



# Investigating Detectability of MTA Method for Subject's Reaching Movement Controllability Under Upper-limb Joints Restrictions

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**Abstract :** Stroke survivor's functional mobility loss is expected to improve if the patient receives intensive therapy, and performs activities of daily living. Providing a quantitative assessment for patients' recovery progression instead of the traditional ordinal scale has received significant attention. In this paper, an investigation was conducted using Mahalanobis-Taguchi-Adjoint, MTA method to develop an evaluation system for stroke patients with upper-limb impairments. Replicating upper-limb impairment, an experiment was conducted by restraining able-body subjects' shoulder, elbow, and wrist joint motion under six restraint conditions. Fifteen able-body subjects' data were collected and implemented as unit space/signal dataset, to detect difference of another fifteen able-body subjects on their capability of performing under shoulder, elbow, wrist, and compound restraint conditions. From the results, MTA method was capable of detecting difference between subjects reaching movement ability between shoulder, elbow, and wrist joints. Measuring estimated value's distribution size with coefficient of variation, CV, wrist restraint CV resulted in 0.575. For elbow and wrist restraint, CV resulted in 0.385, and shoulder restraint CV resulted in 0.354. Therefore, MTA method when using the proposed features, enable clinicians to detect changes on patients' impairment upper-limb performance compared to able-body subjects.

**Key words :** Mahalanobis-Taguchi Adjoint (MTA) method, Motion restraint evaluation, Therapeutic robot, Upper-limb impairment, Computational assessment, Robust quality engineering, Taguchi methods

## 1 Introduction

Stroke patients' exercise performance progres-

sion is traditionally assessed using clinician's visual observation<sup>1)</sup>. Current assessment criteria are five-point ordinal scales. However, investigations regarding the use of ordinal scales, have shown the limits of utilizing five-point ordinal scales to detect small improvements in motor recovery<sup>2)3)</sup>. According to Johnson's study, clinicians' subjective evaluations have reliability and

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