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DEVELOPMENT AND VALIDATION OF MOBILE BASED DECISION SUPPORT SYSTEM FOR POSTURAL ASSESSMENT OF AGRICULTURAL ACTIVITIES USING RAPID UPPER LIMB ASSESSMENT (RULA) TECHNIQUE

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Abstract

Agricultural workers, especially rural people suffer from musculoskeletal disorders (MSDs) in different parts of the body, especially low and upper back pain, during different agricultural activities. The causes of MSDs in agriculture is result of heavy burden, repetitive motion, awkward working postures, long time working and use of non-ergonomically designed traditional tools and implements. Ergonomic risk factors involved in working environment can be measured by using various assessment tools to determine the worker's capabilities and limitations. The work-related risks can be measured directly by using some of the scientifically proven postural assessment tools like RULA, REBA etc. Standard assessment worksheets or tables are used to evaluate the working posture during each operations or activities. RULA is a method designed to provide a quick analysis of the demands on a person's upper limb. It provided an objective measure of the MSDs risk caused by tasks where the demands on the upper body are high RULA technique is primarily assessed the upper limb (hand, wrist, elbow, shoulder), but also the neck and low back (due to trunk postures). Mobile Based Decision Support System (MBDSSs) serve the management, operations and planning levels of an organization (usually mid and higher management) and help people make decisions about problems that may be rapidly changing and not easily specified in advance. Several MBDSS have been developed in different agricultural activities but there is no such system available for postural assessment technique of work-related musculoskeletal disorder. It is in this context, the DSS was developed for postural assessment of agricultural activities with Rapid Upper Limb Assessment (RULA) technique. By this posture will be assessed and farmers may be suggested /recommended the correct posture to avoid developing musculoskeletal disorders.

Ke ywords : *Musculoskeletal disorders (MSDs), RULA, REBA, ergonomics.*

Indian economy is an agriculture based economy where nearly 70% of the population in rural areas depends directly or indirectly on the income derived from agriculture. The agriculture and food processing sector plays an instrumental role in augmenting the growth of economy, as it is an important source of raw material for the industrial sector. In India, large number of human resource is mainly associated with agricultural work which demands human energy. Asymmetric postures, which involve stooping and bending postures, increase the load on spine. A good working posture is the one, which can be sustained with a minimum of static muscular effort and in which it is possible to perform the task more effectively and with least muscular effort (Pheasant, 1991). Postural stress can increase the physiological cost and fatigue while performing the task and may also lead to pain and injuries to vertebral column in the long run. According to (Bredger, 1995), stooped working postures (in which the trunk is inclined forward) results from working surfaces that are too low or for the need to reach over obstacles. (De Looze *et. al,* 1994) reported that different aspects of working body postures are related to specific injuries. A study conducted by (Gangopadhyay and Bandopadhyaya, 1999) revealed that there were symptoms of pain in different parts of musculo skeletal system after completion of work. Agricultural workers, especially rural people suffer from musculoskeletal disorders (MSDs) in different parts of the body, especially low and upper back pain, during different agricultural activities. Farm workers have to perform a fair amount of manual, continuous rigorous tasks in the agricultural field. Agriculture is one of the most harmful working areas involving labor- intensive activities and displays high rates of musculoskeletal disorders (MSDs) in most of the countries. The causes of MSDs in agriculture is result of heavy burden, repetitive motion, awkward working postures, long time working in sitting conditions and use of non-ergonomically designed traditional tools and implements. Ergonomic risk factors involved in working environment can be measured by using various assessment tools to determine the worker's capabilities and limitations. When a person adopts his body to the full bending posture, it is likely to result in work related postural deformities with epidemiological pain in upper extremities or lower extremities of the body (Majumdar *et. al.,* 2000). The work related risks can be measured directly by using some of the scientifically proven assessment

tools like RULA, REBA etc. Standard assessment worksheets or tables are used to evaluate the working posture during each operations or activities.

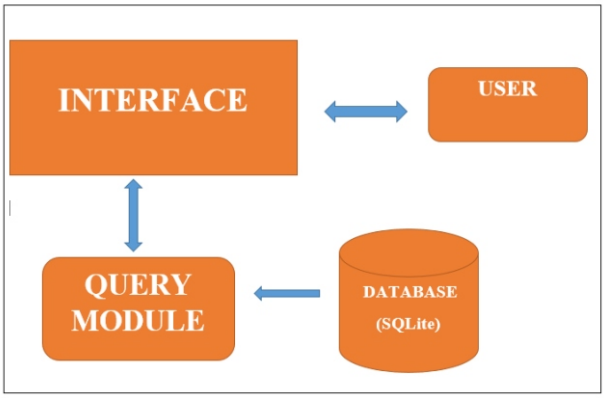
RULA is a method designed to provide a quick analysis of the demands on a person's upper limb. It provided an objective measure of the Musculo-Skeletal Disorder risk caused by tasks where the demands on the upper body are high but the whole body demands (that is, the back and legs) are relatively low (David, G. C. 2005). RULA technique is primarily assessed the upper limb (hand, wrist, elbow, shoulder), but also the neck and low back (due to trunk postures). Typically, the person is working in agricultural sector with undue bending, extension or flexion of upper limbs when performing the some agricultural related task as the weeding in sitting posture. Tools that are used to determine the working posture problem is RULA (Rapid Upper Limb Assessment) that considered an effective tool for measuring the quality of work posture in a job that involves a lot of upper body. RULA score explain the severity of MDS experienced by operator who work under certain conditions.

Decision Support System (DSS) is characterized as interactive tool including computer-based information and modeling systems for the purpose of aiding the decision-making activities, helping to understand the problem, exploring various alternative courses for actions, their impacts and facilitating sensitivity analysis. DSSs serve the management, operations and planning levels of an organization (usually mid and higher management) and help people make decisions about problems that may be rapidly changing and not easily specified in advance. Decision support systems can be either fully computerized or human-powered, or a combination of both.

Several DSS have been developed in different agricultural activities but there is no such system available for postural assessment technique of work related musculoskeletal disorder. For postural assessment of agricultural activities with Rapid Entire Body Assessment (RULA) technique, the DSS was developed which will be online so that user can interact with this system and retrieves any information related to status of biomechanical loads. This web based system will help the evaluator for assessing agricultural activities on the basis of RULA postural assessment technique by which posture can be evaluated and farmers may be suggested /recommended the correct posture to avoid developing musculoskeletal disorders.

MATERIALS AND METHODS

Different types of softwaretools are used in this proposed research work. This software includes Programming Languages, Android Platforms, DB Browser for SQLite, JAVA Libraries, Android Studio IDE, SQLite and Android Virtual Device (AVD) tool.



MDSS architecture

Fig.-1 : Home Screen of MDSS-RULE

RESULTS AND DISCUSSION

An attempt has been made in developing 'MDSS-RULA'. one of android based systems which will support users (for evaluating agricultural operations where upper body parts are more involved for example weeding, harvesting in sitting positions, winnowing, seeping etc.) for making their decision regarding what posture should be adopted for doing agricultural task which can help in reducing drudgery and load on biomechanical aspects. Postures which are initially adopted for occupational reasons may become habitual outside the working context and finally become irreversible owing to the shortening and fibrous contraction of muscles and soft tissues. Therefore the developed DSS helps in posture assessment.

Data can be evaluated on MDSS-RULA and give an score ranges from level 1 to level 4 with different mode of action suggested or recommendations.

CONCLUSION

The MDSS-RULA has been developed for postural assessment of musculoskeletal disorders (MSDs) RULA methodology and the system was tested and validated by using the set of sample data. The system provides accurate results and helpful for evaluating drudgery prone activities for postural assessment.

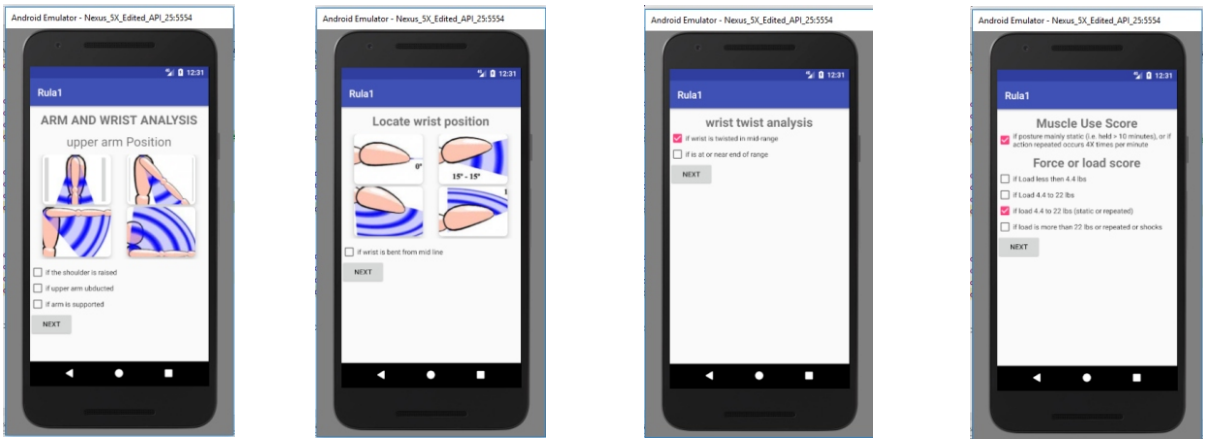


Fig.-2 : Arm and Wrist analysis by using MDSS-RULA.

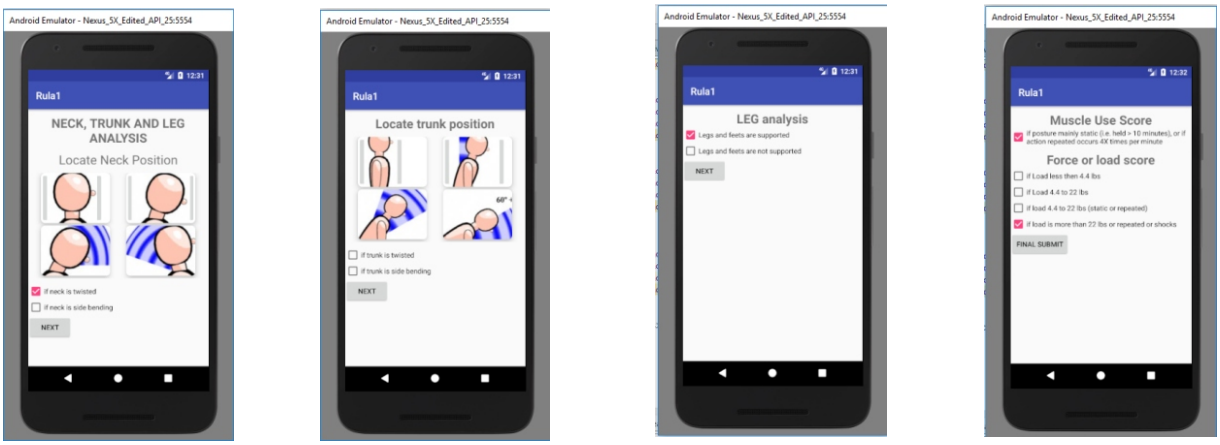


Fig.-3 : Neck, Trunk and Leg analysis by using MDSS-RULA.

Action level	Score	Action Required
(L_1) Level I	1-2	Acceptable Posture
(L_2) Level II	3-4	Low risk, change in the posture / activity may be needed
(L_3) Level III	5-6	Medium risk change soon
(L_4) Level IV	6+	Very high risk, implement changes now or use improved technology

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