Next Generation Bicycle with Regenerative Braking

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The purpose of this senior design project is to optimize the existing design of an electric bicycle that can be seen in Figure 1. This will be accomplished by adding alternative sources of recharging the battery and improving the weight distribution of extra parts on the bike. The current bicycle used a 24 V battery and an offset DC motor to propel the bike with no physical work being done by the rider. However, there was not an alternative source of power to charge the battery such as regenerative braking. The existing bike also attempted to add a solar panel as an alternative source of power, but its function wasn't incorporated into the final design due to time constraints. The current design of the bike also does not have an even weight distribution. The battery is situated on one side of the bike along with the motor. Due to this uneven distribution of the load, the kickstand is inadequate for the bike and requires little to no assistance to tip over.

Several different areas of research were done in order to come up with the initial design of the project. Research was done on regenerative braking and solar energy in order to find an adequate means of alternative sources of charging back into the battery. It was decided that both will be used in order to optimize the design of the current bike. Market research was done on competitive products in order to come up with a cost efficient design that could remain competitive yet profitable. The customer's needs and wants were compared with the actual design constraints in order to formulate a plan of action on completion of the project and which features can be incorporated and which features cannot.

The concept development came down to three main areas; weight distribution, solar energy and regenerative braking. Careful consideration was taken for each methodology by a functional decomposition which weighs the design constraints with the concept variants. After the comparison it was decided that the rear rack was the best choice for the location of the battery solar panels and utility case. The polycrystalline is the best choice for the solar panels due to cost and the inline hub motor is the best choice for regenerative braking. The design embodiment consisted of calculations for weight distribution by comparing four different design concepts varying the locations of the battery, utility case and motor. Calculations for solar energy consisted of geographic location and efficiency of the different solar panel options. Calculations for the regenerative braking consisted of power generated by stopping distance and time.

The manufacturing process involved replacing the offset dc motor with the inline hub motor. The original brakes were replaced with the brakes for regenerative braking. The storage case, brackets for the solar panel assembly and the case for the LCD screen were made using 3D printing. The solar panel assembly was originally made from steel flat stock but needed to be made again using aluminum due to the weight difference. The solar panels are mounted on the solar panel assembly using screws and bolts.

The four main tests run on the bike were to test for max distance of the original motor compared to the inline hub motor, max distance of the bike with and without using regenerative braking, the solar power generation and a combined effort of using both the regenerative braking and solar energy as an alternative source of charging. The results show that the inline hub motor can run 5 /12 more miles than the offset dc motor. The motor using regenerative braking is able to go ½ more mile than using no regenerative braking. This shows that the inline hub motor is a more efficient motor than the offset dc motor.