i-WINDER: PORTABLE FILAMENT WINDING MACHINE

INVENTOR LEADER: TS. DR. MOHD RUZAIMI BIN MAT REJAB
FACULTY: FACULTY OF MECHANICAL ENGINEERING, UNIVERSITI MALAYSIA PAHANG, 26600 PEKAN, PAHANG, MALAYSIA
EMAIL: ruzaimi@ump.edu.my
CO-INVENTORS: MA QUANJIN, IDRIS BIN MAT SAHAT, MOHAMAD NAZIRUL MUBIN BIN MERZUKI

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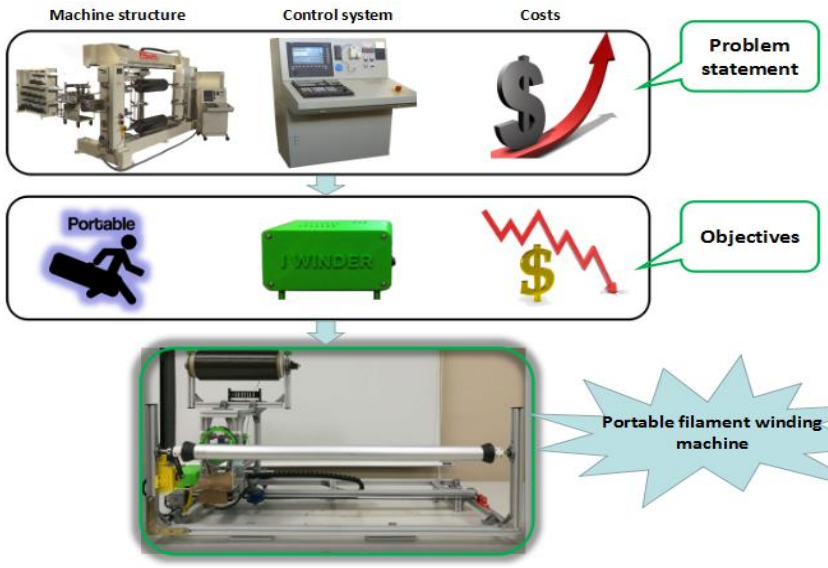
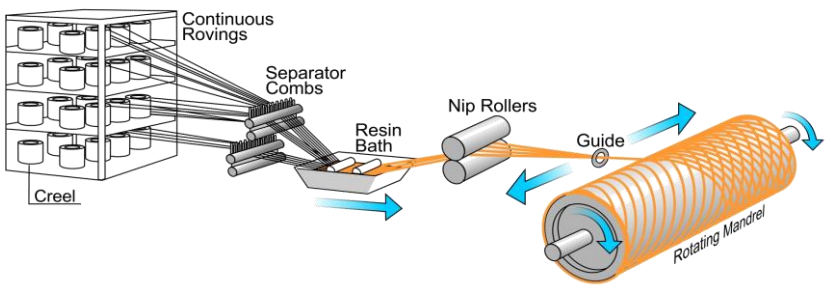
PRODUCT BACKGROUND

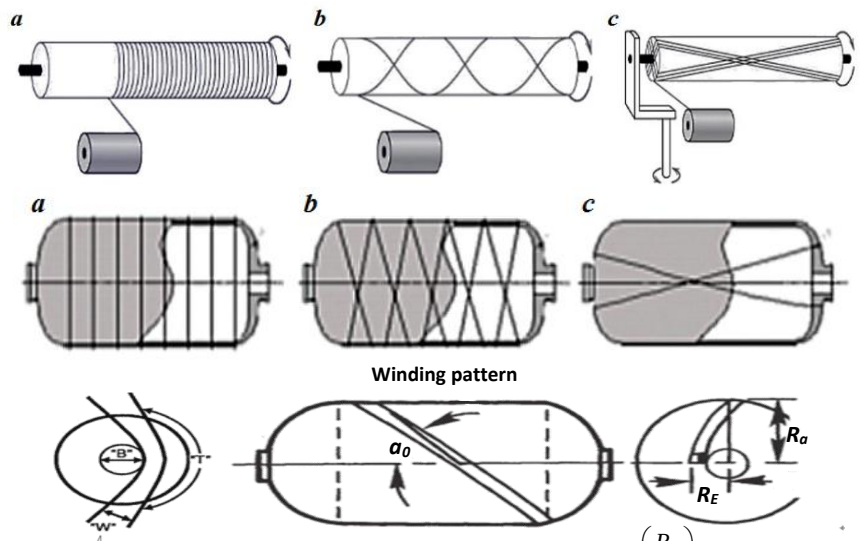


- Filament winding is a composite fabrication technique mainly used for open or close end structures.
- Filament winding offers the possibility of economically and reliably producing parts of complex shape.
- Filament winding is well suited to automation technique, which can produce products in many applications, such as pipe, pressure vessel.
- Filament winding machine is designed and used winding process, which can have different axes.
- Machine with more than four axes can be used for advanced application, six-axis winding machines usually have 3 linear and 3 rotation axes.

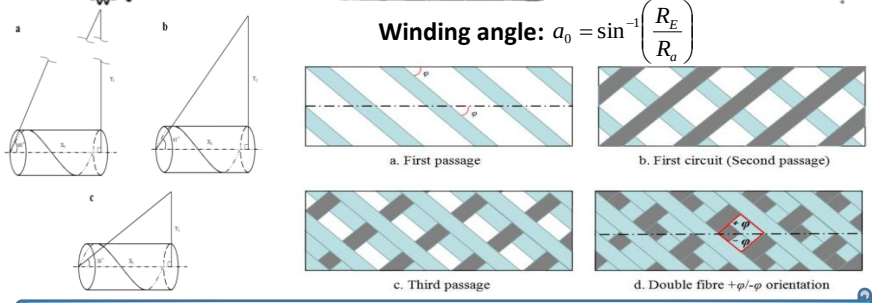


Schematic of filament winding process

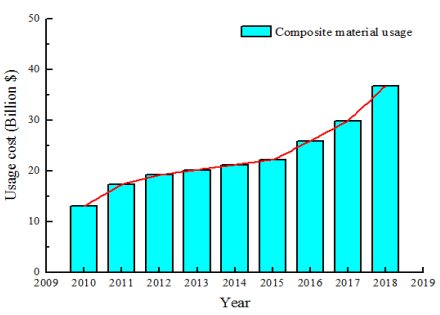
There are three types of winding pattern: (a) Polar, (b)helical and (c) hoop winding.



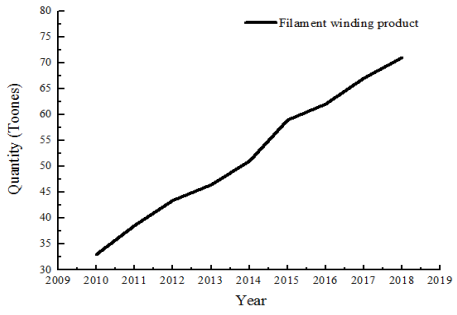
Winding angle: $a_0 = \sin^{-1}\left(\frac{R_E}{R_a}\right)$



MARKET SURVEY



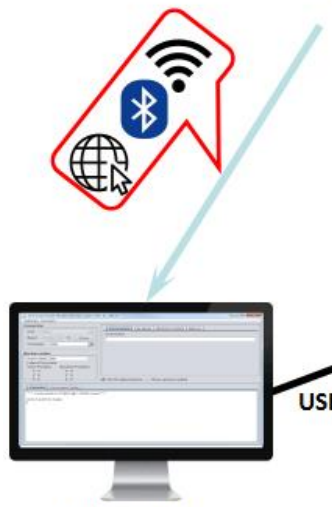
Composite usage (Source: Reportlinker)

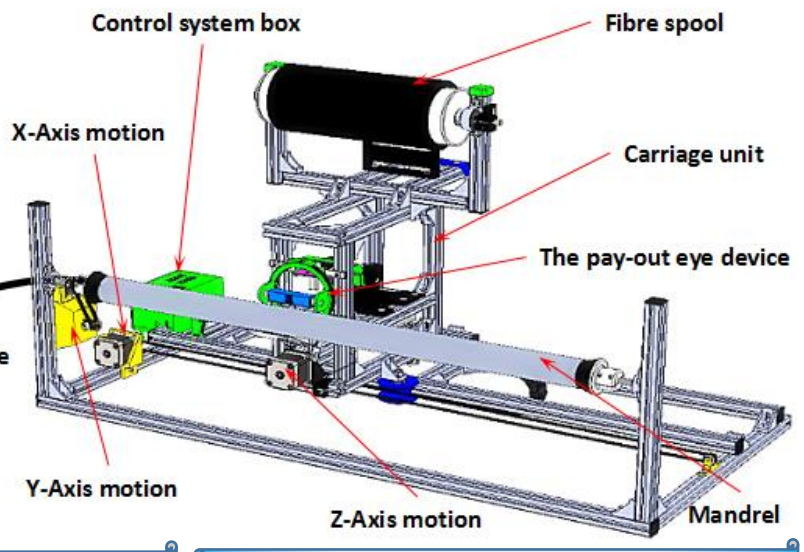


Filament winding product (Source: Google trend)

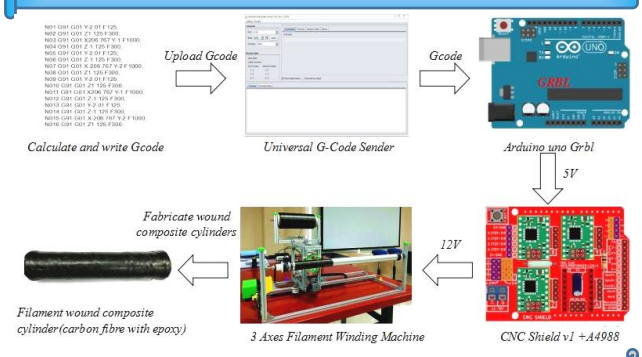
STATE OF ARTS/METHOD

Mini wireless keyboard





CONTROL SYSTEM



MACHINE PRODUCTS

1. Tubular structure

2. Pressure vessel

MARKETABILITY

1. Small and Medium Manufacturing Industries
2. Aerospace Advanced Material Industries
3. Polymer Manufacturing Industries
4. Composite Fabrication Processes Industries
5. Utilizing in Academic Research and Teaching

COST COMPARISON

Manufacturer	Cost (USD)
X-Winder (X-Winder LLC, USA)	2-axis 2X-23: $2,795
	4-axis 4X-23: $3,795
High performance filament winding twisting machine (Shandong Rope Net Machinery Co.,Ltd, China)	2-axis: $10,000
Filament winding machine for FRP or GRP pipe (Shijiazhuang JHR Import & Export Co.,Ltd, China)	4-axis: $10,000-150,000
i-Winder (Faculty of Mechanical Engineering, UMP, Malaysia)	3-axis: $500

BENEFITS/USEFULLNESS

1. Portable filament winding machine structure
2. Machine is lightweight (total weight=10kg)
3. Low cost compared to other winding machine (2-4 times cheaper)
4. Inexpensive control system (10 times cheaper)
5. Bluetooth and *Wifi* techniques
6. Different structure filament wound product can be fabricated
7. Customers can design their own filament wound products

PATENT CONDITION

This *i*-Winder filament winding machine patent is in progress. Submitted to Pintas IP Group.

PUBLICATIONS

1. M.R.M.Rejab, K.Kadirgama, M.M.Noor, M.S.M.Sani and R.Daud. (2008). Modification and testing of four axes filament winding machine. *Journal of Science &Technology*. 15(5-6), 1505-1509. Scopus Indexed.
2. Ma Quanjin, M.R.M.Rejab, M.S.Idris, D.Bachtiar, J.P.Siregar and M.N.Harith. (2017). Design and Optimize of 3-Axis Filament Winding Machine. IOP Conference Series: Materials Science and Engineering, Volume 257, 39. Scopus Indexed, doi:10.1088/1757-899X/257/1/012039.
3. Ma Quanjin, M.R.M.Rejab, M.S.Idris, M.Amiruddin, Bachtiar Dandi, J. P. Siregar and M.I.Ibrahim. (2018). Design of Portable 3-Axis Filament Winding Machine With Inexpensive Control System. *Journal of Mechanical Engineering & Sciences* (JMES).ISSN: 2231-8380. Web of Science Indexed, doi.org/10.15282/jmes.12.1.2018.15.0309.
4. Ma Quanjin, M.R.M.Rejab, Jiang Kaige, M.S.Idris, M.N.Harith. (2018). Filament winding technique, experiment and simulation analysis on tubular structure. (2018). IOP Conference Series: Materials Science and Engineering Volume 257, 112. Scopus Indexed, doi:10.1088/1757-899X/342/1/012029.

ACHIEVEMENTS

✧ **GOLD MEDAL**, CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION (CITREX 2018), 2018, UMP

CONCLUSION

Based on the 3-axis filament winding machine improvements, *pressure vessel* can be fully wound with carbon fibre filament by dry winding pattern. The 3-axis filament winding machine with *inexpensive control system* and low costs improves its processing capability and product diversification. Pressure vessel also can be wound with *different winding angles*, which is suitable for different compressive strengths in complex work conditions.

COLLABORATORS

SALJU BISTARI SDN. BHD.
Composite Solution Company

ZOOMLION 中联重科
Machine Manufacturing Company