Multidisciplinary Applied Research and Innovation Vol. 2 No. 3 (2021) 154-158

MARI

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/mari
e-ISSN :2773-4773

Smart Step Ladder

Muhammad Nabil Najmi Yusjah, Hartiny Abd Kahar*, Muhamad Zulfahizal Amat Rithuan

Department of Mechanical Engineering, Politeknik Banting Selangor, 42700 Banting, Selangor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/mari.2021.02.03.031
Received 05 September 2021; Accepted 05 Oktober 2021; Available online 15 December 2021

Abstract : In the construction sector, a step ladder is a key construction accessory that is required for contractors or roofers to reach their targets, used as climbing apparatuses to achieve greater heights. The challenges with the traditional step ladder used recently are that it needs to be manually moved around. The operator needs to climb up and down several times to move the ladder to the desired position thus this is time and energy-consuming. The objective of the innovation of the Smart Step Ladder is to facilitate the operator in controlling the movement. Using a mobile application controller to move the ladder around, will save time to complete the tasks since the operator does not have to climb up and down the ladder to change position. This will simultaneously increase the efficiency (faster/easier/safer) and reduce the energy of manpower. The design methodology of this innovation includes metal joining-welding for fabrication of the mechanical and electrical part, while control of the movement of the Smart Step Ladder using a mobile phone is developed using IoT - Arduino. The operator can control the movement of the step ladder using input keypads on the mobile app or voice control. The invention of this innovation provides exposure of IoT application in the design construction tools and the way it creates an environment for effective resource utilization to minimize human effort which ultimately saves time and improves security.

Keywords: Smart Device, IoT-Based System, Arduino

1. Introduction

Data released by the Department of Statistics Malaysia shows that the construction sector contributed 4.9 per cent (RM66.71 billion) to the Gross Domestic Product (GDP) in 2018 [1]. In the construction sector, a step ladder is key construction accessories that are required for contractors or roofers to reach their targets, used as climbing apparatuses to achieve greater heights. Step ladders are also useful in the home or the garden to reach things that are not too high, e.g. ceilings or the tops of hedges.

**Corresponding author: hartiny@polibanting.edu.my*

The challenges with the traditional step ladder used recently are that it needs to be manually moved around. The operator needs to climb up and down several times to move the ladder to the desired position thus this is time and energy-consuming. Therefore, the objectives of the innovation of the Smart Step Ladder is to facilitate the operator in controlling the movement. Using IoT platform which allows controlling electronic devices remotely using its iOS and Android apps, a mobile application controller to move the ladder around was designed. This will save time to complete the tasks since the operator does not have to climb up and down the ladder to change position. It will simultaneously increase the efficiency (faster/easier/safer) and reduce the energy of manpower.

This innovation is targeting the construction and maintenance work, also for domestic use. IoT based system has been widely explored in various application such as in smart homes [2][5], in the agriculture sector [3] and for health monitoring [4].

2. Materials and Methods

The materials and methods section, otherwise known as methodology, describes all the necessary information that is required to obtain the results of the study. Figure 1 shows the flow chart of the design process.

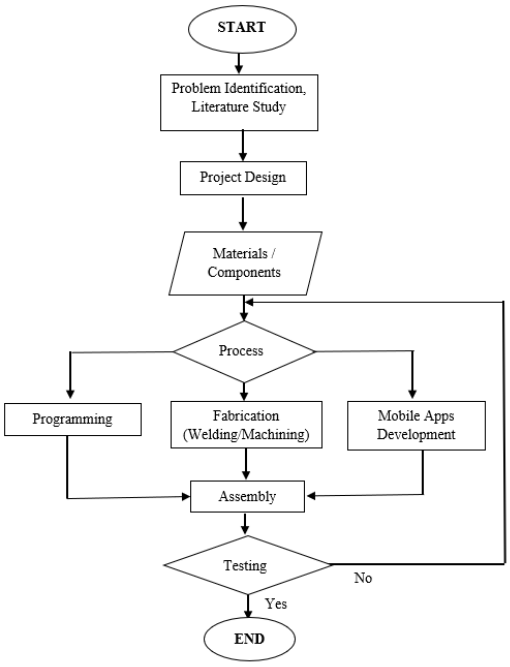

Figure 1: Flow chart of design process

2.1 Materials

The main parts and components needed for the main body part are a foldable step ladder and a set of heavy-duty caster wheels. A pair of power window motor was deployed to move the caster wheels that connected at the front and back legs of the step ladder. The electronic parts are the power source connections, rechargeable battery, direct-current circuit and IoT based system for the programming of the Arduino Apps Controller.

2.2 Methods

The methodology of this innovation includes the metal joining MIG welding for fabrication and assembly of the main body frame. Figure 2 shows the fabrication, installation and wiring process of the Smart Step Ladder. Project field testing was executed frequently as a critical stage and some

modifications are made after being tested. The control of the movement of the Smart Step Ladder by the operator using a mobile phone is developed using IoT based system.

Figure 2: Fabrication and Installation Process,

3. Results and Discussion

3.1 Results

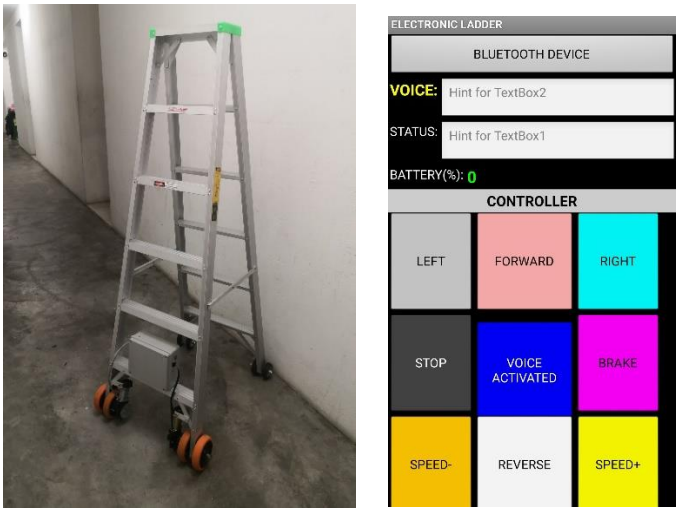

Figure 3: Completed installation with the controller interface

Figure 3 shows the completed installation and the controller interface.The control of the movement of the Smart Step Ladder by the operator using a mobile phone is developed using an IoT system based - Arduino. The operator can control the movement of the step ladder while still being on it either using input keypads on the mobile app or voice control. Variation of smart ladder movements using apps controller is to the front, back, turn left and turn right. Other important design criteria such as safety feature, storage, maintenance are also being considered.

Test run conducted during the development process is to measure the capability and functionality of this innovation. As shown in the Figure 3 is the interface of the controller app and the mechanism of the movement control, whether using keypad input or voice control.

3.2 Discussions

The completed project features are as in Figure 4. The variation of smart ladder movements using apps controller is to the front, back, turn left and turn right. Other important design criteria such as safety feature, storage and maintenance are also being considered. A speed test and load test was conducted during the development process. This is to measure the capability and functionality of this innovation.

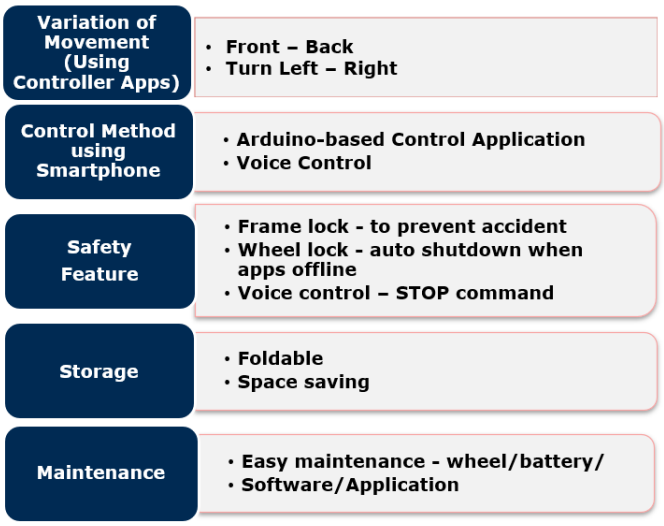

Figure 4: Completed project features

Table 1 shows the speed and load test of the completed Smart Step Ladder. There are 5 levels or steps of speed control using the apps built. The functionality of the design was tested in terms of the speed of the step ladder with and without load. Here, low load consists of 50 kg while high load with 100 kg. From the test results, the minimum and maximum speed that can be achieved low load of 50kg are 0.12 to 0.19 m/s, while at the high load of 100 kg are 0.09 to 0.13 m/s.

Table 1: Speed and load test

Control Step	Speed Without Load (m/s)	Speed With Low Load (m/s)	Speed With High Load (m/s)
1	0.22	0.12	0.09
2	0.25	0.15	0.10
3	0.26	0.16	0.11
4	0.32	0.17	0.12
5	0.34	0.19	0.14

4. Conclusion

In conclusion, this innovation benefits the construction sector especially contractors, roofers or domestic uses (home or garden). It creates an environment for effective resource utilization by minimizing human effort which ultimately saves time and increases productivity. In another aspect, it will improve the security and safety of the operators. The innovation also provides exposure to an IoT application in the design of construction tools.

Acknowledgement

The authors would like to thank the Mechanical Engineering Department, Politeknik Banting Selangor and Research and Innovation Centre, Politeknik Banting Selangor for its support.

References

[1] Department of Statistics Malaysia, “Keluaran Dalam Negara Kasar Tahunan 2015-2018”, 2019. [Online]. Available: https://www.dosm.gov.my. [Accessed Jan 1, 2021]

[2] Bohara, B. and Maharjan, S., "IoT Based Smart Home Using Blynk Framework", Zerone Scholar, 1(1), pp. 26–30. 2016

[3] Gomathy, P., J. S. Joshima, R. PriyamVadha, and S. P., (2018) "IOT Based Smart Farming E-monitoring System", International Journal of Pure and Applied Mathematics, 119(15), pp. 769–776. 2018

[4] Taştan, M., "IoT Based Wearable Smart Health Monitoring System", Celal Bayar University Journal of Science, 14(3), pp. 343–350. 2018

[5] Shivani Jadon and Arnav Chaudary, “Comfy Smart Home using IoT”, Proceedings of the International Conference on Innovative Computing & Communications (ICICC), April 1, 2020, Available at http://dx.doi.org/10.2139/ssrn.3565908. 2020