months and so on. On the other hand, for neonates, a set of ten examinations has been proposed in the Hammersmith chart which are carried out once at the gestational age of 40 weeks. The examinations include accurate measurement of posture, arm recoil, arm traction, leg recoil, leg traction, popliteal angle, head control, head lag and ventral suspension. Finally, the overall score of the neurological development index is estimated by adding scores of individual examinations.

However, we have not found any application that tries to automate the HINE examination process. Therefore, till date, doctors conduct and record the outcomes of HINE manually. Even no application is available that records visual evidence of the examinations including respective patient registration information and outcomes. But, such an application has the potential to improve the assessment process. This has motivated us to propose a scheme that uses visual evidence. Also, one of the goals of designing such an application is to obtain significant speedup over manual process with the help of scientific decision making step. Issues that have been taken care of while designing the application are listed below.

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