I. Title: Cattle Health Care and Welfare

II. Nature of work: Application of basic principles of science and technology

III. Rationale: Implementing a cattle health monitoring system is vital, as cattle cannot indicate when something is amiss with their well-being. Often, by the time a farmer detects an issue, it may be too late for preventive action. With regular checkups and the support of advanced technology, farmers can proactively safeguard their livestock from adverse conditions, ensuring their well-being and potentially boosting milk production.

IV. Scientific Principle(s)/ Concepts: Sensor technology, chemical knowledge

V. Materials Used: Arduino, Sensors- temperature, pulse oximeter, ecg, rain, soil moisture, ultrasonic, flame. Chemicals- Nitroprusside, NaOH, Biuret reagent, Methylene blue.

VI. Procedure/ Description:

HAWK (Health And Welfare Kit)-

1) **Wearable belt-**

i) Components and Working-

a) *DS18B20*- The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. It measures temperature changes via an internal diode, converts this data to a digital signal, and sends it to the Arduino through a 1-Wire protocol. This allows precise, scalable temperature monitoring across multiple points.

b) The LCD displays values in celsius and fahrenheit.

c) *MAX30100*- The MAX30100 is an integrated pulse oximetry and heartrate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.
Data is converted to a digital signal and transmitted via an I2C interface to an Arduino. The readings are displayed on the JHD204A 20x4 LCD, enabling farm staff to easily monitor vital signs in real time.

This health monitoring belt is particularly useful for dairy farms, and any livestock management operation that requires close monitoring of animal health. Early detection of conditions like fever or irregular heart rates enables prompt care, potentially preventing the spread of illness within the herd.

Overall, the Wearable Health Monitoring Belt is an invaluable tool for modern farming, enabling proactive health management, reducing operational costs, and ultimately supporting the welfare and productivity of cattle in a sustainable and efficient manner.

2) Chemical kit-

Our chemical kit, using microchemistry principles, enables farmers to test cow urine and milk samples, offering insights into disease detection, milk quality, and protein content. This simple tool aids in monitoring cows' health and ensuring optimal milk production quality.

a) *Ketone test*- These are ketone strips, yellow in color, which turn red when dipped in urine which has high levels of acetone (main byproduct of cattle suffering from ketosis)
Chemical reaction taking place-

$$Na_2[Fe(CN)_5NO] + R\text{-}CO\text{-}CH_3 + NaOH \rightarrow [Fe(CN)_5NO]R\text{-}CO\text{-}CH_2(Na) + H_2O$$

The red color is due to the formation of a nitroprusside-acetone complex, indicating the presence of a methyl ketone group, which is why this reaction is commonly used in detecting ketones.

b) *Methylene blue test*- This test checks for the milk quality. A few drops of this reagent is put in a sample of cow's milk.
Interpretation:

- Quick color loss (within 30 minutes to 2 hours) - indicates high bacterial contamination and poor milk quality.
- Slow or no color change (beyond 6 hours) - suggests low bacterial activity, meaning better milk quality.

c) *Biuret reagent test*- A few drops of this reagent is dropped in a urine sample, if the colors turn from blue to purple, depending on the shade of purple, we can interpret the amount of protein present. High protein levels show a darker purple, which typically indicate kidney stress, dietary imbalance, or underlying infections, signaling potential health issues.

3) Remedies/treatment -

a) *Molasses*- given to cattle suffering from ketosis because it is a rich source of rapidly available energy in the form of sugars, primarily sucrose. Ketosis occurs when cattle experience an energy deficiency, often due to inadequate carbohydrate intake, leading to the breakdown of fat stores and the accumulation of ketones in the blood. Molasses helps by providing quick energy, helping to reduce the reliance on fat metabolism, lowering ketone production, and supporting the cow's recovery. Additionally, molasses contains trace minerals and can encourage appetite, further aiding in the management of ketosis.

b) *Antibacterial antiseptic*- This is a natural remedy designed to help manage mild udder infections in cows. Combining garlic's potent antibacterial properties with turmeric's anti-inflammatory effects, the paste can provide relief and promote healing. Regular application helps combat infection while reducing inflammation, aiding in the overall health of the udder. It's a gentle, natural alternative for addressing minor infections, though care should be taken to avoid open sores. The remedy is safe and effective for supporting udder health without the use of harsh chemicals.

The IDEAL Cowshed-

1) **Footbath-** Potassium permanganate ($KMnO_4$) is a compound used as a disinfectant at the entrance of the cowshed for disinfection, water treatment, disease prevention, and soil health improvement. It helps control pathogens, reduce odours, and improve manure composting. When used safely, it promotes hygiene, animal health, and a cleaner farm environment. It washes any bacteria off the hooves of the cow when they walk through it.

2) **Cow shower-** Installing a shower bath near the cowshed improves animal welfare by relieving heat stress, promoting cleanliness, and preventing diseases. It enhances udder health, improves milk quality, and reduces stress, leading to better cow behavior and productivity. It also aids farm management by streamlining routines and promoting environmental sustainability.
3) **Roof plans for Cowshed-**
    a) **Solar-** Solar cells convert sunlight into electricity using the photovoltaic effect. A solar tracker ensures the panel faces the sun, while a convex lens concentrates sunlight. Solar cells are made of two silicon layers (N-type and P-type) that create an electric field, generating current. They produce clean, long-lasting, low-maintenance energy. Advantages of Solar Cell are- no pollution associated with it, it lasts a long time, no maintenance cost.
    b) **Green roof-** A green roof on a cowshed offers benefits like temperature regulation, water management, and improved air quality. It supports biodiversity, reduces energy costs, and enhances the roof's lifespan. Additionally, it helps control pests, provides potential feed, and contributes to a more sustainable, aesthetically appealing farm environment.
    c) **Bamboo-** Bamboo in a cowshed offers benefits like natural cooling, ventilation, and shade, improving cow comfort. It's eco-friendly, cost-effective, and durable, with natural pest resistance. Bamboo also provides structural flexibility, promotes animal well-being, and can be used for fodder and protection against rain and wind, aligning with sustainable farming practices.

4) Rain water- Rainwater harvesting around a cowshed promotes sustainability by collecting rainwater from the roof, storing it in tanks, and using it for cattle drinking, cleaning, and irrigation. It reduces water costs, prevents runoff, and supports groundwater recharge. Combined with other eco-friendly features, it enhances farm efficiency and environmental impact.

5)Food for cattle -

a) **Hydroponic Wheatgrass-** Hydroponic wheatgrass is a nutrient-rich, fast-growing fodder ideal for cows, offering high protein, vitamins, and minerals. It improves milk yield, requires minimal space, and uses 80-90% less water than traditional farming. Hydroponic systems provide year-round production, reducing dependency on seasonal fodder while promoting environmental sustainability.
b) **Azolla-** Azolla, a high-protein aquatic fern, is an eco-friendly, cost-effective feed for cows, enhancing milk yield and digestion. It grows rapidly in shallow water with minimal resources. An open harvesting system near the cowshed optimizes fresh forage availability, reduces transport costs, and supports sustainability, waste management, and animal welfare.

6) Isolation room- An isolation room near the cowshed helps manage diseases, enhances biosecurity, and supports animal welfare by providing a controlled environment for sick animals, improving treatment, monitoring, and preventing disease spread.

7) CELLFENU- is a material made by impregnating paper, cardboard, pulp, wood, or cotton with fenugreek seed extract, which has antibacterial, antifungal, antiviral, and insect-repellent properties. Fenugreek, rich in mucilage, has various health benefits, including antidiabetic,

anticancer, antimicrobial, and lactation-stimulating properties. The polysaccharide fenugreek gum, extracted from the seeds, is used industrially for mixing water and oil, controlling blood sugar, reducing cholesterol, and preventing heart attacks.

8) Security and Safety-

1. Rain Sensor with LED Indicator

The rain sensor detects precipitation by bridging conductive plates or measuring resistance. When rain is present, it completes the circuit, triggering the LED indicator to light up. This alert helps farmers take preventive measures, such as moving cattle to shelter, in response to changing weather conditions.

2. Flame Sensor with Water Pump Activation

This system detects flames using infrared technology. When a flame is detected, the sensor signals the microcontroller to activate a water pump that sprays water to extinguish the fire. It provides an automated response to fires, minimizing damage, protecting livestock, and reducing fire risk to property.

3. Flood Detection System with Soil Moisture Sensor

The soil moisture sensor measures moisture content in the soil. If the soil becomes overly saturated, indicating a flood, it triggers an alert through a buzzer. The system helps farmers take preventive action to protect livestock and property by providing early warnings of potential flooding conditions.

4. Alarm System with Ultrasonic Sensor

This security system uses ultrasonic waves to detect movement and potential intrusions. The ultrasonic sensor measures distance and activates a buzzer and LED indicator when movement is detected. It provides audible and visual alerts to protect livestock and property from theft or unauthorized access.

9) Water system- The water pump system can be activated through two methods: a switch and a pedal. When the switch is pressed, it sends a signal to the pump to turn on. Alternatively, pressing the pedal activates the same process. This dual control system offers convenience and versatility in operating the pump.

VII. References

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