The 6th Joint International Conference on the Multibody System Dynamics and
The 10th Asian Conference on Multibody System Dynamics
October 16-20, 2022, New Delhi, India

Multibody Dynamics Software-based simulation of a game for Robotics competitions

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Abstract: Due to advancements in the area of automation, there is a need of skills for engineers. These skills are obtained through various workshops, seminars and participating in competitions. Apart from the practical work skills, there is a requirement of proper simulation to get an idea of the final tasks on the field. This paper presents the use of multibody dynamics software for simulating the game to check the effectiveness and completeness of several tasks. In this work, ADAMS [1], a multibody dynamics software, has been used for simulations. The tasks that have been performed are the tasks of the Indian traditional game "Lagori" [2], which is also the theme of the upcoming ABU Robocon 2022 [3] that will be held in New Delhi, India. Lagori is a game of breaking the pyramid made of discs placed one over the other as shown in Fig. 1a, then piling up the pyramid without getting hit by the opponent team. The opponent team needs to throw a ball and hit the ball placed over the top of the robot piling up the pyramid Fig. 2b.

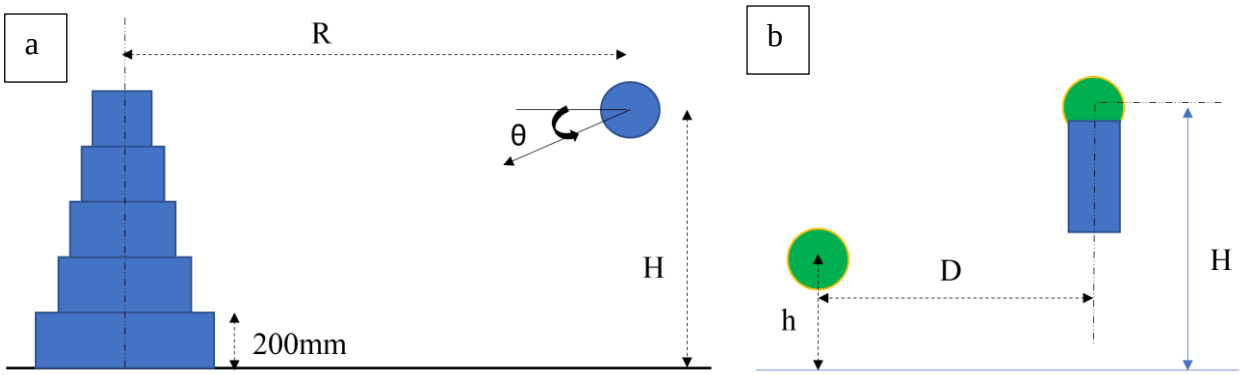

Figure 1: (a) A ball hitting the Lagori (made of discs) (b) A ball hitting another ball placed on top of the robot.

The above two tasks are shown in this work. The variables in the first simulations are speed of the ball, height (H) and placement of the discs etc. The current arrangement shown is 54321, as 5 means the biggest disc, 4 means the second biggest and so on. The disc diameters are 500mm, 425mm, 350mm, 275mm and 200mm in the decreasing order. The hitting ball has a diameter of 140mm. The contact model is implemented in all the possible contacts. The ball is made of leather, discs are made of plastics and the ground is considered to be made of wood. The possible contact

in the first task can be disc-floor, disc-disc, disc-ball and ball-floor. The contact model is based on the Hertzian model written as (1), here k is the stiffness, e is the force exponent and x is the penetration depth. All the parameters for the simulations are taken close to those available.

$$F = k \times x^e \tag{1}$$

Further, static and dynamic friction coefficients are used for all contacts. Damping is used to create the damping force that dissipates the energy. Various simulations are done to check the effectiveness of the task. Some of the output results are shown in Figure 2.

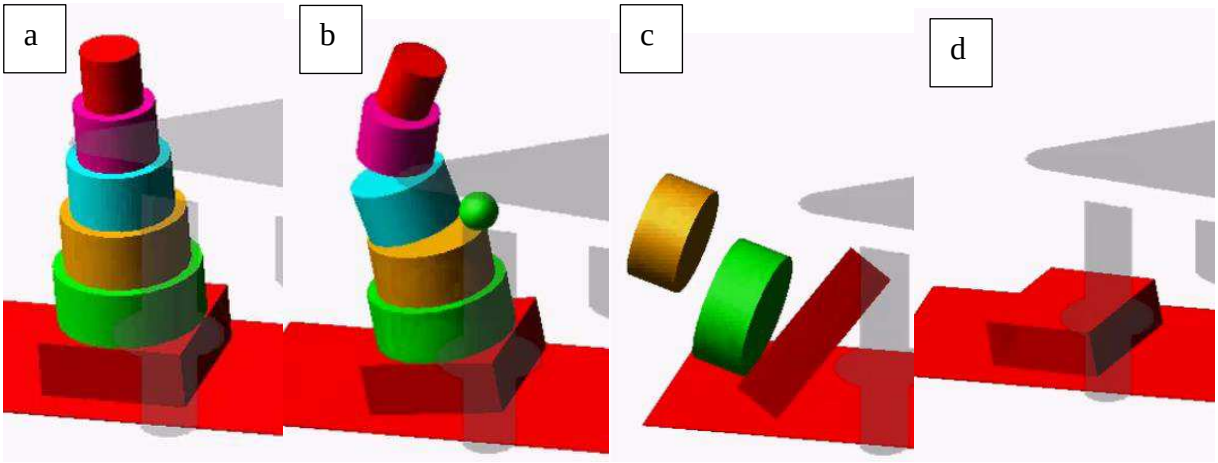

Figure 2: Breaking of Lagori (a) Time =0sec (b) 0.12sec (c) 0.24sec (d) 0.84sec

These kinds of simulations are very important for understanding the physics of the tasks to be done during competitions. These simulations check the angle, speed and height of the ball to be thrown to break the Lagori so that maximum points can be earned. For the second case, the target is to drop the ball placed on the top of the robot by hitting at an appropriate point. Similar to the first case, for the second case, various simulations are done by varying the various parameters like speed, angle, height (h) of the ball thrown from the ground and height (H) of the ball placed at top of the robot. The initial speed and angle are calculated using projectile motion. This paper gives an overview of tasks simulations that need to be performed by the robots in competitions.

References

[1] ADAMS 2021, Student Edition, User manual

[2] https://en.wikipedia.org/wiki/Seven_stones

[3] https://www.aburobocon2022.com/ , https://en.wikipedia.org/wiki/ABU_Robocon.