Electrically Varying Tension Power Generating (eVaT Gen) Exercise Bicycle

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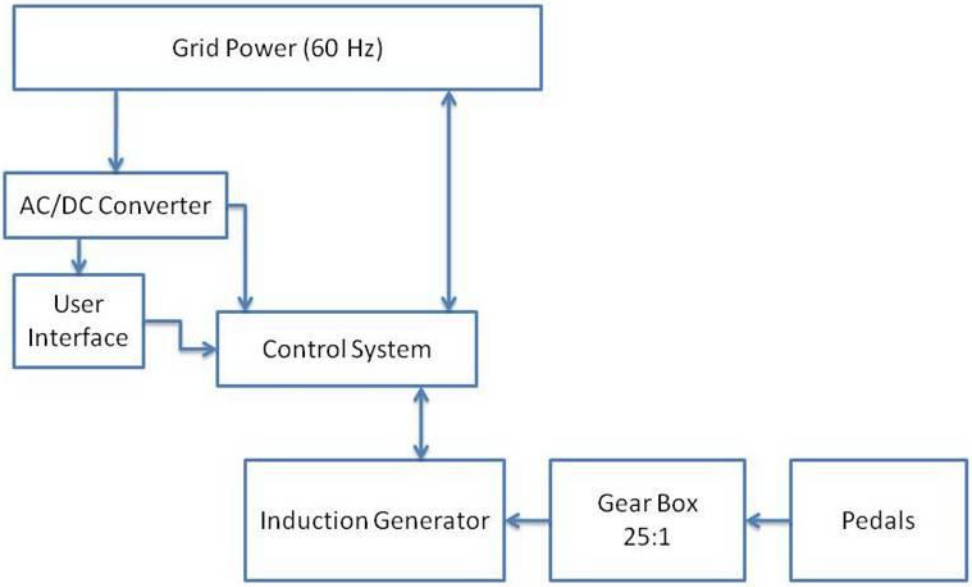
Motivation:
Every action human beings do, most often when we exercise, exerts energy. In an age when people are looking more and more for alternate sources of electric energy as well as new ways of saving money, an exercise bicycle that generates energy as you pedal would be an excellent solution for both problems. Being a common idea, the novelty of this project lies in removing mechanical controls and external resistances by simply controlling the electrical inputs to an Induction Generator.

Objective:
This project aims to design an exercise bicycle that generates electric power as a person pedals by using an induction generator. The resistance on the pedaling will be changed by controlling the voltage at the input of the induction machine, which can be indicated by +/- buttons on a simple panel by the handles. This would allow for more power to be produced with higher resistances. A control system would ramp up the voltage to indicated resistance value when the cycle is in use, and ramp it down to zero when use is discontinued. This will maintain proper generator functionality on the machine. A single gear ratio will take the lower speeds of pedaling and make them closer to synchronous speed, thus generating power. The control will take 60Hz power from the grid transform the voltage to desired level. The use of the induction machine allows for simple integration into the grid of the power generated.

Benefits:
- Save on electric bills: More fit, more exercise, more savings
- Reduced noise, compared to traditional exercise bikes

Features:
- Production of grid-ready electric power while pedaling
- Reduction of mechanical parts due to electric controls
- Simple controls
- Variable resistance internal to induction machine

Block Diagram:



Block Descriptions:

- 60 Hz Power
  - Output: 60 Hz power from the grid
- AC/DC converter
  - Takes 60 Hz AC power from the grid and converts it to 5V DC power used by the User Interface and controller (Control System).
- User Interface
  - Control Panel with buttons for user to press. These will indicate to a controller the level of resistance desired for the pedaling by sending a distinct signal for each button pressed.
- Control System
  - Consisting of a controller, transistors, and other electronic components used to control power settings given to the generator determined by signals received from Control Panel.
- Gear Box
  - The Gear Box contains a gear ration of 25:1 to increase the rotational speed from the pedals. This will make a pedaling speed above 72 rpm be above synchronous speed (1800 rpm) at the Induction Machine Rotor.
- Induction Generator
  - When pedaling, its rotor will move above synchronous speed, thus generating electric power.

Performance Requirements:

- Increased resistance controlled from the User Interface panel
- Generate electric power when pedaling, except for initial power draw to establish power setting to the generator. Power will be drawn no more than 5 seconds at beginning and end of usage.

Testing Procedure:

- Resistance control:
    - Connect control signals to oscilloscope and monitor increase or decrease when pressing appropriate buttons on User Interface panel.
    - Monitor voltage at input of induction machine with multimeter. Confirm that voltage increases or decreases with appropriate panel action as mentioned above.
    - While pedaling, confirm physical resistance increases as + button in control panel is pressed.
    - This could also be tested with a secondary machine with well defined speed and torque, and calculating the voltage and current values that should be obtained at the terminals of the generator before measuring then.
- Power generation
    - Connect multimeter at the output of the grid. Confirm that after 5 seconds of beginning of use power is being generated (ie. polarity of power measurement changes).

Tolerance Analysis:

In terms of design, the Control System block is the most important for this project. It needs to be protected against power surges, which can be tested by suddenly changing the voltage source for a moment and confirming that voltage at generator terminals does not change drastically with it, as well as black outs, by stopping outflow of power when grid voltage drops to 0.

Schedule:

Week	Task
February 6	● Research Parts ● Determine which parts can be obtained from the ECE department ● Finish proposal ● Begin Design Review
February 13	● Sign-up for Design Review ● Order parts ● Obtain parts provided by ECE department ● Select controller and design control system (flow chart & logic) ● Complete Design Review
February 20	● Get necessary requests to Machine Shop ● Setup and test controller
February 27	● Setup and test Generator Control
March 5	● Integrate User Interface ● Testing and Tolerance Analysis
March 12	● Complete physical setup (construction) ● Prepare charts and graphs of results ● Prepare for mock-up presentation
March 26	● Design and order PCB ● Mock-up Demo
April 2	● Write Final Report ● Mock-up Presentation ● Assemble and test PCB (if finished)
April 9	● Assemble and test PCB (if not already done) ● Prepare for final presentation
April 16	● Casings (cycle, control panel, etc.)
April 23	● Demo
April 30	● Final Presentation ● Checkout

Cost Analysis:
Ideal salary: $30/hour
Hours spent: (15 hours/week) * (11 weeks) = 165 hours
Labor: ($30/hour) * (165 hours) * 2.5 = $12375.00

Parts:
Frame: $100.00
3-phase 0.75HP 1800RPM 208-230/460V Induction Machine: $111.00
Controller: $10.00
Twisted Pair 18 gauge shielded wires (8760-001) x 30 ft: $4.50
Wires (AWG 12): $35.00
5.5VDC 300MA Regulated Power Supply (DCTX-532): $4.08
FET N-Channel 100V 9.2A @ $0.59 (IRF520) x 20: $11.80
Gear Box 25:1 ratio: $85.00