AI-Driven Smart Reusable Bottles with Enhancing Water Purification and Business/ Financial Modeling.

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Abstract

The paper explores to develop a smart water purity management Tank based on the integration of advanced machine learning techniques. The SmartBottle AI project aims to revolutionize purity, hydration and sustainability by developing an advanced reusable water bottle integrated with AI driven technology.

The water bottle equipped with sensor capable of accurately recognizing the purity of water as well as water level. The collected data by this sensor will be analyzed and processed using an AI based algorithm. Infact, the system will be user-friendly by allowing users to easily monitor on water quality and water levels with customize alarm settings by combining smart sensors, data analytics and mobile connectivity.

1.Problem Statement:

Plastic waste has become a critical environmental issue, impacting ecosystems wildlife and human health. The increasing concern for the condition of the environment has expanded the demand for reusable water bottles. Despite increasing awareness about the benefits of staying hydrated and reducing plastic waste, many people struggle with maintaining adequate hydration throughout day, often forgetting to drink enough water or underestimating their hydration needs. Even they won't focus on the quality of water either it is clean and safe drinking or not as it remains a significant challenge globally.

Additionally, ensuring the purity of water in reusable water bottles is a concern. Inadequate hydration and contaminated water drinking can cause serious health issues, including decrease cognitive and physical performance, kidney diseases and waterborne diseases respectively. Also, traditional reusable bottles lack the features to track hydration, provide personalized recommendations and analyze the recommendations to ensure safety and cleanliness.

Thus, there is a need for a solution to overcome on these problems. And SmartBottle AI has potential to improve drinking habits and promote healthy drinking activities.

2. Market/Customer/Business Need Assessment:

2.1. Market Need Assessment:

2.1.1. Global Hydration Market:

 The global reusable water bottle market is expected to grow significantly, driven by increasing health consciousness and demand for eco-friendly product. Even according to a report by Grand View Research, the global reusable water bottle market size was valued at USD 8.1 billion in 2020 and is projected to expand at a CAGR of 4.0% from 2021 to 2028.

2.1.2. Environmental Concerns:

 According to National Geographic over 8 million tons of plastic enter the oceans each year and single use plastic bottles are a major contributor to this solution. The environmental impact of single use plastic bottles is a significant

driver for the adoption of reusable alternatives. And that's why consumers are increasingly looking for sustainable products that reduce their environmental footprint.

2.1.3. Health and Wellness Trends:

Proper hydration habits linked with improved physical performance, cognitive function and general health. The increasing prevalence of health issues related to dehydration and contaminated water such as kidney stones and waterborne diseases. Thus, there is need for growing awareness of the importance for effective hydration for overall health and well-being.

2.1.4. Technological Advancements:

Since the integration of IOT and AI in consumer products is a growing trend now-a-day. And thus, smart devices that offer real time data, personalized recommendations and enhanced user experiences are becoming more popular. The SmartBottle AI leverages these technologies to provide a comprehensive hydration, sustainability solution and healthy drinking activities.

2.2. Customer Segments:

2.2.1 Health Consumers:

- ❖ Demographics: Fitness enthusiasts, athletes, and health-conscious individuals of all ages who are proactive about their health and wellness.
- ❖ Needs: Tools that monitor and improve hydration habits, track physical performance and provide personalize health insights.

2.2.2 Eco-conscious Consumers:

- ❖ Demographics: Mostly young adults, educated and tech-savvy individuals who prioritize sustainability.
- ❖ Needs: Products that help to reduce environmental impact, provide transparency about their environmental benefits.

2.2.3. Parents and Caregivers:

❖ Demographics: Parents and caregivers are always concerned about the health and hydration of their children.

❖ Needs: Safe and easy to use products that ensure their children stay healthy and hydrated.

2.2.4. Busy Professionals:

❖ Demographics: Working professionals, particularly those who are in demanding jobs may neglect hydration due to busy schedules.

❖ Needs: Convenient solutions that remind them to drink water, track their intake, and fit seamlessly into their daily routines.

2.3. Business Assessment:

2.3.1. Market Opportunities:

- Retail Partnerships: Partnership with retailers and fitness brands to promote the product.
- Corporate Partnerships: Collaboration with companies for employee wellness initiatives.
- Health and Wellness Industry: Integration with wellness programs and health-focused business.

2.3.2. Revenue Streams:

- Direct Sales: Selling the SmartBottle AI through online as well as offline mode.
- Subscription Services: Offering premium features and personalized coaching through subscription model.
- Advertising and Partnerships: Revenue from advertising on the mobile app and collaborations with brands for co-branded products.

2.3.3. Competitive Landscape:

- Existing Products: Analysis of current smart bottles and hydration tracking apps. Identifying their strengths and weaknesses to position SmartBottle AI as a superior solution.

- Unique Selling Points (USPs): Highlighting the advanced AI features, real-time data analytics, environmental impact tracking, and user-friendly mobile app.

3.0 Target Specifications and Characterization:

3.1. Functional Specifications:

- Hydration Tracking: The SmartBottle AI should accurately track water intake, providing real time data on the quantity and frequency of water consumed.
- Water Quality Monitoring: The bottle should have sensors to track on water quality, including pH levels, temperature, turbidity and the presence of contaminants.
- Purification System: To ensure either water is safe to drink or not bottle should have integrated purification system.

3.2. Design Specification:

- Comfort Design: The bottle should easy to use and comfortable to carry.
- Durability: Made up of those materials which are durable that are environment friendly and of high quality.

3.3. Technical Specifications:

- Battery Life: Must have long lasting battery that supports extended use without frequent charging. Also, it should be rechargeable through USB port.
- Sensors: It should have advance sensors for real time tracking of water intake and quality which are accurate and reliable and requires low maintenance.
- Connectivity: Bluetooth or Wi-Fi to connect with mobile app or cloud for storing data performing data analysis.

4. External Search:
To obtain insights and knowledge for SmartBottle AI a complete external search

was done. The product requires machine learning algorithms for personalized hydration recommendations, data analysis for usage patterns and Natural Language Processing (NLP) for user interaction. Also, online sources, academic journals, market reports were researched.

Research paper explores on hydration patterns, AI in health monitoring, and environmental impact studies. By analyzing websites and reviews of current smart bottles like Ozmo Water Bottle, Hidrate Spark Smart Water Bottle, etc. we were able to discover new trends, innovation and studies related to AI – driven experiences and how they have been applied.

5. Benchmarking Alternate Products:

Benchmarking is necessary to understand the competition and find ways to make SmartBottle AI different from available products. Here are some pros and cons of each smart water bottle with water purity sensors:

1.Ozmo Water Bottle:
Pros: Tracks water intake and temperature as well as monitors coffee and tea consumption and compatible with apple watch and iPhone.

Cons: Limited battery life (up to 6 months) and no built-in water purification system.

2. Hidrate Spark Smart Water Bottle:
Pros: Tracks water intake and sends reminders. Even glows to remind you to drink more water and integrates with popular fitness apps.

Cons: Battery life up to 1 year and then needs replacement. No built–in purity sensors.

3.Purist Smart Water Bottle:
Pros: Built-in water purity sensor detects contaminants. Tracks water intake and self-cleaning technology.

Cons: Expensive compared to other smart bottles. Limited battery life up to 6 months.

4. Thermos Connected Hydration Bottle:
Pros: Keeps drinks hot or cold for hours. Tracks water intake and temperature as well as durable and leak-proof.

Cons: No built-in water purification system. Limited compatibility with non-Thermos apps.

5.Elkay Smart Bottle:

Pros: Built-in water purity sensor detects contaminates and tracks water intake and sends remainders. Also, it is compatible with popular fitness apps.

Cons: Limited availability and high price. Even some users reported connectivity issues.

6. Business Model:

6.1. Subscription Model:

SmartBottle AI offers premium feature with advance analytics and no adds with additional features and priority customer support.

6.2. Freemium Model:

Provide a basic version of the app for free with adds and limited features like tracking water intake and recommendations.

6.3. In-App advertising and Partnerships:

Collaborate with fitness and wellness brands for co-branded product and cross-promotions. It offers ads from wellness brands and fitness centres which can boost income and user experience.
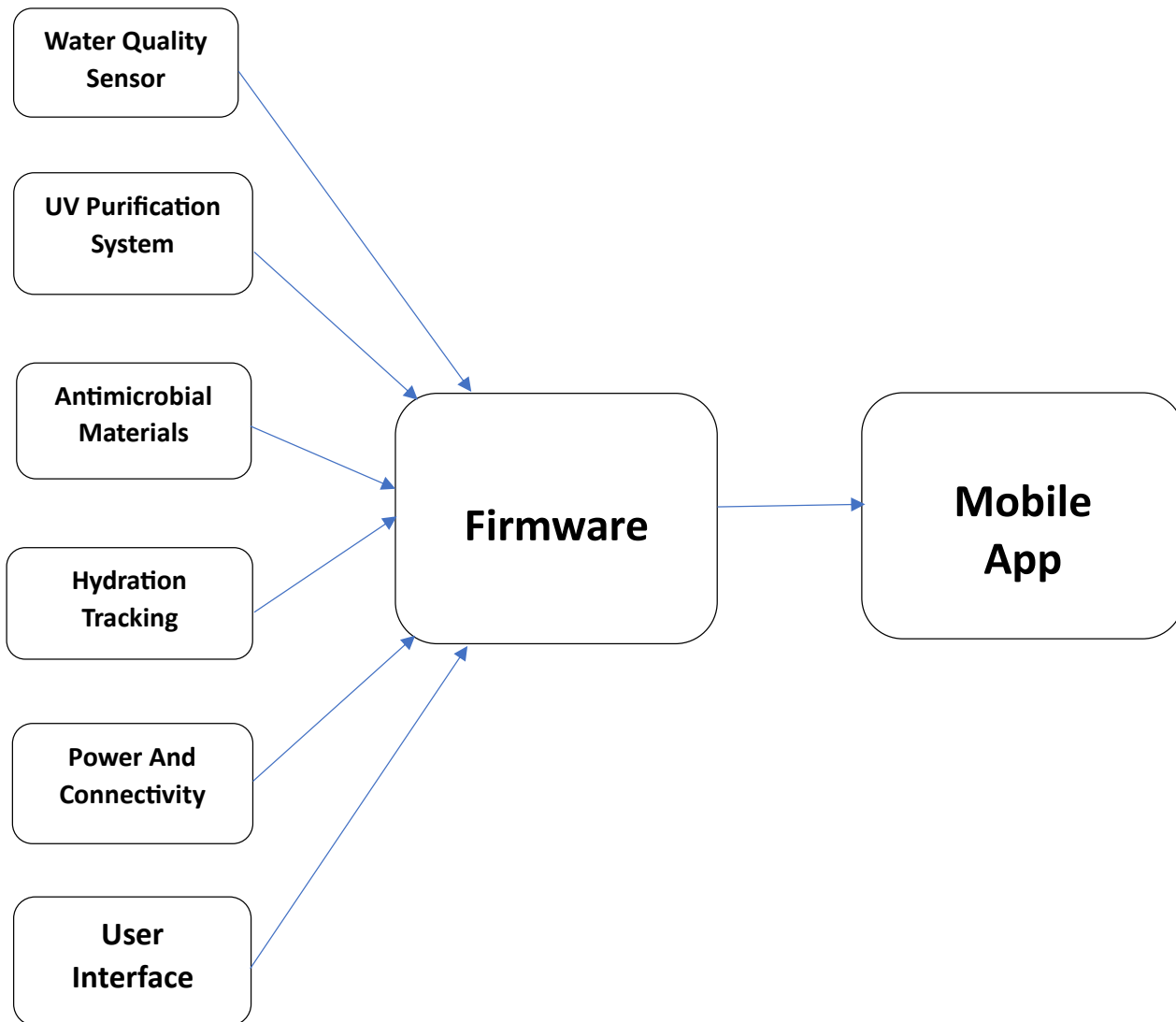
6.4. Data Analytics:

User behaviour can inform about product development, marketing and industry research. Also, anonymized and privacy-compliant data can be licensed to research institutes and public health agencies.

7. Final Product Prototype (Abstract) with Schematic Diagram:

The proposed model integrates a reusable water bottle with built-in sensors for tracking water quality, hydration and purifies water on-the-go. Equipped with UV purification system, and antimicrobial materials which ensures to clean drinking water anywhere.

All the obtained data is processed and fed through machine learning models and AI. Which will predict when UV purification system and filters need replacement or maintenance and will analyse user behaviour, identifying trends and patterns to provide insights on hydration habits and offers suggestions for improvement.

Schematic Diagram:

Water Quality Sensor	
UV Purification System	
Antimicrobial Materials	
Hydration Tracking	**Firmware** → **Mobile App**
Power And Connectivity	
User Interface	

EDA:

Loading Dataset:

```python
water = pd.read_csv('water_potability.csv')
water.head()
```

	ph	Hardness	Solids	Chloramines	Sulfate	Conductivity	Organic_carbon	Trihalomethanes	Turbidity	Potability
0	NaN	204.890455	20791.318981	7.300212	368.516441	564.308654	10.379783	86.990970	2.963135	0
1	3.716080	129.422921	18630.057858	6.635246	NaN	592.885359	15.180013	56.329076	4.500656	0
2	8.099124	224.236259	19909.541732	9.275884	NaN	418.606213	16.868637	66.420093	3.055934	0
3	8.316766	214.373394	22018.417441	8.059332	356.886136	363.266516	18.436524	100.341674	4.628771	0
4	9.092223	181.101509	17978.986339	6.546600	310.135738	398.410813	11.558279	31.997993	4.075075	0

Data Info:

```python
water.info()
```
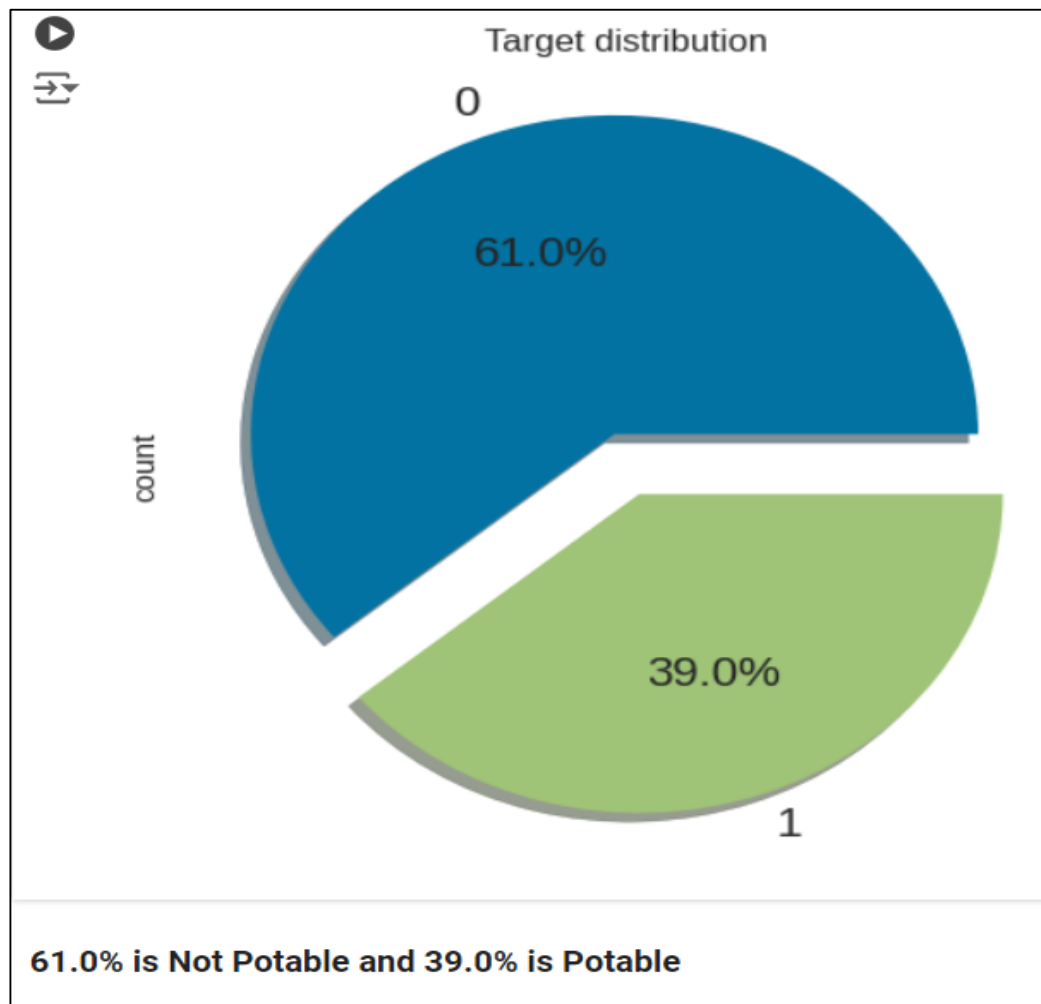
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3276 entries, 0 to 3275
Data columns (total 10 columns):
 #   Column           Non-Null Count  Dtype
---  ------           --------------  -----
 0   ph               3276 non-null   float64
 1   Hardness         3276 non-null   float64
 2   Solids           3276 non-null   float64
 3   Chloramines      3276 non-null   float64
 4   Sulfate          3276 non-null   float64
 5   Conductivity     3276 non-null   float64
 6   Organic_carbon   3276 non-null   float64
 7   Trihalomethanes  3276 non-null   float64
 8   Turbidity        3276 non-null   float64
 9   Potability       3276 non-null   int64
dtypes: float64(9), int64(1)
memory usage: 256.1 KB
```
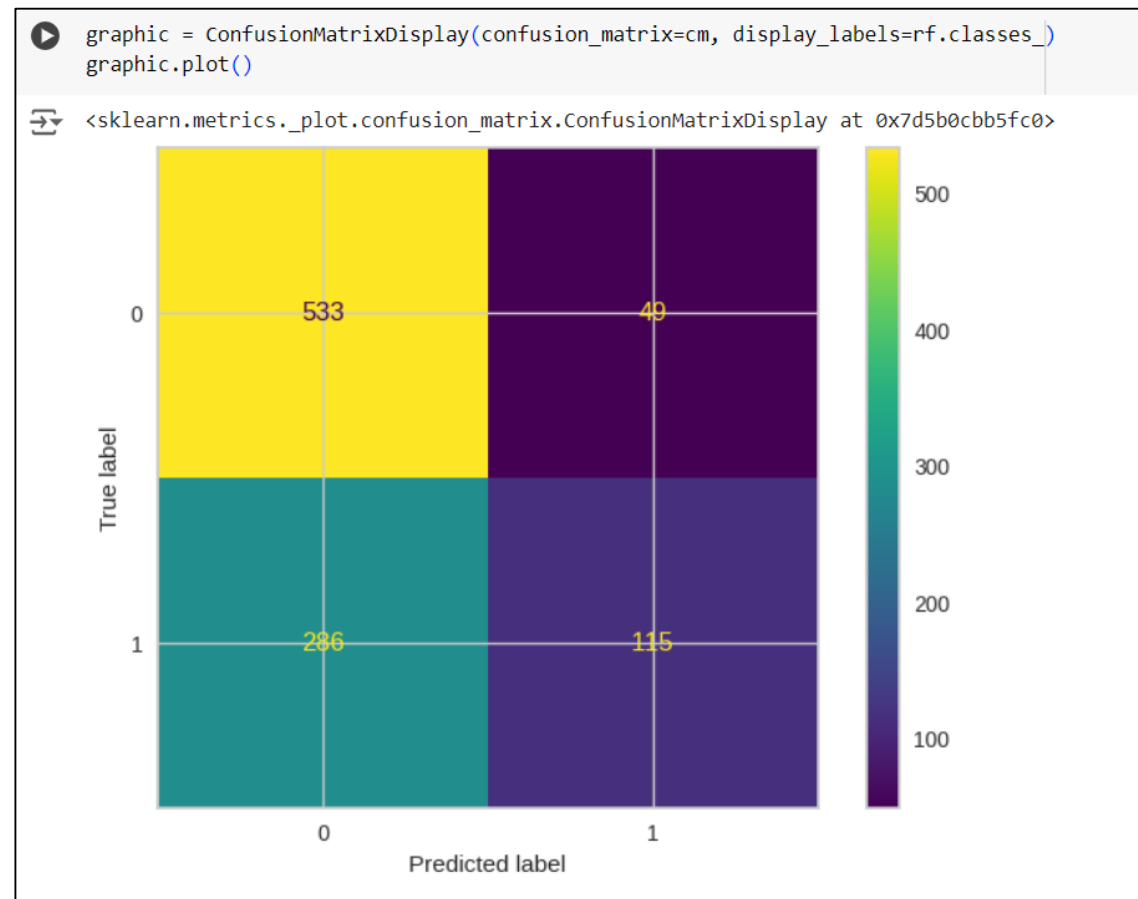
Descriptive Statistic:

```python
water.describe()
```

	ph	Hardness	Solids	Chloramines	Sulfate	Conductivity	Organic_carbon	Trihalomethanes	Turbidity	Potability
count	3276.000000	3276.000000	3276.000000	3276.000000	3276.000000	3276.000000	3276.000000	3276.000000	3276.000000	3276.000000
mean	7.080795	196.369496	22014.092526	7.122277	333.775777	426.205111	14.284970	66.396293	3.966786	0.390110
std	1.469956	32.879761	8768.570828	1.583085	36.142612	80.824064	3.308162	15.769881	0.780382	0.487849
min	0.000000	47.432000	320.942611	0.352000	129.000000	181.483754	2.200000	0.738000	1.450000	0.000000
25%	6.277673	176.850538	15666.690297	6.127421	317.094638	365.734414	12.065801	56.647656	3.439711	0.000000
50%	7.080795	196.967627	20927.833607	7.130299	333.775777	421.884968	14.218338	66.396293	3.955028	0.000000
75%	7.870050	216.667456	27332.762127	8.114887	350.385756	481.792304	16.557652	76.666609	4.500320	1.000000
max	14.000000	323.124000	61227.196008	13.127000	481.030642	753.342620	28.300000	124.000000	6.739000	1.000000

Pie Chart:

Target distribution

0

61.0%

count

39.0%

1

61.0% is Not Potable and 39.0% is Potable

Confusion Matrix:

```
graphic = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=rf.classes_)
graphic.plot()
```

<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7d5b0cbb5fc0>

9.Financial Equation:

One can design a simple financial equation for revenue and profit, after the market trends and sales prediction are modeled. This equation will consider the cost of running the business and the sales volume.

Example: Financial Equation

Total revenue = product unit cost * total number of sales – cost to produce

Let's assume the following condition:

The product price is Rs.1000 per product.
The monthly operating cost is Rs.2,000.
In the month of June, there are 100 selling units.

The total revenue for June can be calculated as:

1000*100 – 2000 = 100000 – 2000 = 98000

Now assuming the sales number is x, the financial equation becomes:

Y = 1000x – 2000

Where,
- x is total number of sales in given month.
- Y is total revenue.

Financial Modeling Using Market Forecasting:

If the time series or regression model predicts a 18.72% increase in sales every month, then one can adjust equation accordingly.

Y = 1000 x (1+0.18)^t

Where, t is time interval

Hence, one can forecast revenue for the coming months based on the predicted sales growth.

10. Conclusion:

By applying Regression and time series Forecasting, one can predict future sales as well as market trends. Then, this data is incorporated into a simple financial equation that links revenue to sales number, helping you model the business's profitability over time.

Github Link:

https://github.com/payalchauhan9/Feynn_Labs_Last_Project