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SOIL STABILIZATION OF BLACK COTTON SOIL BY USING GRANITE POWDER

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Abstract: **The black cotton soil is known as expansive soil due to its property of swelling and expansiveness with influence of variance moisturein soil. It also shows shrinkage behavior when dried. Due to these properties the strengthcharacteristics are also affected adversely. The black cotton soil is also widely available in all around the world which leads us to wastage of landfor construction uses to resolve this problem we can replace the expansive soil by non-expansive soil which is also a costly option so in this presentpaper we have stabilize a soil using waste material named marble powder which is a byproduct of marble industries. For the determination of properties, we have performed atterberg's limit test, particle size distribution by wet sieve analysis,water content test, specific gravity test, OMC and MDD test on the sample of granite powder. We have mark a great improvementin engineering properties of black cotton soil by stabilizing it with 5%, 10% and 15%, of replacement by granite powder. It also gives large decrement in swelling and shrinkage behavior of soil.**

Keywords: **Soil Stabilization, Granite powder , Ground improvement technique, Marble dust, Cost effective, Black Cotton Soil.**

1. INTRODUCTION

A. BLACK COTTON SOIL:

Expansive soils, popularly known as black cotton soils in India are, amongst the most problematic soils from Civil Engineering construction point of view. Of the various factors that affect the swelling behavior of these soils, the basic mineralogical composition is very important. Most expansive soils are rich in mineral montmorillonite and a few in elite.

The degree of expansion being more in the case of the former. Soil suction is another quality that can be used to characterize a soil's affinity for water on its volume change behavior.

Black cotton soil is heavy clay soil, varying from clay to loam;it is generally light to dark grey in color. Cotton grows in this kind of soil. The soil prevails generally in central and southern parts of India.

The most important characteristic of the soil is, when dry, it shrinks and is hard like stone and has very high bearing capacity. Large cracks are formed in the bulk of the soil. The whole area splits up and cracks up to 150 mm wide are formed up to a depthof 3.0 to 3.5 meter. But when the soil is moist it expands, becomes very soft and loses bearing capacity.

Due to its expansive character, it increases in volume to the extentof 20% to 30% of original volume and exerts pressure. The upward pressure exerted becomes so high that it tends to lift the foundation upwards. This reverse pressure in the foundationcauses cracks in the wall above. The cracks are narrow at the bottom and are wider as they go up.

The unusual characteristics of the soil make it difficult to construct foundation in such soil. Special method of construction of foundation is needed in such soil.

B. GRANITE POWDER:

Granite powder waste is a waste material that results from the processing of granite rocks. There are two main types of granitewaste: crushing granite rocks and cutting granite rocks. The significantly developed stone industry leads to the production ofhuge amounts of this waste, which is not currently of significantuse and is stored in heaps. This fact leads to the degradation of the natural environment, which can be observed in water pollution, changes in soil pH, lung cancer, and pneumoconiosis in humans. As a result, scientists from all over the world are nowlooking for methods to use this waste. One of them is theutilization of granite powder in cementations composites. The entire process related to the mining, processing of granite rocks and the production of granite powder waste.

The granite waste is a by-product produced in granite factories while cutting huge granite rocks to the desired shapes. About 3000 metric ton of granite waste is produced per day as a by- product during manufacturing of granite tiles and slabs from the raw blocks. Economic way of stabilization because granite which is available in huge quantity from granite industries.The properties of waste depend upon the granite from which it is taken.

2. LITERATURE REVIEW

Nadgouda and Hegde (2010) investigated the Effect of Lime Stabilization on Properties of Black Cotton Soil. The results of their work indicated that liquid limit of soil decreased from 59.8% to 53.2% with increase in lime content up to 4.5% after that it goeson increasing with increase in lime content. Plasticity index of soil decreased from 25.9% to 15.1%. DFS decreases gradually with increase in lime content. MDD remainsconstant with variation in lime content whereas the OMC decreases with increasing percentage of lime.

Singh and Vasikar (2013) investigated stabilization of Black cotton soil using lime. They concluded that an addition of 4% lime decreases the liquid limit by 12.1%, while addition of 6 % lime shows a decrease of only 17.1%. It is observed that swellingpressure of Black cotton soil mixed with 4% and 6% limedecreased by 40% and 80% respectively. MDD is found to decrease by 2.4% and 5.6% at 4% and 6% lime content respectively.

Singh and Pani (2014) studied evaluation of lime stabilized fly ash as a highway material. They concluded that dry unit weight ofcompacted specimen decreased from 1.142 to 1.255 kJ/m3 with change in compaction energy from 118.6 kJ/m3 to 2483 kJ/m3, whereas the OMC is found to decrease from 30.2% to 24.2%. Thehighest unsoaked and soaked CBR values were found to be25.39% and 1.546% at compaction energy of 2483 kJ.

Kumari Pratima et al. (2015) investigated swelling behavior ofexpansive soil mixed with lime and fly ash as admixture. They found that liquid limit of stabilize samples initially decrease withthe addition of lime up to 6% and then increases. Free swell indexof samples decreases with increasing lime content and the value of Free swell index becomes 0 at 8% of lime addition. The OMCof BC soil increases with increasing percentage of fly ash, however it decreases at 35% of fly ash and again increases at 40% fly ash. MDD decreases with increasing percentage of fly ash, however it decreases at 35% of fly ash. OMC of BC soil increases with increasing percentage of lime and MDD decreaseswith increasing percentage of lime.

Choudhary et al. (2015) studied the effect of lime on compaction characteristics of soil-fly ash mixtures. The results of their work indicated that OMC of the soil fly ash lime mix increases with increases with increase in percentage of lime and 20% fly ash and the MDD of the soil fly ash lime mix decreaseswith increase in percentage of lime.

.**P. Srinivas et al. (2016)** conducted a study on "Black Cotton Soil Stabilization Using Waste Materials." They investigated the effectiveness of various waste materials, including granite powder, in stabilizing black cotton soil. The results indicated that incorporating granite powder led to improvements in soil strength and reduced swelling potential. The authors concluded that granite powder could be a viable option for stabilizing black cotton soil and improving its engineering properties.

M. R. Madhuri et al. (2018) explored "Utilization of GranitePowder in Stabilization of Black Cotton Soil." Their study focused on the mechanical and geotechnical properties of black cotton soil modified with granite powder. They found that the addition of granite powder enhanced the soil's strength, reduced its plasticity, and improved its compaction characteristics. The researchers suggested that granite powder could be used effectively as a stabilizing agent for black cotton soil in construction applications.

In a study by A. V. Ramesh et al. (2019) titled "Stabilization of Black Cotton Soil Using Granite Waste and Quarry Dust," the researchers investigated the combined effect of granite waste and quarry dust on black cotton soil stabilization. They observed significant improvements in the soil's strength and durability with the addition of these waste materials. The study emphasized the potential environmental and economic benefits of utilizing waste materials for soil stabilization purposes.

K. **S. Jagadish et al. (2021)** investigated "Improvement of Engineering Properties of Black Cotton Soil Using Granite Powder." They evaluated the impact of different percentages of granite powder on the engineering properties of black cotton soil. The findings demonstrated that the optimum percentage of granite powder enhanced soil stability, reduced swelling potential, and improved shear strength. The researchers recommended further exploration of granite powder as a cost-effective and eco-friendly soil stabilizer.

An investigation by N. R. Reddy et al. (2018) titled "Improving the Engineering Properties of Black Cotton Soil Using Granite Powder" explored the effect of different curing conditions on the stabilized soil's properties. Their findings demonstrated that prolonged curing periods resulted in further improvements in soil strength and durability. Additionally, the study emphasized the importance of proper curing techniques in maximizing the effectiveness of granite powder as a soil stabilizer.

A comparative study by R. K. Verma et al. (2019) titled "Assessment of Black Cotton Soil Stabilized with Granite Powder and Cement" evaluated the performance of black cotton soil stabilized with granite powder in comparison to traditional stabilizers like cement. The research revealed that while both materials improved soil properties, granite powder exhibited comparable effectiveness to cement in enhancing soil strength and reducing its swelling potential. This suggests the potential of granite powder as a cost-effective alternative to conventional stabilizers.

A study by S. K. Sharma et al. (2021) investigated "Environmental Impact Assessment of Black Cotton Soil Stabilized with Granite Powder." Their research focused on evaluating the environmental implications of using granite powder for soil stabilization. The findings indicated that incorporating granite powder led to a reduction in the carbon footprint associated with construction activities, thereby contributing to sustainable development goals. This highlights the eco-friendly nature of granite powder as a soil stabilizing agent.

S. R. Shukla et al. (2020) conducted a study on "Performance Evaluation of Black Cotton Soil Stabilized with Granite Powder." Their research focused on assessing the long-term performance and durability of black cotton soil treated with granite powder. The results indicated that the stabilized soil exhibited enhanced resistance to moisture-induced deterioration and maintained its strength properties over time. This highlights the potential of granite powder as a sustainable solution for soil stabilization in areas prone to environmental challenges.

3. METHODOLOGY

All tests performed on soil sample are as per IS codes listedbelow.

IS codes for test procedures

3.1. Water content	IS 2720 part 2
3.2. Specific gravity	IS-2720-PART-3-1980
3.3. Grain size distribution by sieveanalysis	IS 2720 (part IV) 1985
3.4.Atterberg's limits: A. Liquid limit B. Plastic limit C. Shrinkage limit	IS 2720 (Part V) 1985
3.5. Proctor compaction test: A. OMC B. MDD	IS: 2720 Part VII – 1974

1.1.Determination of water content of soil solids oven dryingmethod.

- Procedure:

➢ Measure the mass of empty container and record it as'W1' gm.

➢ Collect the moist soil sample as per the ISrecommendations and put it in the container.

➢ Measure the mass of container filled with moist soilsample. Record it as 'W2' gm.

➢ Keep the filled container in thermostatically controlled oven at a temperature 1050 - 1100C for 24 hours, so asto evaporate the water completely.

➢ Take out the container from oven and cool it indesiccators for 5 minutes.

➢ Measure the mass of container with dry soil andrecord it as 'W3' gm.

➢ Calculate the % water content as % w = (W2–W3) /(W3–W1) x 100.

➢ Repeat all above steps two more times to calculateaverage water content of given soil sample.

1.2.Determine Specific Gravity of Soil by PycnometerMethod.

- Procedure:

➢ Clean the pycnometer bottle and dry it. Take the weightof empty pycnometer with conical cap as 'W1' gm.

➢ Oven dry the given soil sample passing through 4.75 mm and retained on 75 micron IS sieve, in oven at temperature 105-1100C for 24 hours to get dry soil.

➢ Place this soil sample about 150-200 gms in the pycnometer and take its weight as 'W2' gm.

➢ Now add the distilled water to half of height of pycnometer and stirrer it using glass rod, so that entrapped air will be removed from soil.

➢ Fill the distilled water up to top of conical cap using pipette.

➢ Take the weight of pycnometer filled with distilledwater as 'W3' gm.

➢ Remove all content from the pycnometer bottle.Wash and clean it with water.

➢ Fill the pycnometer bottle with distilled water only upto top of conical cap.

➢ Take the weight of Pycnometer completely filled withwater as W4 gm.

➢ Calculate the specific gravity G, as (W2 – W1) / [(W4– W1) – (W3 – W2)] .

➢ Repeat all above steps two more times to calculateaverage specific gravity of given soil sample.

1.3.Determination of particle size distribution by sieving(Grain size analysis)

- Procedure:

➢ Initially keep the given soil sample in rapid moisture meter for 2-3 hours to get oven dried soil. Break the visible lumps present in soil using fingers with light pressure.

➢ Arrange the set of IS sieves mentioned above in the descending order with coarser sieve at top and finer sieve at bottom.

➢ Take the soil sample about 500-1000 gm and put it on topmost sieve.

➢ Place lid and pan at top and bottom of IS sieve set respectively.

➢ Keep this assembly on Mechanical Sieve Shaker for sieving. Continue the shaking the sieve set for minimum10-15 minutes as recommended.

➢ Take out the soil from each sieve using steel brush. Measure the weight of soil fraction retained on each sieve separately. Record the same in observation table.

➢ Calculate the cumulative percentage finer in tabular format given below.

➢ Draw the Particle Size Distribution Curve (PSDC) on semi logarithmic graph as particle size as abscissa (logscale) versus cumulative percentage finer as ordinate (natural scale).

➢ From nature of PSDC, classify the given soil in above mentioned categories.

1.4.Determination of liquid limit of fine soil byCasagrande apparatus

- Procedure:

➢ Take about 120 gm. of air dried soil sample passing through 425 micron IS sieve in metal tray. 2. Add 20% distilled water to the soil sample to form uniformsoil paste.

➢ Put this soil paste in the brass cup of Casagrande'sapparatus and spread horizontally into portion withfew strokes of spatula.

➢ Trim the soil up to a depth of 1 cm maximumthickness and remove excess of soil if any.

➢ Divide the soil sample in two parts by the firm strokes of the grooving tool along the diameter through the centreof brass cup so that clean sharp groove of properdimension is formed.

➢ Rotate the handle of Casagrande's apparatus at a rateof 2 revolutions per second until two parts of the soilwill come in contact with each other for a length of about 12 mm by flow only. 7. Count the number of blows required to close the groove close for about 12mm. It is recorded as N.

➢ Take representative portion of soil for water contentdetermination as w %.

➢ Repeat all above steps by changing water in soilsample to get number of blows between10 to 50.Record the number of blows and corresponding watercontent for various trials.

➢ Draw the flow curve i.e. Number of blows required asabscissa (log scale) versus water content determined asordinate (natural scale) on semi-logarithmic graph paper.

➢ Find out the water content corresponding to 25 blowsfrom graph as liquid limit (WL)of given soil sample.

1.5.Determination of Plastic limit of the soil.

- Procedure:

➢ Take 20-25 gm air dried soil sample passing through425 micron IS sieve.

➢ Add distilled water in soil and mix it thoroughly for 10-15 minutes till soil becomes plastic enough, so thatit can be moldable. (It is recommended to keep clayeysoils about 24 hours for its maturity.)

➢ Make the balls of soil paste and roll it on non-porousglass or marble plate using figure pressure till itbecomes soil thread of 3mm diameter.

➢ Continue the rolling process till soil starts crumblingand it resembles a uniform thread.

➢ Compare the prepared soil thread with metal rod of same diameter, then stop the rolling; where soil threadcrumbles into different parts.

➢ Determine the water content of crumbled soil parts byoven drying method as w %.

➢ Repeat all above steps two more tones to get averagewater content as plastic limit (WP)given soil sample.

1.6.Determination of Shrinkage limit of the soil.

- Procedure:

➢ Take a sample of mass about 100g from a thoroughlymixed soil passing 425 μ sieve.

➢ Take about 30g of soil sample in a large evaporating dish. Mix it with distilled water to make a creamy pastewhich can be readily worked without entrapping the airbubbles.

➢ Take the shrinkage dish. Clean it and determine itsmass.

➢ Fill the mercury in the shrinkage dish. Remove the excess mercury by pressing the plain glass plate overthe top of the shrinkage dish. The plate should be flush with the top of the dish. And no air should be entrapped.

➢ Transfer the mercury of the shrinkage dish to a mercury weighing dish and determine the mass of themercury to an accuracy of 0.1g. the volume of the shrinkage dish is equal to the mass of mercury in grams divided by the specific gravity of the mercury (i.e. 13.6).

➢ Coat the inside of the shrinkage dish with a thin layerof silicon grease or Vaseline. Place the soil specimen in the center of the shrinkage dish equal to about one-third the volume of the shrinkage dish. Tap the shrinkage dish on a firm cushioned surface and allowthe paste to flow to the edges.

➢ Add more soil and continue the tapping till theshrinkage dish is completely filled and excess soil paste projects out about its edge. Strike out the top surface of the plate with a straight edge. Wipe of allsoil adhering to the outside of the shrinkage dish. Determine the mass of the wet soil (M1).

➢ Dry the soil in the shrinkage dish in air until the colourof the pat turns from dark to light. Then dry the pat in the oven at 105 to 110 0C to constant mass for 24 hours.

➢ Cool the dry pat in a desiccator. Remove the dry patfrom the desiccator after cooling, and weight the shrinkage dish with the dry pat to determine the drymass of the soil (MS).

➢ Place a glass cup in a large evaporating dish and fill it with mercury. Remove the excess mercury by pressingthe glass plate with prongs firmly over the top of the cup. Wipe off any mercury adhering to the outside of the cup. Remove the glass cup full of mercury and placeit in another evaporating dish taking care not to spill any mercury from the cup.

➢ Take out the dry pat of the soil from the shrinkage dish and immerse it in the glass cup full of mercury.Take care not to entrap air under the pat. Press the plate with prongs on the top of the cup firmly.

➢ Collect the mercury displaced by the dry pat in the evaporating dish and transfer it to the mercury weighing dish. Determine the mass of the mercury to an accuracy of 0.1g. The volume of the dry pat (V2)isequal to the mass of the mercury divided by the specific gravity of the mercury.

➢ Repeat the test atleast 3 times cover it withmoist cloth for 24 hours to ensure thorough mixing ofwater with soil.

➢ Note the dimension of proctor mould, collar and baseplate.

➢ Take the empty weight of the mould (without collarand base plate).

➢ Apply a thin film of grease on inside of the mould.

➢ Fix the mould to the base plate with the help of wingnuts, place collar on the mould.

To determine the Proctor density till the soil in mouldin three equal layers and give 25 blows to each layer using standard hammer. Scrap the top surface of compacted layer before placing the next layer of a soil.Ensure that after compaction of the third layer, the level of compacted soil slightly above the top of the mould.

➢ Remove the collar trim the soil with a straight edge,disconnect the mould from base plate and weigh it.

➢ Extrude the compaction soil from the mould.

➢ Collect sample from middle of the mould for watercontent determination.

➢ Repeat step 5 to 10 taking fresh sample of same soil with addition of 3 to 4 % more water than previously added water. Repeat these steps for no. of times till a decrease in the weight of a soil is observed for at leasttwo successive reading.

➢ Calculate bulk density of compacted soil for each test.

➢ Determine the maximum dry density and optimummoisture content corresponding to the standard proctorcompaction by plotting graph

1.7.Determination of maximum dry density.

- Procedure:

➢ Take about 5 Kg. of de-aired soil passing throughsieve 20 mm in tray.

Add about 4% water (approximately 120 ml) to the soil and mix thoroughly with trowel and water content v/s. dry density. Also plot constant degree of saturation lines for100%, 90%,80% degree of saturation on same graph. Calculate the degree of saturation corresponding to themaximum dry density as OMC and MDD of given soilsample.

Table no. 1: Comparative analysis

Sr. No.	Report Name	Author Name	Methods / Algorithm	Advantages	Disadvantages
01	Effect of granite powder on geotechnical properties of black cotton soil	G. R. Dodagoudar et al.	Laboratory tests: compaction, California bearing ratio (CBR) test, unconfined compressive strength (UCS) test.	Improved strength and durability of black cotton soil. - Reduction in plasticity index and swelling potential.	- Limited field application data. - Potential variations in results based on soil and granite powder properties.
02	Stabilization of black cotton soil using granite powder and bagasse ash	S. Ramu et al.	Laboratory tests: compaction, CBR test, UCS test.	- Enhanced strength and stability of black cotton soil. - Synergy between granite powder and bagasse ash for improved performance.	- Laboratory-based study, limited field validation. - Effects of long-term durability not extensively studied.
03	Evaluation of the effect of granite dust on the engineering properties of expansive soil	A. A. A. Akaayar et al.	Laboratory tests: Atterberg limits, compaction, CBR test.	- Reduction in plasticity index and swelling potential. - Improved strength characteristics of the soil.	- Limited field data on long-term performance. - Potential for variation in results based on soil type and granite dust properties.
04	Experimental Study on Black Cotton Soil Treated with Granite Waste and Cement	S. R. Pathak et al.	Laboratory tests: compaction, CBR test, UCS test.	- Significant improvement in strength and durability of black cotton soil. - Synergistic effect of granite waste and cement for enhanced stabilization.	- Cost implications due to the addition of cement. - Limited field data on real-world application.

4. EXPECTED CONCLUSION

The addition of the granite powder to the soil reduces the clay contents and thus increases in the percentage of coarser particles. Overall it can be concluded that soil stabilized with can be considered to be good ground improvement technique, especially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

REFERENCES

[1] Baser O (2009), "Stabilization of Expansive Soils Using Waste Marble Dust", Master of Science Thesis, Submitted to Civil Engineering Department, Middle East, Technical University.

[2] Biswas (2012), "Utilization of Rice Husk with Lime in Sub- Grade Soil for a Rural Road", International Conference on Emerging Frontier in Technology for Rural Area.

[3] Chavhan Pooja J (2014), "To Study the Behaviour of Marble Powder as SupplementryCementitous Material in Concrete", Journal Environment & Research and Department, Vol. 4, No. 4, pp. 377-381.

[4] Chen F H (1988), "Foundations on Expansive Soils", Chen and Associates, Elsevier Publications, USA.

[5] Choudhary A K, Gill K S and Jha K N (2011), "Improvement in CBR Values of Expansive Soil Sub Grade Using Geo-Synthetics", Proc. Indian Geotechnical Conference, pp. 569-572.

[6] Corinaldesi V, Moriconi G and Naik T R (2009), "Characterization of Marble Powder for its Use in Mortar and Concrete", United States, Construction and Building Materials, Vol. 24, pp. 113-117. Demirel B (2010), "The Effect of the Using Waste Marble Dust as Fine Sand on the Mechanical Properties of the Concrete", Turkey, International Journal.

[7] Ergu A N (2010), "Effects of the Usage of Diatomite and Waste Marble Powder as Partial Replacement of Cement on the Mechanical Properties of Concrete", Turkey, Construction and Building Materials, Vol. 25, pp. 806-812.

[8] Gourley C S, Newill D and Shreiner H D (1993), "Expansive Soils", TRL's Research Strategy, Proc. 1st Int. Symp. on Engineering Characteristics of Arid Soils.

[9] Gupta Chayan and Sharma Ravi Kumar (2014), "Influence of Marble Dust, Fly Ash and Beas Sand on Sub-Grade Characteristics of Expansive Soil", Journal of Mechanical & Civil Engineering, pp. 13-1

Energy and exergy studies on the receiver models with materials and heat transfer fluids

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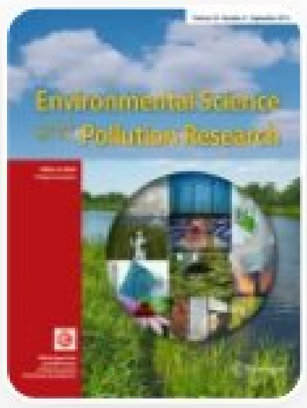

Environmental Science and Pollution Research

Rajendran Duraisamy Ramalingam, Ganapathy Sundaram Esakkimuthu, Sendhil Kumar Natarajan & Muthu Manokar Athikesavan

Abstract

This work focuses on meeting the growing demand in solar energy conversion for small-scale applications. In this regard, experimental and CFD research has been done to examine the thermal performance (energy and exergy efficiencies) of a dish collector (reflector and receiver) system with different receiver models. In this work, receivers with uniform absorber cavity areas having cylindrical and hemispherical shapes were modeled for length-to-diameter ratios (L/D) of 1.5, 1, and 0.75. The modeled receivers

having coil tube configurations concerning the geometrical shape of the models were tested with two different materials of aluminum and copper. The performance of the receiver models was compared by experimental and CFD methods for the average solar direct normal irradiations of 860 W/m^2 by the dish reflector area of almost 12 m^2. The supplied average heat flux by the dish reflector was 7 kW/m^2 at the absorbing area of the cavity receivers. The energy and exergy efficiencies from the experimental and CFD analyses on the models were determined based on the cavity surface temperature distribution of receiver walls, and heat gain for different mass flow rates by the heat transfer fluid water. The receiver with copper material and L/D ratio of 0.75 has been found as the optimized one among all other models with the maximum obtained energy and exergy efficiencies of 73.64 and 7.31% when water is used as the heat transfer fluid. The performance of the optimized receiver model was also validated with a few other heat transfer fluids such as SiC + water nanofluid and therminol VP1.

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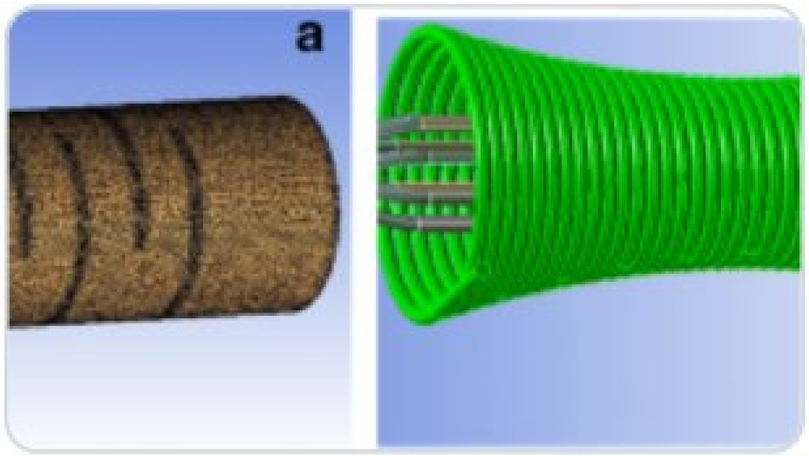

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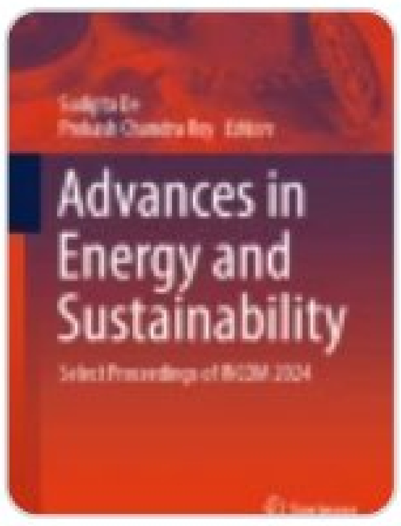

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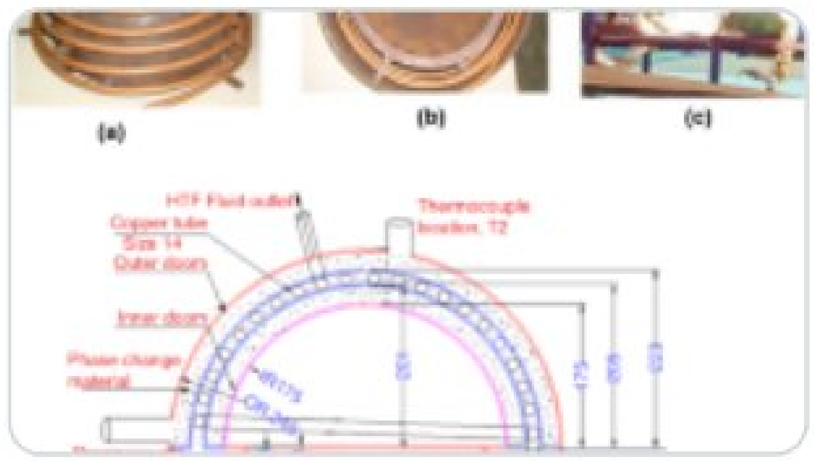

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Data availability

All data are given in the manuscript.

Abbreviations

A_R: Area of the receiver (m^2)

A_{ref}: Area of the reflector (m^2)

T_{atm}: Atmospheric temperature (°C)

c_{av}: Average specific heat capacity (J/kg K)

T_{avg}: Average wall temperature (°C)

DNI: Direct normal irradiation (Wh/m^2)

E_a: Energy focused on the receiver (kWh)

E_R: Energy gained by the receiver (kWh)

T_{in}: Fluid inlet temperature (°C)

$\dot{m}$: Mass flow rate of heat transfer fluid (kg/s)

η_{EnR}: Receiver energy efficiency

η_{ExR}: Receiver exergy efficiency

References

Arjun Singh K, Natarajan SK (2021) Thermal analysis of modified conical cavity receiver for a paraboloidal dish collector system. Energy Sources, Part A: Recov Util Environ Effects. https://doi.org/10.1080/15567036.2021.2017516

Bhutta MMA, Hayat N, Bashir MH, Khan AR, Ahmad KN, Khan S (2012) CFD applications in various heat exchangers design: a review. Appl Therm Eng 32:1–12

Daabo AM, Mahmoud S, Al-Dadah RK (2016) The effect of receiver geometry on the optical performance of a small-scale solar cavity receiver for parabolic dish applications. Energy 114:513–525

Kanatani K, Yamamoto T, Tamaura Y, Kikura H (2017) A model of a solar cavity receiver with coiled tubes. Sol Energy 153:249–261

Kumar NS, Reddy KS (2008) Comparison of receivers for solar dish collector system. Energy Convers Manage 49(4):812–819

Li S, Xu G, Luo X, Quan Y, Ge Y (2016) Optical performance of a solar dish concentrator/receiver system: influence of geometrical and surface properties of cavity receiver. Energy 113:95–107

Loni R, Kasaeian AB, Asli-Ardeh EA, Ghobadian B, Le Roux WG (2016) Performance study of a solar-assisted organic Rankine cycle using a dish-mounted rectangular-cavity tubular solar receiver. Appl Therm Eng 108:1298–1309

Loni R, Asli-Ardeh EA, Ghobadian B, Bellos E, Le Roux WG (2018) Numerical comparison of a solar dish concentrator with different cavity receivers and working fluids. J Clean Prod 198:1013–1030

Mahian O, Kianifar A, Kalogirou SA, Pop I, Wongwises S (2013) A review of the applications of nanofluids in solar energy. Int J Heat Mass Transf 57(2):582–594

Mahian O, Kolsi L, Amani M, Estellé P, Ahmadi G, Kleinstreuer C, ... & Pop I (2019a) Recent advances in modeling and simulation of nanofluid flows-part I: fundamentals and theory. Phys Rep 790:1–48

Mahian O, Kolsi L, Amani M, Estellé P, Ahmadi G, Kleinstreuer C, ... & Pop I (2019b) Recent advances in modeling and simulation of nanofluid flows-part II: applications. Phys Rep 791:1–59

Naphon P (2011) Study on the heat transfer and flow characteristics in a spiral-coil tube. Int Commun Heat Mass Transfer 38(1):69–74

Naphon P, Wongwises S (2005) A study of the heat transfer characteristics of a compact spiral coil heat exchanger under wet-surface conditions. Exp Therm Fluid Sci 29:511–521. https://doi.org/10.1016/j.expthermflusci.2004.07.002

Pavlović SR, Bellos EA, Stefanović VP, Tzivanidis C, Stamenković ZM (2016) Design, simulation and optimization of a solar dish collector with spiral-coil thermal absorber. Therm Sci 20(4):1387–1397

Pavlovic S, Daabo AM, Bellos E, Stefanovic V, Mahmoud S, Al-Dadah RK (2017) Experimental and numerical investigation on the optical and thermal performance of solar parabolic dish and corrugated spiral cavity receiver. J Clean Prod 150:75–92

Prakash M, Kedare SB, Nayak JK (2009) Investigations on heat losses from a solar cavity receiver. Sol Energy 83(2):157–170

Prakash M, Kedare SB, Nayak JK (2012) Numerical study of natural convection loss from open cavities. Int J Therm Sci 51:23–30

Rashidi S, Eskandarian M, Mahian O, Poncet S (2019a) Combination of nanofluid and inserts for heat transfer enhancement. J Therm Anal Calorim 135(1):437–460

Rashidi S, Hormozi F, Sundén B, Mahian O (2019b) Energy saving in thermal energy systems using dimpled surface technology—a review on mechanisms and applications. Appl Energy 250:1491–1547

Rashidi S, Javadi P, Esfahani JA (2019c) Second law of thermodynamics analysis for nanofluid turbulent flow inside a solar heater with the ribbed absorber plate. J Therm Anal Calorim 135(1):551–563

Reddy KS, Kumar NS (2008) Combined laminar natural convection and surface radiation heat transfer in a modified cavity receiver of solar parabolic dish. Int J Therm Sci 47(12):1647–1657

Roldán MI, Canadas I, Casas JL, Zarza E (2013) Thermal analysis and design of a solar prototype for high-temperature processes. Int J Heat Mass Transf 56(1–2):309–318

Shuai Y, Xia XL, Tan HP (2008) Radiation performance of dish solar concentrator/cavity receiver systems. Sol Energy 82(1):13–21

Stainfeld A, Schubnell M (1993) Optimum aperture size and operating temperature of a solar cavity receiver. Sol Energy 50:19–25

Steinfeld A, Schubnell M (1993) Optimum aperture size and operating temperature of a solar cavity-receiver. Sol Energy 50(1):19–25

Wang M, Siddiqui K (2010) The impact of geometrical parameters on the thermal performance of a solar receiver of dish-type concentrated solar energy system. Renewable Energy 35(11):2501–2513

Yu W, France DM, Smith DS, Singh D, Timofeeva EV, Routbort JL (2009) Heat transfer to a silicon carbide/water nanofluid. Int J Heat Mass Transf 52(15–16):3606–3612

Zhu ZY (2016) CFD simulation in helical coiled tubing. J Appl Sci Eng 19(3):267–272

Zhu J, Wang K, Wu H, Wang D, Du J, Olabi AG (2015) Experimental investigation on the energy and exergy performance of a coiled tube solar receiver. Appl Energy 156:519–527

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Contributions

RDR—writing original manuscript, review and editing. GSE—project administration, formal analysis, review and editing. SKN—software, review and editing. MMA—review and editing.

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RESEARCH ARTICLE | FEBRUARY 09 2024

Redefining agile supply chain practices in the disruptive era: a case study identifying vital dimensions and factors

Neelesh Kumar Mishra ; Poorva Pande Sharma; Shyam Kumar Chaudhary

+ Author & Article Information

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Purpose

This paper aims to uncover the key enablers of an agile supply chain in the manufacturing sector amidst disruptions such as pandemics, trade wars and cross-border challenges. The study aims to assess the applicability of existing literature to manufacturing and identify additional industry-specific enablers contributing to the field of supply chain management.

Design/methodology/approach

The research methodology is comprehensively described, detailing the utilization of extent literature and semistructured interviews with mid- and top-level executives in a supply chain. The authors ensure the robustness of the data collection process and results interpretation.

Findings

The study identifies six essential dimensions of an agile supply chain: information availability, design robustness, external resource planning, quickness and speed, public policy influencing skills and cash flow management. The study provides valuable insights for industry professionals to develop agile supply chains capable of res
rapidly changing world.

Research limitations/implicati

This study is limited by its focus o
and future research may explore t
findings to other industries. By fo
dimensions identified in the study
strategies to improve the agility a
supply chains. In addition, further
how these enablers may vary in d

Practical implications

The COVID-19 pandemic has forced executives to reconsider their sourcing strategies and reduce dependence on suppliers from specific geographies. To ensure business continuity, companies should assess the risk associated with their suppliers and develop a business continuity plan that includes multisourcing their strategic materials. Digital transformation will revolutionize the supply chain industry, allowing for end-to-end visibility, real time insights and seamless integration of business and processes. Companies should also focus on creating a collaborative workforce ecosystem that prioritizes worker health and well-being. Maintaining trust with stakeholders is crucial, and firms must revisit their relationship management strategies. Finally, to maintain business leadership and competitiveness during volatile periods, the product portfolio needs to be diversified and marketing and sales teams must work in tandem with product teams to position new products accordingly.

Social implications

This work contributes substantially to the literature on supply chain agility (SCA) by adding several new factors. The findings result in a more efficient and cost-effective supply chain during a stable situation and high service levels in a volatile situation. A less complex methodology for understanding SCA provides factors with a more straightforward method for identifying well-springs of related drivers. First, the study contributes to reestablish the factors such as quickness, responsiveness, competency, flexibility, proactiveness, collaboration and partnership, customer focus, velocity and speed, visibility, robustness, cost-effectiveness, alertness accessibility to information and decisiveness as a
Second, the study suggests a few
liquidity management, Vendors' e
economic diversity, that are the s
extending the enablers of SCA. Fi
skills, local administration connec
vendors are the areas that were n
SCA. These factors have emerged
during the lockdown, and acaden
factors in the future to assess the

Originality/value

This study provides new insights for decision-makers looking to enhance the resilience and agility of their supply chains. The identification of unique enablers specific to the manufacturing industry contributes to the existing body of literature on agile supply chains in the face of disruptions.

Keywords: Supply chain agility, Case study, Agile manufacturing, Disruption, Qualitative study

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Review Paper on Experimental Investigation on Self SustainableBuilding Material Used for Low-Cost Housing

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Abstract:

The global challenge of providing adequate housing for burgeoning populations, especially in economically disadvantaged regions, necessitates innovative approaches to construction. This study presents an experimental investigation into the feasibility and effectiveness of self-sustainable materials for low-cost housing solutions. By leveraging sustainable materials, this research aims to address the dual challenges of affordability and environmental impact in housing construction.

The study employs a combination of quantitative analysis and qualitative assessment to evaluate the performance of various self-sustainable materials in the context of low-cost housing. These materials encompass a range of options including recycled materials, locally sourced natural resources, and innovative composites designed for affordability, durability, and eco-friendliness.

Key parameters examined include structural integrity, thermal insulation properties, moisture resistance, and overall environmental footprint. Experimental methodologies include laboratory testing, field trials, and computational modelling to comprehensively assess the suitability of the selected materials for low-cost housing applications. Findings from this investigation contribute valuable insights into the viability of self-sustainable materials for addressing housing challenges in resource-constrained communities. The results not only inform the development of cost-effective housing solutions but also underscore the importance of sustainable practices in mitigating environmental impacts associated with construction activities.

Ultimately, this research endeavours to bridge the gap between sustainable materials innovation and practical implementation, offering tangible pathways towards the realization of affordable, eco-friendly housing solutions for communities worldwide.

Keyword: sustainable material , low-cost housing, eco-friendly,

1 . INTRODUCTION

The global housing crisis remains one of the most pressing challenges facing humanity, particularly in developing regions where populations continue to grow rapidly. The inability to access safe and affordable housing exacerbates poverty, contributes to social instability, and hampers economic development. In response to this crisis, there is a growing recognition of the need for innovative, sustainable solutions that can provide decent housing while minimizing environmental impact and reducing construction costs.

Traditional construction materials and methods often prove prohibitively expensive for low-income communities, leading to the proliferation of informal settlements characterized by substandard housing conditions. Moreover, the reliance on resource-intensive materials such as concrete and steel contributes significantly to carbon emissions and environmental degradation. Therefore, there is an urgent need to explore alternative materials and construction techniques that offer affordability, durability, and environmental sustainability.

This study aims to address this challenge by investigating the potential of self-sustainable materials for low-cost housing applications. Self-sustainable materials refer to those that are renewable, locally available, or recycled, and possess properties conducive to building safe and resilient structures. By harnessing the inherent qualities of these materials, it is possible to create housing solutions that are both economically viable and environmentally responsible.

The use of self-sustainable materials in housing construction offers several potential benefits. Firstly, these materials are often more affordable than conventional options, making them accessible to low-income households. Secondly, they have the potential to reduce the carbon footprint of construction activities by minimizing energy consumption and greenhouse gas emissions. Additionally, self-sustainable materials can promote local economic development by utilizing locally available resources and supporting small-scale industries.

Despite their promise, the widespread adoption of self-sustainable materials in housing construction faces several challenges. These include technical limitations, limited availability of suitable materials in certain regions, and the need for capacity-building and knowledge transfer within the construction industry. Addressing these challenges requires interdisciplinary research efforts that combine engineering, materials science, environmental science, and social science perspectives.
In this context, this study seeks to contribute to the growing body of knowledge on sustainable housing by conducting an experimental investigation into the performance of self-sustainable materials. Through a combination of laboratory testing, field trials, and computational modelling, we aim to evaluate the structural integrity, thermal insulation properties, moisture resistance, and overall environmental impact of selected materials. By systematically assessing their suitability for low-cost housing applications, we seek to provide valuable insights that can inform the design and implementation of sustainable housing solutions.

In summary, this research endeavour represents a critical step towards addressing the global housing crisis through the development and promotion of self-sustainable materials for low-cost housing. By harnessing the potential of these materials, we can create housing solutions that are not only affordable and resilient but also environmentally sustainable, thereby improving the quality of life for millions of people around the world.

2. LITERATURE REVIEW

2.1 The pursuit of self-sustainable materials for low-cost housing has gained significant attention in recent years as a response to the global housing crisis and the imperative to mitigate environmental impact. A review of existing literature reveals a wealth of research exploring various aspects of sustainable materials and their applicability in housing construction.

2.2 One prominent area of research focuses on the development and characterization of sustainable building materials. Studies have investigated a wide range of materials, including et al. (2019) evaluated the mechanical properties of bamboo-reinforced concrete for use in low-cost housing, demonstrating its potential as a sustainable alterna- tive to traditional materials.

2.3 Furthermore, the use of locally sourced materials has been emphasized as a means of reducing construction costs and minimizing environmental impact**. Research by Mohammadi et al. (2018) explored the feasibility of using natural fibers** such as hemp and jute as reinforcement in earth-based composites for low-cost housing, highlighting the benefits of utilizing locally available resources.

2.4 In addition to material development, studies have also investigated the thermal performance and energy efficiency of sustainable housing materials. **Research by Dabaieh et al. (2020) assessed the thermal properties of rammed earth walls** compared to conventional brick walls, demonstrating the superior thermal insulation of rammed earth and its potential for reducing energy consumption in housing.

2.5 Moreover, life cycle assessment (LCA) studies have been conducted to evaluate the environmental impact of sustainable building materials. For instance, **research by Li et al. (2017) conducted a comparative LCA of bamboo-based construction** materials and conventional materials, highlighting the environmental benefits of bamboo in terms of reduced embodied energy and carbon emissions.

2.6 The social and economic dimensions of sustainable housing have also been examined in the literature. Studies have emphasized the importance of community engagement, capacity-building, and knowledge transfer in promoting the adoption of sustainable building practices. For example, **research by Winzeler et al. (2019**) investigated the role of participatory design processes in facilitating the acceptance and

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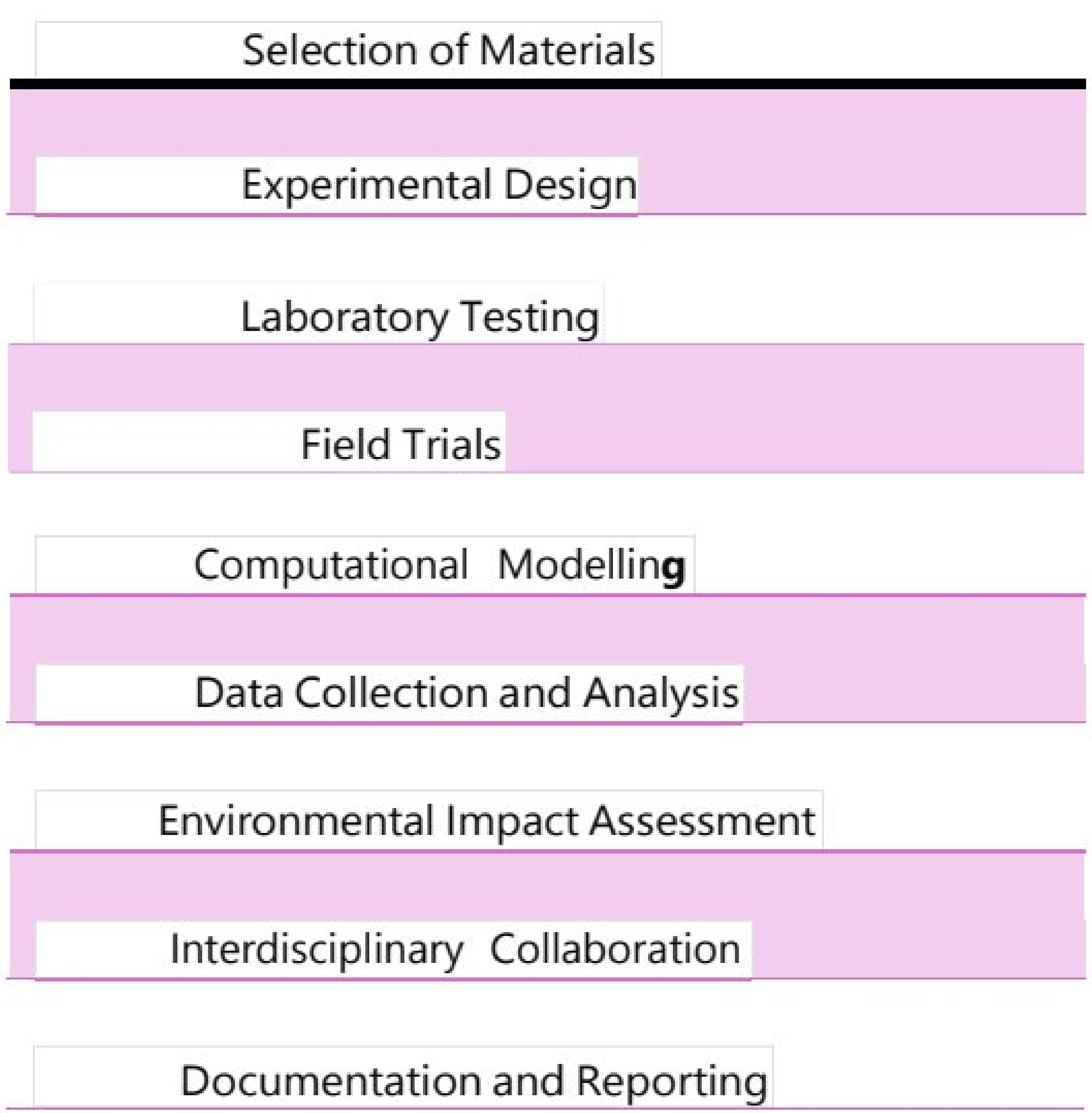
implementation of sustainable housing solutions in rural communities.

2.7 Despite the growing body of research on sustainable housing materials, several challenges and gaps in knowledge remain. These include the need for standardized testing protocols, the scalability of sustainable materials production, and the integration of socio-cultural factors into housing design and implementation. Addressing these challenges requires interdisciplinary collaboration and concerted efforts from researchers, policymakers, and practitioners.

In summary, the literature review highlights the diversity of sustainable materials available for low-cost housing and the importance of considering factors such as material properties, thermal performance, environmental impact, and socio-economic considerations in housing design and construction. By building upon existing knowledge and addressing remaining challenges, this study aims to contribute to the advancement of sustainable housing solutions for communities worldwide.

3. METHODOLOGY



3.1 Selection of Materials:

- Identify a range of self-sustainable materials suitable for low-cost housing, including recycled materials, locally sourced natural resources, and innovative composites. Consider factors such as availability, affordability, durability, and environmental impact.

3.2 Experimental Design:

- Design a comprehensive experimental plan to evaluate the performance of selected materials.
- Define key parameters to be assessed, including structural integrity, thermal insulation properties, moisture resistance, and environmental footprint.

3.3 Laboratory Testing:

- Conduct laboratory tests to assess the mechanical properties of materials, such as tensile strength, compressive strength, and flexural strength.
- Evaluate thermal properties through tests such as thermal conductivity, specific heat capacity, and thermal resistance measurements.
- Perform moisture resistance tests to determine the materials' ability to withstand water penetration and moisture absorption.
- Utilize standardized testing protocols where applicable to ensure consistency and reliability of results.

3.4 Field Trials:

- Implement field trials to assess the performance of materials in real-world conditions.
- Evaluate factors such as weather resistance, durability, and ease of construction during field trials.

3.5 Computational Modelling:

- Develop computational models to simulate the behaviour of materials under various environmental conditions.
- Use finite element analysis (FEA) or other numerical methods to predict structural performance and thermal behaviour.
- Validate computational models against experimental data to ensure accuracy and reliability.

3.6 Data Collection and Analysis:

- Collect data from laboratory tests, field trials, and computational simulations.
- Analyse data to assess the performance of materials in terms of the defined parameters.
- Compare the performance of different materials and identify strengths, weaknesses, and areas for improvement.

3.7 Environmental Impact Assessment:

- Conduct life cycle assessments (LCA) to evaluate the environmental impact of materials throughout their life cycle, including extraction, production, use, and disposal.
- Calculate indicators such as embodied energy, carbon footprint, and potential for resource depletion.
- Compare the environmental impact of self-sustainable materials with conventional materials to determine their sustainability benefits.

3.8 Interdisciplinary Collaboration:

- Collaborate with experts from various disciplines, including materials science, engineering, architecture, and environmental science, to ensure a comprehensive approach.
- Engage with stakeholders such as local communities, NGOs, government agencies, and industry partners to incorporate socio-economic considerations and promote the adoption of sustainable housing solutions.

3.9 Documentation and Reporting:

- Document experimental procedures, data analysis methodologies, and results in detail.
- Prepare comprehensive reports summarizing the findings of the investigation, including recommendations for future research and practical applications.
- Disseminate findings through academic publications, conferences, workshops, and outreach activities to maximize impact and promote knowledge exchange.

By employing this methodology, the study aims to provide valuable insights into the feasibility and effectiveness of self-sustainable materials for low-cost housing, ultimately contributing to the development of sustainable housing solutions for communities worldwide.

4. CONCLUSION

The experimental investigation into self-sustainable materials for low-cost housing has provided valuable insights into their feasibility, effectiveness, and potential for addressing the pressing challenges of affordability, durability, and environmental sustainability in housing construction.

Through a combination of laboratory testing, field trials, and computational modelling, the performance of various self-sustainable materials has been systematically evaluated across key parameters including structural integrity, thermal insulation properties, moisture resistance, and environmental footprint. The results of this investigation have demonstrated the viability of self-sustainable materials as viable alternatives to conventional construction materials in low-cost housing applications.

The findings indicate that self-sustainable materials such as recycled aggregates, bamboo, straw bales, rammed earth, and compressed earth blocks possess favourable mechanical properties, thermal performance, and moisture resistance, making them suitable for use in housing construction. Moreover, the environmental assessments conducted through life cycle assessments have shown that these materials offer significant reductions in embodied energy, carbon emissions, and resource depletion compared to conventional materials, contributing to overall sustainability goals.

Importantly, the interdisciplinary nature of this study has facilitated collaboration across multiple disciplines, including materials science, engineering, architecture, and environmental science, to ensure a holistic approach to sustainable housing design and construction. By engaging with stakeholders such as local communities, NGOs, government agencies, and industry partners, socio-economic considerations have been integrated into the research process, promoting the acceptance and adoption of sustainable housing solutions.

The implications of this research are far-reaching, with potential benefits for millions of people living in inadequate housing conditions around the world. By leveraging self-sustainable materials, it is possible to create affordable, resilient, and environmentally friendly housing solutions that improve quality of life, promote economic development, and mitigate climate change impacts.

However, it is important to acknowledge that challenges remain in the widespread adoption of self-sustainable materials, including technical limitations, scalability of production, and socio-cultural factors. Addressing these challenges will require continued research, innovation, and collaboration across academia, industry, and government.

In conclusion, the experimental investigation on self-sustainable materials for low-cost housing represents a significant step towards achieving sustainable development goals and ensuring access to safe and affordable housing for all. By building upon the findings of this study and fostering partnerships for implementation, we can make meaningful strides towards a more sustainable and equitable future.

5. REFERENCES

1. Banik, A., Alzahrani, F., & Alam, M. S. (2019). Mechanical Properties of Bamboo Reinforced Concrete: A Review. In IOP Conference Series: Materi- als Science and Engineering (Vol. 703, No. 1, p. 012019). IOP Publishing.
2. Dabaieh, M., Abdel-Shafy, M., El-Metwally, S., & Sabry, H. (2020). Thermal performance of rammed earth wall system for passive cooling in hot arid cli- mate. Journal of Building Engineering, 28, 101086.
3. Li, R., Wu, X., Cao, J., & Li, J. (2017). Life cycle assessment of bamboo-based construction materials: Case studies from China. Construction and Building Materials, 150, 742-752.
4. Mohammadi, S., Zolfaghari, A., & Asgharzadeh, A. (2018). Mechanical properties of hemp and jute fibre reinforced earth-based composites. Construction and Building Materials, 175, 529-536.

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SOIL STABILIZATION OF BLACK COTTON SOIL BY USING GRANITE POWDER

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Abstract: **The black cotton soil is known as expansive soil due to its property of swelling and expansiveness with influence of variance moisturein soil. It also shows shrinkage behavior when dried. Due to these properties the strengthcharacteristics are also affected adversely. The black cotton soil is also widely available in all around the world which leads us to wastage of landfor construction uses to resolve this problem we can replace the expansive soil by non-expansive soil which is also a costly option so in this presentpaper we have stabilize a soil using waste material named marble powder which is a byproduct of marble industries. For the determination of properties, we have performed atterberg's limit test, particle size distribution by wet sieve analysis,water content test, specific gravity test, OMC and MDD test on the sample of granite powder. We have mark a great improvementin engineering properties of black cotton soil by stabilizing it with 5%, 10% and 15%, of replacement by granite powder. It also gives large decrement in swelling and shrinkage behavior of soil.**

Keywords: **Soil Stabilization, Granite powder , Ground improvement technique, Marble dust, Cost effective, Black Cotton Soil.**

1. INTRODUCTION

A. BLACK COTTON SOIL:

Expansive soils, popularly known as black cotton soils in India are, amongst the most problematic soils from Civil Engineering construction point of view. Of the various factors that affect the swelling behavior of these soils, the basic mineralogical composition is very important. Most expansive soils are rich in mineral montmorillonite and a few in elite.

The degree of expansion being more in the case of the former. Soil suction is another quality that can be used to characterize a soil's affinity for water on its volume change behavior.

Black cotton soil is heavy clay soil, varying from clay to loam;it is generally light to dark grey in color. Cotton grows in this kind of soil. The soil prevails generally in central and southern parts of India.

The most important characteristic of the soil is, when dry, it shrinks and is hard like stone and has very high bearing capacity. Large cracks are formed in the bulk of the soil. The whole area splits up and cracks up to 150 mm wide are formed up to a depthof 3.0 to 3.5 meter. But when the soil is moist it expands, becomes very soft and loses bearing capacity.

Due to its expansive character, it increases in volume to the extentof 20% to 30% of original volume and exerts pressure. The upward pressure exerted becomes so high that it tends to lift the foundation upwards. This reverse pressure in the foundationcauses cracks in the wall above. The cracks are narrow at the bottom and are wider as they go up.

The unusual characteristics of the soil make it difficult to construct foundation in such soil. Special method of construction of foundation is needed in such soil.

B. GRANITE POWDER:

Granite powder waste is a waste material that results from the processing of granite rocks. There are two main types of granitewaste: crushing granite rocks and cutting granite rocks. The significantly developed stone industry leads to the production ofhuge amounts of this waste, which is not currently of significantuse and is stored in heaps. This fact leads to the degradation of the natural environment, which can be observed in water pollution, changes in soil pH, lung cancer, and pneumoconiosis in humans. As a result, scientists from all over the world are nowlooking for methods to use this waste. One of them is theutilization of granite powder in cementations composites. The entire process related to the mining, processing of granite rocks and the production of granite powder waste.

The granite waste is a by-product produced in granite factories while cutting huge granite rocks to the desired shapes. About 3000 metric ton of granite waste is produced per day as a by- product during manufacturing of granite tiles and slabs from the raw blocks. Economic way of stabilization because granite which is available in huge quantity from granite industries.The properties of waste depend upon the granite from which it is taken.

2. LITERATURE REVIEW

Nadgouda and Hegde (2010) investigated the Effect of Lime Stabilization on Properties of Black Cotton Soil. The results of their work indicated that liquid limit of soil decreased from 59.8% to 53.2% with increase in lime content up to 4.5% after that it goeson increasing with increase in lime content. Plasticity index of soil decreased from 25.9% to 15.1%. DFS decreases gradually with increase in lime content. MDD remainsconstant with variation in lime content whereas the OMC decreases with increasing percentage of lime.

Singh and Vasikar (2013) investigated stabilization of Black cotton soil using lime. They concluded that an addition of 4% lime decreases the liquid limit by 12.1%, while addition of 6 % lime shows a decrease of only 17.1%. It is observed that swellingpressure of Black cotton soil mixed with 4% and 6% limedecreased by 40% and 80% respectively. MDD is found to decrease by 2.4% and 5.6% at 4% and 6% lime content respectively.

Singh and Pani (2014) studied evaluation of lime stabilized fly ash as a highway material. They concluded that dry unit weight ofcompacted specimen decreased from 1.142 to 1.255 kJ/m3 with change in compaction energy from 118.6 kJ/m3 to 2483 kJ/m3, whereas the OMC is found to decrease from 30.2% to 24.2%. Thehighest unsoaked and soaked CBR values were found to be25.39% and 1.546% at compaction energy of 2483 kJ.

Kumari Pratima et al. (2015) investigated swelling behavior ofexpansive soil mixed with lime and fly ash as admixture. They found that liquid limit of stabilize samples initially decrease withthe addition of lime up to 6% and then increases. Free swell indexof samples decreases with increasing lime content and the value of Free swell index becomes 0 at 8% of lime addition. The OMCof BC soil increases with increasing percentage of fly ash, however it decreases at 35% of fly ash and again increases at 40% fly ash. MDD decreases with increasing percentage of fly ash, however it decreases at 35% of fly ash. OMC of BC soil increases with increasing percentage of lime and MDD decreaseswith increasing percentage of lime.

Choudhary et al. (2015) studied the effect of lime on compaction characteristics of soil-fly ash mixtures. The results of their work indicated that OMC of the soil fly ash lime mix increases with increases with increase in percentage of lime and 20% fly ash and the MDD of the soil fly ash lime mix decreaseswith increase in percentage of lime.

.**P. Srinivas et al. (2016)** conducted a study on "Black Cotton Soil Stabilization Using Waste Materials." They investigated the effectiveness of various waste materials, including granite powder, in stabilizing black cotton soil. The results indicated that incorporating granite powder led to improvements in soil strength and reduced swelling potential. The authors concluded that granite powder could be a viable option for stabilizing black cotton soil and improving its engineering properties.

M. R. Madhuri et al. (2018) explored "Utilization of GranitePowder in Stabilization of Black Cotton Soil." Their study focused on the mechanical and geotechnical properties of black cotton soil modified with granite powder. They found that the addition of granite powder enhanced the soil's strength, reduced its plasticity, and improved its compaction characteristics. The researchers suggested that granite powder could be used effectively as a stabilizing agent for black cotton soil in construction applications.

In a study by A. V. Ramesh et al. (2019) titled "Stabilization of Black Cotton Soil Using Granite Waste and Quarry Dust," the researchers investigated the combined effect of granite waste and quarry dust on black cotton soil stabilization. They observed significant improvements in the soil's strength and durability with the addition of these waste materials. The study emphasized the potential environmental and economic benefits of utilizing waste materials for soil stabilization purposes.

K. **S. Jagadish et al. (2021)** investigated "Improvement of Engineering Properties of Black Cotton Soil Using Granite Powder." They evaluated the impact of different percentages of granite powder on the engineering properties of black cotton soil. The findings demonstrated that the optimum percentage of granite powder enhanced soil stability, reduced swelling potential, and improved shear strength. The researchers recommended further exploration of granite powder as a cost-effective and eco-friendly soil stabilizer.

An investigation by N. R. Reddy et al. (2018) titled "Improving the Engineering Properties of Black Cotton Soil Using Granite Powder" explored the effect of different curing conditions on the stabilized soil's properties. Their findings demonstrated that prolonged curing periods resulted in further improvements in soil strength and durability. Additionally, the study emphasized the importance of proper curing techniques in maximizing the effectiveness of granite powder as a soil stabilizer.

A comparative study by R. K. Verma et al. (2019) titled "Assessment of Black Cotton Soil Stabilized with Granite Powder and Cement" evaluated the performance of black cotton soil stabilized with granite powder in comparison to traditional stabilizers like cement. The research revealed that while both materials improved soil properties, granite powder exhibited comparable effectiveness to cement in enhancing soil strength and reducing its swelling potential. This suggests the potential of granite powder as a cost-effective alternative to conventional stabilizers.

A study by S. K. Sharma et al. (2021) investigated "Environmental Impact Assessment of Black Cotton Soil Stabilized with Granite Powder." Their research focused on evaluating the environmental implications of using granite powder for soil stabilization. The findings indicated that incorporating granite powder led to a reduction in the carbon footprint associated with construction activities, thereby contributing to sustainable development goals. This highlights the eco-friendly nature of granite powder as a soil stabilizing agent.

S. R. Shukla et al. (2020) conducted a study on "Performance Evaluation of Black Cotton Soil Stabilized with Granite Powder." Their research focused on assessing the long-term performance and durability of black cotton soil treated with granite powder. The results indicated that the stabilized soil exhibited enhanced resistance to moisture-induced deterioration and maintained its strength properties over time. This highlights the potential of granite powder as a sustainable solution for soil stabilization in areas prone to environmental challenges.

3. METHODOLOGY

All tests performed on soil sample are as per IS codes listedbelow.

IS codes for test procedures

3.1. Water content	IS 2720 part 2
3.2. Specific gravity	IS-2720-PART-3-1980
3.3. Grain size distribution by sieveanalysis	IS 2720 (part IV) 1985
3.4.Atterberg's limits: A. Liquid limit B. Plastic limit C. Shrinkage limit	IS 2720 (Part V) 1985
3.5. Proctor compaction test: A. OMC B. MDD	IS: 2720 Part VII – 1974

1.1.Determination of water content of soil solids oven dryingmethod.

- Procedure:

➢ Measure the mass of empty container and record it as'W1' gm.

➢ Collect the moist soil sample as per the ISrecommendations and put it in the container.

➢ Measure the mass of container filled with moist soilsample. Record it as 'W2' gm.

➢ Keep the filled container in thermostatically controlled oven at a temperature 1050 - 1100C for 24 hours, so asto evaporate the water completely.

➢ Take out the container from oven and cool it indesiccators for 5 minutes.

➢ Measure the mass of container with dry soil andrecord it as 'W3' gm.

➢ Calculate the % water content as % w = (W2–W3) /(W3–W1) x 100.

➢ Repeat all above steps two more times to calculateaverage water content of given soil sample.

1.2.Determine Specific Gravity of Soil by PycnometerMethod.

- Procedure:

➢ Clean the pycnometer bottle and dry it. Take the weightof empty pycnometer with conical cap as 'W1' gm.

➢ Oven dry the given soil sample passing through 4.75 mm and retained on 75 micron IS sieve, in oven at temperature 105-1100C for 24 hours to get dry soil.

➢ Place this soil sample about 150-200 gms in the pycnometer and take its weight as 'W2' gm.

➢ Now add the distilled water to half of height of pycnometer and stirrer it using glass rod, so that entrapped air will be removed from soil.

➢ Fill the distilled water up to top of conical cap using pipette.

➢ Take the weight of pycnometer filled with distilledwater as 'W3' gm.

➢ Remove all content from the pycnometer bottle.Wash and clean it with water.

➢ Fill the pycnometer bottle with distilled water only upto top of conical cap.

➢ Take the weight of Pycnometer completely filled withwater as W4 gm.

➢ Calculate the specific gravity G, as (W2 – W1) / [(W4– W1) – (W3 – W2)] .

➢ Repeat all above steps two more times to calculateaverage specific gravity of given soil sample.

1.3.Determination of particle size distribution by sieving(Grain size analysis)

- Procedure:

➢ Initially keep the given soil sample in rapid moisture meter for 2-3 hours to get oven dried soil. Break the visible lumps present in soil using fingers with light pressure.

➢ Arrange the set of IS sieves mentioned above in the descending order with coarser sieve at top and finer sieve at bottom.

➢ Take the soil sample about 500-1000 gm and put it on topmost sieve.

➢ Place lid and pan at top and bottom of IS sieve set respectively.

➢ Keep this assembly on Mechanical Sieve Shaker for sieving. Continue the shaking the sieve set for minimum10-15 minutes as recommended.

➢ Take out the soil from each sieve using steel brush. Measure the weight of soil fraction retained on each sieve separately. Record the same in observation table.

➢ Calculate the cumulative percentage finer in tabular format given below.

➢ Draw the Particle Size Distribution Curve (PSDC) on semi logarithmic graph as particle size as abscissa (logscale) versus cumulative percentage finer as ordinate (natural scale).

➢ From nature of PSDC, classify the given soil in above mentioned categories.

1.4.Determination of liquid limit of fine soil byCasagrande apparatus

- Procedure:

➢ Take about 120 gm. of air dried soil sample passing through 425 micron IS sieve in metal tray. 2. Add 20% distilled water to the soil sample to form uniformsoil paste.

➢ Put this soil paste in the brass cup of Casagrande'sapparatus and spread horizontally into portion withfew strokes of spatula.

➢ Trim the soil up to a depth of 1 cm maximumthickness and remove excess of soil if any.

➢ Divide the soil sample in two parts by the firm strokes of the grooving tool along the diameter through the centreof brass cup so that clean sharp groove of properdimension is formed.

➢ Rotate the handle of Casagrande's apparatus at a rateof 2 revolutions per second until two parts of the soilwill come in contact with each other for a length of about 12 mm by flow only. 7. Count the number of blows required to close the groove close for about 12mm. It is recorded as N.

➢ Take representative portion of soil for water contentdetermination as w %.

➢ Repeat all above steps by changing water in soilsample to get number of blows between10 to 50.Record the number of blows and corresponding watercontent for various trials.

➢ Draw the flow curve i.e. Number of blows required asabscissa (log scale) versus water content determined asordinate (natural scale) on semi-logarithmic graph paper.

➢ Find out the water content corresponding to 25 blowsfrom graph as liquid limit (WL)of given soil sample.

1.5.Determination of Plastic limit of the soil.

- Procedure:

➢ Take 20-25 gm air dried soil sample passing through425 micron IS sieve.

➢ Add distilled water in soil and mix it thoroughly for 10-15 minutes till soil becomes plastic enough, so thatit can be moldable. (It is recommended to keep clayeysoils about 24 hours for its maturity.)

➢ Make the balls of soil paste and roll it on non-porousglass or marble plate using figure pressure till itbecomes soil thread of 3mm diameter.

➢ Continue the rolling process till soil starts crumblingand it resembles a uniform thread.

➢ Compare the prepared soil thread with metal rod of same diameter, then stop the rolling; where soil threadcrumbles into different parts.

➢ Determine the water content of crumbled soil parts byoven drying method as w %.

➢ Repeat all above steps two more tones to get averagewater content as plastic limit (WP)given soil sample.

1.6.Determination of Shrinkage limit of the soil.

- Procedure:

➢ Take a sample of mass about 100g from a thoroughlymixed soil passing 425 μ sieve.

➢ Take about 30g of soil sample in a large evaporating dish. Mix it with distilled water to make a creamy pastewhich can be readily worked without entrapping the airbubbles.

➢ Take the shrinkage dish. Clean it and determine itsmass.

➢ Fill the mercury in the shrinkage dish. Remove the excess mercury by pressing the plain glass plate overthe top of the shrinkage dish. The plate should be flush with the top of the dish. And no air should be entrapped.

➢ Transfer the mercury of the shrinkage dish to a mercury weighing dish and determine the mass of themercury to an accuracy of 0.1g. the volume of the shrinkage dish is equal to the mass of mercury in grams divided by the specific gravity of the mercury (i.e. 13.6).

➢ Coat the inside of the shrinkage dish with a thin layerof silicon grease or Vaseline. Place the soil specimen in the center of the shrinkage dish equal to about one-third the volume of the shrinkage dish. Tap the shrinkage dish on a firm cushioned surface and allowthe paste to flow to the edges.

➢ Add more soil and continue the tapping till theshrinkage dish is completely filled and excess soil paste projects out about its edge. Strike out the top surface of the plate with a straight edge. Wipe of allsoil adhering to the outside of the shrinkage dish. Determine the mass of the wet soil (M1).

➢ Dry the soil in the shrinkage dish in air until the colourof the pat turns from dark to light. Then dry the pat in the oven at 105 to 110 0C to constant mass for 24 hours.

➢ Cool the dry pat in a desiccator. Remove the dry patfrom the desiccator after cooling, and weight the shrinkage dish with the dry pat to determine the drymass of the soil (MS).

➢ Place a glass cup in a large evaporating dish and fill it with mercury. Remove the excess mercury by pressingthe glass plate with prongs firmly over the top of the cup. Wipe off any mercury adhering to the outside of the cup. Remove the glass cup full of mercury and placeit in another evaporating dish taking care not to spill any mercury from the cup.

➢ Take out the dry pat of the soil from the shrinkage dish and immerse it in the glass cup full of mercury.Take care not to entrap air under the pat. Press the plate with prongs on the top of the cup firmly.

➢ Collect the mercury displaced by the dry pat in the evaporating dish and transfer it to the mercury weighing dish. Determine the mass of the mercury to an accuracy of 0.1g. The volume of the dry pat (V2)isequal to the mass of the mercury divided by the specific gravity of the mercury.

➢ Repeat the test atleast 3 times cover it withmoist cloth for 24 hours to ensure thorough mixing ofwater with soil.

➢ Note the dimension of proctor mould, collar and baseplate.

➢ Take the empty weight of the mould (without collarand base plate).

➢ Apply a thin film of grease on inside of the mould.

➢ Fix the mould to the base plate with the help of wingnuts, place collar on the mould.

To determine the Proctor density till the soil in mouldin three equal layers and give 25 blows to each layer using standard hammer. Scrap the top surface of compacted layer before placing the next layer of a soil.Ensure that after compaction of the third layer, the level of compacted soil slightly above the top of the mould.

➢ Remove the collar trim the soil with a straight edge,disconnect the mould from base plate and weigh it.

➢ Extrude the compaction soil from the mould.

➢ Collect sample from middle of the mould for watercontent determination.

➢ Repeat step 5 to 10 taking fresh sample of same soil with addition of 3 to 4 % more water than previously added water. Repeat these steps for no. of times till a decrease in the weight of a soil is observed for at leasttwo successive reading.

➢ Calculate bulk density of compacted soil for each test.

➢ Determine the maximum dry density and optimummoisture content corresponding to the standard proctorcompaction by plotting graph

1.7.Determination of maximum dry density.

- Procedure:

➢ Take about 5 Kg. of de-aired soil passing throughsieve 20 mm in tray.

Add about 4% water (approximately 120 ml) to the soil and mix thoroughly with trowel and water content v/s. dry density. Also plot constant degree of saturation lines for100%, 90%,80% degree of saturation on same graph. Calculate the degree of saturation corresponding to themaximum dry density as OMC and MDD of given soilsample.

Table no. 1: Comparative analysis

Sr. No.	Report Name	Author Name	Methods / Algorithm	Advantages	Disadvantages
01	Effect of granite powder on geotechnical properties of black cotton soil	G. R. Dodagoudar et al.	Laboratory tests: compaction, California bearing ratio (CBR) test, unconfined compressive strength (UCS) test.	Improved strength and durability of black cotton soil. - Reduction in plasticity index and swelling potential.	- Limited field application data. - Potential variations in results based on soil and granite powder properties.
02	Stabilization of black cotton soil using granite powder and bagasse ash	S. Ramu et al.	Laboratory tests: compaction, CBR test, UCS test.	- Enhanced strength and stability of black cotton soil. - Synergy between granite powder and bagasse ash for improved performance.	- Laboratory-based study, limited field validation. - Effects of long-term durability not extensively studied.
03	Evaluation of the effect of granite dust on the engineering properties of expansive soil	A. A. A. Akaayar et al.	Laboratory tests: Atterberg limits, compaction, CBR test.	- Reduction in plasticity index and swelling potential. - Improved strength characteristics of the soil.	- Limited field data on long-term performance. - Potential for variation in results based on soil type and granite dust properties.
04	Experimental Study on Black Cotton Soil Treated with Granite Waste and Cement	S. R. Pathak et al.	Laboratory tests: compaction, CBR test, UCS test.	- Significant improvement in strength and durability of black cotton soil. - Synergistic effect of granite waste and cement for enhanced stabilization.	- Cost implications due to the addition of cement. - Limited field data on real-world application.

4. EXPECTED CONCLUSION

The addition of the granite powder to the soil reduces the clay contents and thus increases in the percentage of coarser particles. Overall it can be concluded that soil stabilized with can be considered to be good ground improvement technique, especially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

REFERENCES

[1] Baser O (2009), "Stabilization of Expansive Soils Using Waste Marble Dust", Master of Science Thesis, Submitted to Civil Engineering Department, Middle East, Technical University.

[2] Biswas (2012), "Utilization of Rice Husk with Lime in Sub- Grade Soil for a Rural Road", International Conference on Emerging Frontier in Technology for Rural Area.

[3] Chavhan Pooja J (2014), "To Study the Behaviour of Marble Powder as SupplementryCementitous Material in Concrete", Journal Environment & Research and Department, Vol. 4, No. 4, pp. 377-381.

[4] Chen F H (1988), "Foundations on Expansive Soils", Chen and Associates, Elsevier Publications, USA.

[5] Choudhary A K, Gill K S and Jha K N (2011), "Improvement in CBR Values of Expansive Soil Sub Grade Using Geo-Synthetics", Proc. Indian Geotechnical Conference, pp. 569-572.

[6] Corinaldesi V, Moriconi G and Naik T R (2009), "Characterization of Marble Powder for its Use in Mortar and Concrete", United States, Construction and Building Materials, Vol. 24, pp. 113-117. Demirel B (2010), "The Effect of the Using Waste Marble Dust as Fine Sand on the Mechanical Properties of the Concrete", Turkey, International Journal.

[7] Ergu A N (2010), "Effects of the Usage of Diatomite and Waste Marble Powder as Partial Replacement of Cement on the Mechanical Properties of Concrete", Turkey, Construction and Building Materials, Vol. 25, pp. 806-812.

[8] Gourley C S, Newill D and Shreiner H D (1993), "Expansive Soils", TRL's Research Strategy, Proc. 1st Int. Symp. on Engineering Characteristics of Arid Soils.

[9] Gupta Chayan and Sharma Ravi Kumar (2014), "Influence of Marble Dust, Fly Ash and Beas Sand on Sub-Grade Characteristics of Expansive Soil", Journal of Mechanical & Civil Engineering, pp. 13-1

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Parkinson's Disease Predictio

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Abstract Voice-based biomarkers can help diagnose symptoms of dementia such as Pa neurodegenerative disease affecting about 7 million people worldwide (usually adults), with diagnoses performed each year. Historically, PD has been difficult to find and documents tend t ignore some, depending on the scores of independent points. Due to the decline in motor manip term can be used as a means of detecting and diagnosing PD. Common sense has meant that ph of PD while ignoring the other. By using independent measurement scales, the term can be used This paper presents evidence to support the concept of supervised classification, which can b diseases such as diabetes and pulmonary fibrosis. Through Linear Regression, Logistic Regres Machine, Random Forest, XGBoost, Neural Network and Adaboost we were able to achieve a p pathological conditions. The project also uses various Evaluation Methods and Metrics such Report, F1 - Score, Accuracy, Precision, Recall.

I. INTRODUCTION

Parkinson's disease is a neurodegenerative disorder that results in unintended or inev is estimated to affect numerous people across the globe and has negatively affected affected. If not treated on time and not given the effective treatment, it will start level. So, a proper treatment in proper time, is a must for Parkinson's disease.

A program model can be taught to detect the disease with the help of large sets So, a proper treatment in proper time, is a must for Parkinson's

II. LITERATURE SURVEY

Parkinson's disease (PD) is a neurodegenerative disorder affecting millions glo for better disease management. Machine learning and data mining technique predicting PD. Here's a breakdown of key areas to explore in literature survey

1. L. Naranjo, C. J. Pérez, J. Martín and Y. Campos-Roca, "A

two-stage variable selection and classification

approach for Parkinson's disease detection by using voice recording replications," C *Programs in Biomedicine*, vol. 142, pp.147-156, 2017.

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Automatic Tyre Killer

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Abstract—In India, people does not follow traffic rules and driving on the wrong side of the prohibited and considered a significant traffic offense. The penalties for wrong-side driving inc INR 1,000, and in severe cases, imprisonment of up to three months. Additionally, the offense meaning that it cannot be resolved through payment of a fine without appearing before a court. Tl Act has strengthened the penalties for various traffic violations, including not follow traffic encourage greater compliance with traffic rules. Break the traffic signal and Wrong side drivi well as in all over world. Fine is not the permanent solution to aware the people about the traffi is most essential and helpful system in the traffic management system to drive safely and follo of the project is to aware the people for the traffic rules. For that issues we developed such ty good traffic management. Keywords: Traffic Management, Traffic Signal.

I. INTRODUCTION

Tyre Killer is an electro hydraulically operated heavy duty spike barrier which rises above the signal and thus prevents unauthorized intrusions at Traffic signal premises. The Traffic Flow P heavy-duty steel constructed vehicle barrier designed to handle vehicles of all sizes and volume semi-permanent vehicle barrier offering the ability to control vehicle movements through a s WHO the traffic accident is about 1.25 million annually. The automatic tyre killer project helps people follow the traffic rule.

Properly. In modern world, vehicle user increases largely. As the all-electric machines (vehicle increasing. By this effect, we can see a lot of road accidents. To rescue the victims, several probl because of traffic problems. The main objective of this system is to stop the vehicle at signal an to break the signal. This system can be used in the retractable spikes after the zebra crossing th is red and goes off when the traffic signal turns to green. This is an legit idea mainly to avoid cc In the usual traffic system, the peoples were not following the traffic rules properly. To implementing this system. The main aim of this system is to obey and follow the traffic rules prc of spikes. It will make all the people to obey the traffic rules correctly. The major objective c secured system for our society this. On using the spikes module, the spikes system operates u reaches signal the spikes will gets OFF and other signals gets ON with an emergency alert. Thi for our society. No other way of breaking the traffic rule

II. BACKGROUND

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Hand Gesture Control Wheelchair for Disabled People

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Abstract—A new assistive technology, called the Hand Gesture Control Wheelchair (HGCW) system, is designed to help individuals with mobility impairments increase their independence and mobility. The system consists of a wearable device with sensors that detect hand movements and Arduino microcontrollers for real-time data processing and wheelchair control. The HGCW system uses gesture recognition algorithms to translate hand gestures into corresponding wheelchair movements, such as forward, backward, left, and right turns, and communicates wirelessly with the wheelchair's control unit. The system is cost-effective, customizable, and intuitive, making it accessible to a wide range of users. The HGCW system has the potential to revolutionize the way disabled individuals navigate their environment, empowering them to lead more independent and fulfilling lives. By changing the head movement, the data is sent wirelessly to the microcontroller-based motor driver circuit to control the rotation of the chair in five different modes: forward, backward, right, left and special standing lock. The proposed system was assembled using products procured from the local market and its performance was tested in the laboratory and the test results are included in this article.

Keywords – Internet of Things, Health Care Industry, Movement Disabled People, Hand Gesture.

I. INTRODUCTION

Mobility improvement is a significant challenge faced by millions of individuals worldwide, greatly affecting their independence and quality of life. For people with disabilities, particularly those with limited upper body mobility, conventional wheelchair controls can be cumbersome and restrictive. However, advancements in technology, particularly in the fields of Internet of Things (IoT) and Arduino, offer promising solutions to enhance mobility and autonomy for disabled individuals This paper presents the development and implementation of a Hand Gesture Control Wheelchair (HGCW) system designed to empower individuals with mobility impairments through intuitive hand gesture-based control. By leveraging IoT and Arduino technology, the HGCW system provides an innovative approach to wheelchair navigation, enabling users to manoeuvre their chairs with simple hand gestures The motivation behind the HGCW system stems from the need to address the limitations of traditional wheelchair controls, which often require precise manual manipulation and may not be suitable for individuals with dexterity issues. By introducing a hands-free control mechanism based on natural hand movements, the HGCW system aims to improve accessibility and usability for users with diverse mobility needs.

Due to this high proportion, there is growing demand for developing technologies that can aid this population group from international health care organization, universities and companies interested in developing and adapting news products**.** One of the most adaptable body parts is the hand. It has the capacity to produce a wider variety of signals than any other limb. Hand signals are viewed as the most effective method of communication that doesn't rely on spoken words, for conveying information between two people. The primary challenge is creating a system that tackles the issue of allowing those with disabilities to access their fundamental requirements. This project aims to develop a wheelchair controlled by hand gestures, proving beneficial for those with physical limitations

Through the successful development and implementation of the HGCW system, this research aims to contribute to the field of assistive technology by offering a user-friendly and innovative solution for individuals with mobility challenges. By harnessing the power of IoT and Arduino technology, the HGCW system has the potential to revolutionize wheelchair navigation, providing greater freedom and independence to users with disabilities.

II. LITERATURE SURVEY

In a published article, G. Bourhis and K. Moumen show that there are currently many navigation systems on the market that make it easier for people with disabilities to navigate. The established system is very competitive in replacing the old system **[1]**

Rakhi A. Kalanthri and D. K. Chitra demonstrated in their work that the wheelchair can be controlled in four directions by tilting the acceleration sensor. Ultrasonic sensors are used to control the movement of the wheelchair, avoiding the possibility of collisions with objects until the user is able to take over some of the responsibility of steering. It simply calculates the degree of inclination and decides which direction to move **[2]**

Mahipal Manda and B Shankar Babu developed a wheelchair using MEMS technology, can be integrated to develop a useful wheelchair control system using hand movements.
The electric chair with a high steering seat can be considered a great success in terms of the integration of physically and mentally disabled individuals into society. **[3].**

The concept developed by Shreedeep Gangopadhyay ensures that it works completely independently without any wires or restrictions. The ability to avoid obstacles is kept within certain limits from the wheelchair. The wheelchair is configured to turn in a different direction if it detects obstacles while moving **[4].**

A study by Kannan Megalingam, Srikanth and Raj shows that the combination of displays and Bluetooth technology allows peopl e with disabilities to control movement by swiping the screen. In addition, even when the disabled person cannot move his hands, the second person can control the movement without pushing the chair. **[5].**

According to the founder, Dr. Stewart James Hildebrand, a wheelchair project. A brief survey of research on the development of autonomy in wheelchairs is presented, and AAI's R&D for the construction of a series of intelligent autonomous wheelchairs is discussed. The modular autonomous control system can be installed in a power chair, having been carefully designed, developed and tested over the years. It is a course of action that will reduce the use and cost of equipment in a way that will create the suitability of the ship and ensure performance, adequate protection, uniformity of appearance and design capacity. To date, the add-on system has been installed and tested on two common wheelchair power models. The initial findings are very promising **[6]**

II.I. PROPOSED SYSTEM

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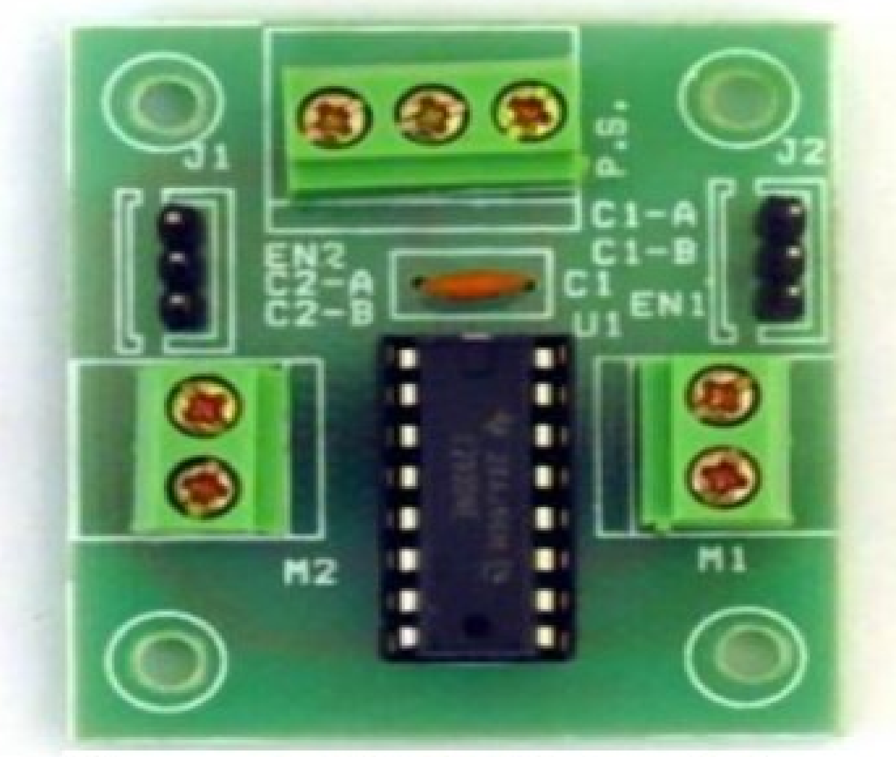

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The Transmitter Receiver Module, often referred to as a wireless communication module or RF (Radio Frequency) module, plays a crucial role in facilitating communication between the wearable hand gesture detection device and the Hand Gesture Control Wheelchair (HGCW) system. These modules enable the transmission of control signals wirelessly from the wearable device to the wheelchair's control unit, allowing for seamless and intuitive operation without the need for physical connections.

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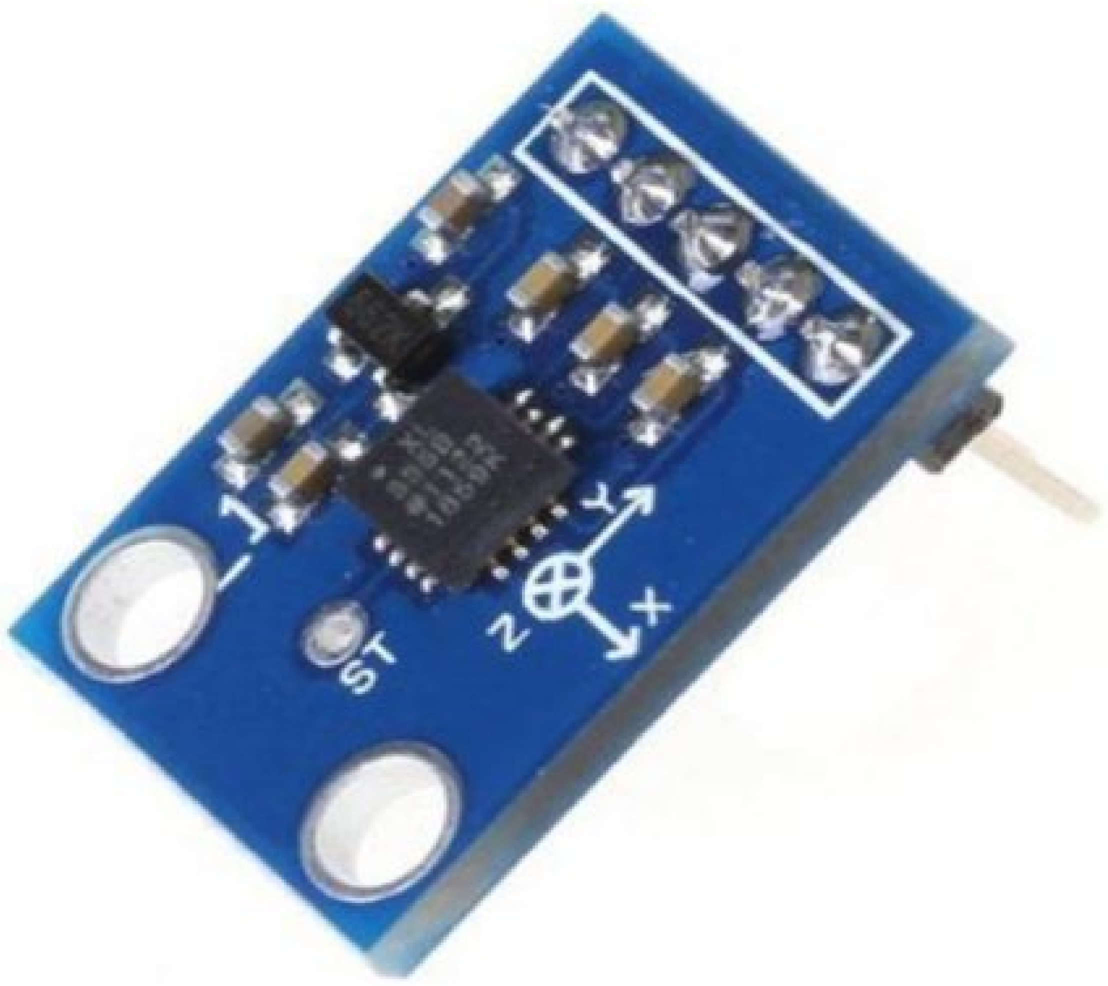

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5	**Electric Motors**	Provide power for wheelchair movement	**DC Motors:** Common choice for wheelchairs, consider power rating based on weight and desired speed.
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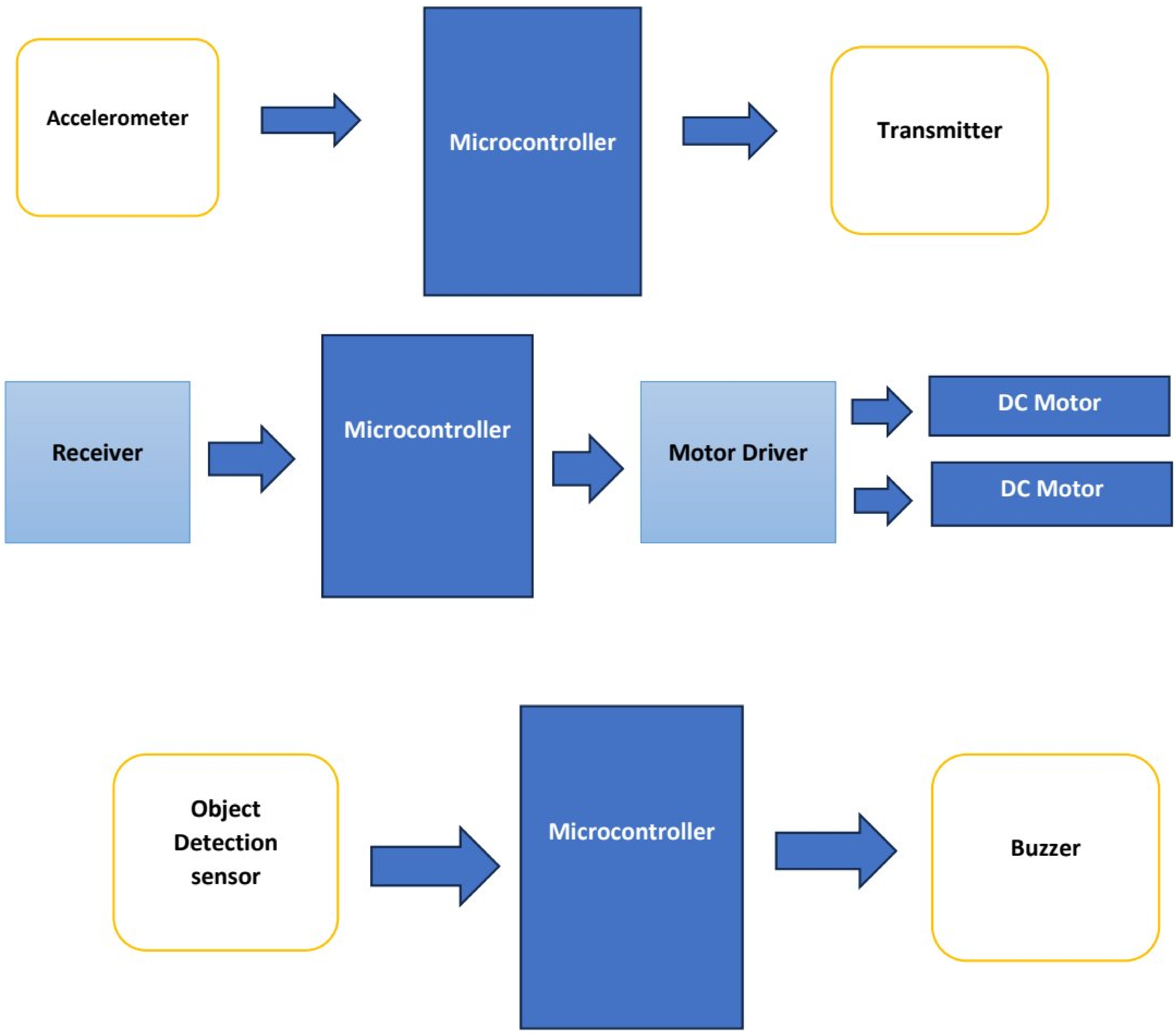
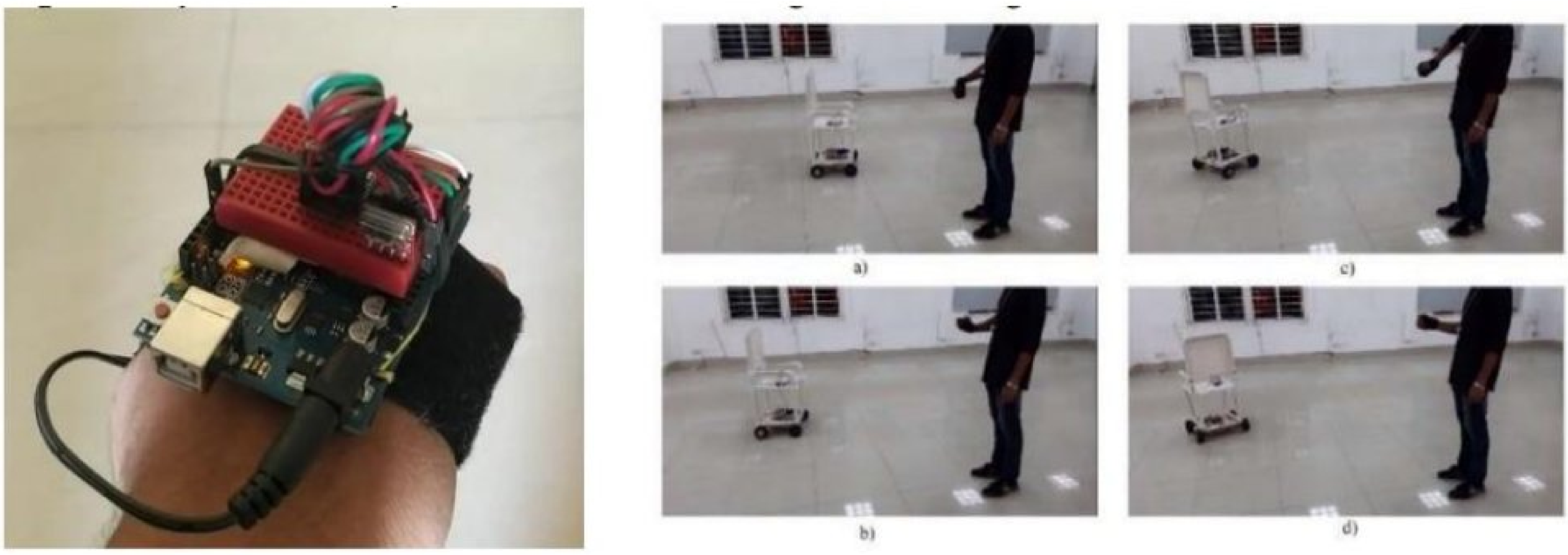
ER Diagram HGCW



IV. RESULT

When the user moves their hand, accelerometer sensors detect these motions. The system interprets this data to control movement. Figure 8 illustrates the completed hand gesture control gloves. The physically challenged peoples are easily move from one place to another.



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V. CONCLUSION

Our research effectively enables wheelchair control for individuals with disabilities through hand gestures. It incorporates object and fall detection for enhanced safety. Further advancements could utilize diverse body movements like eye tracking, leg motions, voice control, or head tilts, for personalized user experiences.

Future scope

The future scope for hand gesture wheelchairs for disabled people is quite promising, with potential for increased functionality, personalization, and accessibility. Here are some exciting areas for development.

Advanced Gesture Recognition:

- **Multiple Gestures:** Expanding the range of hand gestures beyond basic movements to include complex combinations for more intuitive control.
- **Customization:** Allowing users to personalize the gestures used for specific commands, catering to individual needs and preferences.

Multimodal Integration:

- **Fusion with Other Sensors:** Combining hand gestures with eye gaze tracking, head movement, or voice commands for a more nuanced control experience.
- **Brain-Computer Interfaces (BCI):** Exploring BCI technology to potentially control wheelchairs directly through brain signals, offering a powerful option for individuals with severe limitations.

Enhanced Intelligence and Safety:

- **Environmental Recognition:** Incorporating object and obstacle detection with real-time path planning for safer navigation.
- **Fall Prevention:** Utilizing sensors and algorithms to predict and prevent falls, improving user safety.
- **Smart Features:** Integrating features like voice assistants, environmental controls, and self-docking capabilities for greater independence.

Accessibility and Affordability:

- **Cost Reduction:** Focusing on cost-effective designs and materials to make hand gesture wheelchairs more affordable for a wider range of users.
- **Standardization:** Establishing industry standards to ensure compatibility and ease of use across different wheelchair models.
- **Accessibility Features:** Exploring designs that cater to diverse physical abilities, ensuring everyone can benefit from this technology.

REFERENCE

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2. Kalantri, R.A., & Chitre, D. K. (2013, August). Automatic WheelchairusingGestureRecognition.www.ijeat.org. Retrieved November 4, 2022.
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5. Megalingam, R. K., Sreekanth, S., A, G., Teja, C. R., & Raj, A. (2017, January). Wireless gesture-controlled wheelchair. IEEE Xplore. Retrieved November 4, 2022, from https://ieeexplore.ieee.org/document/8014621.
6. Development of smart wheelchair system for a user with severe motor impairment international symposium on intelligent sensors 2012 in iris.
7. www.engineersgarage.com/electronic_circuits.
8. "Working Principle Of Arduino And Using It As A Tool For Study And Research" by Louis, IJCACS, Vol.1, No.2, April 2016, pp.21-29
9. "Automatic wheelchair for physically disabled persons" by Prof. R.S. Nipankar, V. Gaikwad, C. Choudhari, R. Gosavi, V. Harne, IJARECE, Volume 2, Issue 4, April 2013, ISSN: 2278 – 909X, pp.466-474
10. InvenSens, MPU 6000 and MPU 6050 Product Specification. Available at: https://www.invensense.com/wpcontent/uploads/2015/02/MPU-6000- Datasheet1.pdf, Accessed 09 Jun. 2018
11. R. Hassani, M. Boumehraz, M. Hamzi, And Z. Habba, "Gyro Accelerometer based Control of an Intelligent Wheelchair". Journal of Applied Engineering Science & Technology, vol. 4, no.1, pp.101-107, 2018.
12. (PDF) Head gesture-based wheelchair control (researchgate.net)

Hand Gesture Control Wheelchair for Disabled People

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Abstract—A new assistive technology, called the Hand Gesture Control Wheelchair (HGCW) system, is designed to help individuals with mobility impairments increase their independence and mobility. The system consists of a wearable device with sensors that detect hand movements and Arduino microcontrollers for real-time data processing and wheelchair control. The HGCW system uses gesture recognition algorithms to translate hand gestures into corresponding wheelchair movements, such as forward, backward, left, and right turns, and communicates wirelessly with the wheelchair's control unit. The system is cost-effective, customizable, and intuitive, making it accessible to a wide range of users. The HGCW system has the potential to revolutionize the way disabled individuals navigate their environment, empowering them to lead more independent and fulfilling lives. By changing the head movement, the data is sent wirelessly to the microcontroller-based motor driver circuit to control the rotation of the chair in five different modes: forward, backward, right, left and special standing lock. The proposed system was assembled using products procured from the local market and its performance was tested in the laboratory and the test results are included in this article.

Keywords – Internet of Things, Health Care Industry, Movement Disabled People, Hand Gesture.

I. INTRODUCTION

Mobility improvement is a significant challenge faced by millions of individuals worldwide, greatly affecting their independence and quality of life. For people with disabilities, particularly those with limited upper body mobility, conventional wheelchair controls can be cumbersome and restrictive. However, advancements in technology, particularly in the fields of Internet of Things (IoT) and Arduino, offer promising solutions to enhance mobility and autonomy for disabled individuals This paper presents the development and implementation of a Hand Gesture Control Wheelchair (HGCW) system designed to empower individuals with mobility impairments through intuitive hand gesture-based control. By leveraging IoT and Arduino technology, the HGCW system provides an innovative approach to wheelchair navigation, enabling users to manoeuvre their chairs with simple hand gestures The motivation behind the HGCW system stems from the need to address the limitations of traditional wheelchair controls, which often require precise manual manipulation and may not be suitable for individuals with dexterity issues. By introducing a hands-free control mechanism based on natural hand movements, the HGCW system aims to improve accessibility and usability for users with diverse mobility needs.

Due to this high proportion, there is growing demand for developing technologies that can aid this population group from international health care organization, universities and companies interested in developing and adapting news products**.** One of the most adaptable body parts is the hand. It has the capacity to produce a wider variety of signals than any other limb. Hand signals are viewed as the most effective method of communication that doesn't rely on spoken words, for conveying information between two people. The primary challenge is creating a system that tackles the issue of allowing those with disabilities to access their fundamental requirements. This project aims to develop a wheelchair controlled by hand gestures, proving beneficial for those with physical limitations

Through the successful development and implementation of the HGCW system, this research aims to contribute to the field of assistive technology by offering a user-friendly and innovative solution for individuals with mobility challenges. By harnessing the power of IoT and Arduino technology, the HGCW system has the potential to revolutionize wheelchair navigation, providing greater freedom and independence to users with disabilities.

II. LITERATURE SURVEY

In a published article, G. Bourhis and K. Moumen show that there are currently many navigation systems on the market that make it easier for people with disabilities to navigate. The established system is very competitive in replacing the old system **[1]**

Rakhi A. Kalanthri and D. K. Chitra demonstrated in their work that the wheelchair can be controlled in four directions by tilting the acceleration sensor. Ultrasonic sensors are used to control the movement of the wheelchair, avoiding the possibility of collisions with objects until the user is able to take over some of the responsibility of steering. It simply calculates the degree of inclination and decides which direction to move **[2]**

Mahipal Manda and B Shankar Babu developed a wheelchair using MEMS technology, can be integrated to develop a useful wheelchair control system using hand movements.
The electric chair with a high steering seat can be considered a great success in terms of the integration of physically and mentally disabled individuals into society. **[3].**

The concept developed by Shreedeep Gangopadhyay ensures that it works completely independently without any wires or restrictions. The ability to avoid obstacles is kept within certain limits from the wheelchair. The wheelchair is configured to turn in a different direction if it detects obstacles while moving **[4].**

A study by Kannan Megalingam, Srikanth and Raj shows that the combination of displays and Bluetooth technology allows peopl e with disabilities to control movement by swiping the screen. In addition, even when the disabled person cannot move his hands, the second person can control the movement without pushing the chair. **[5].**

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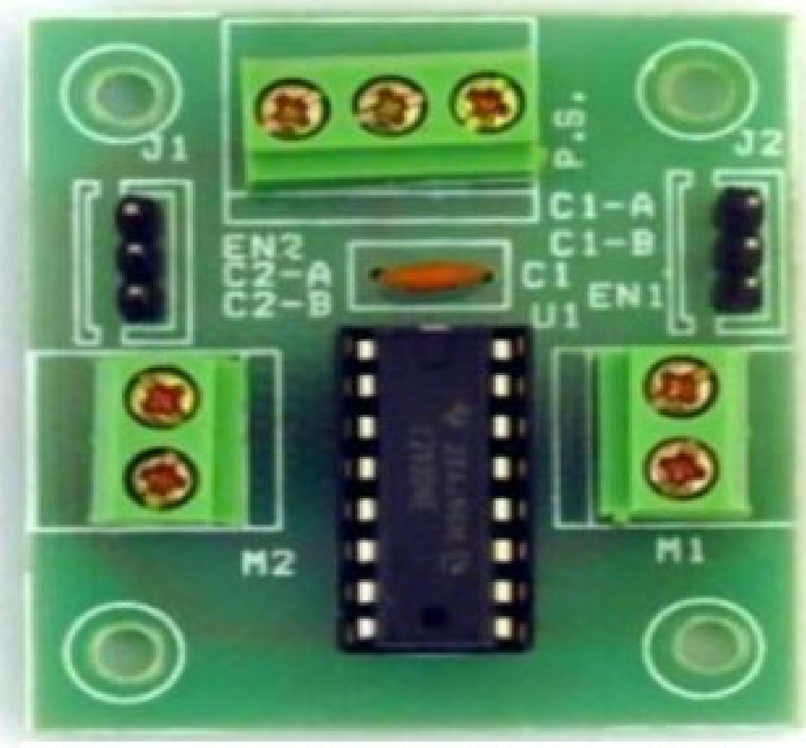

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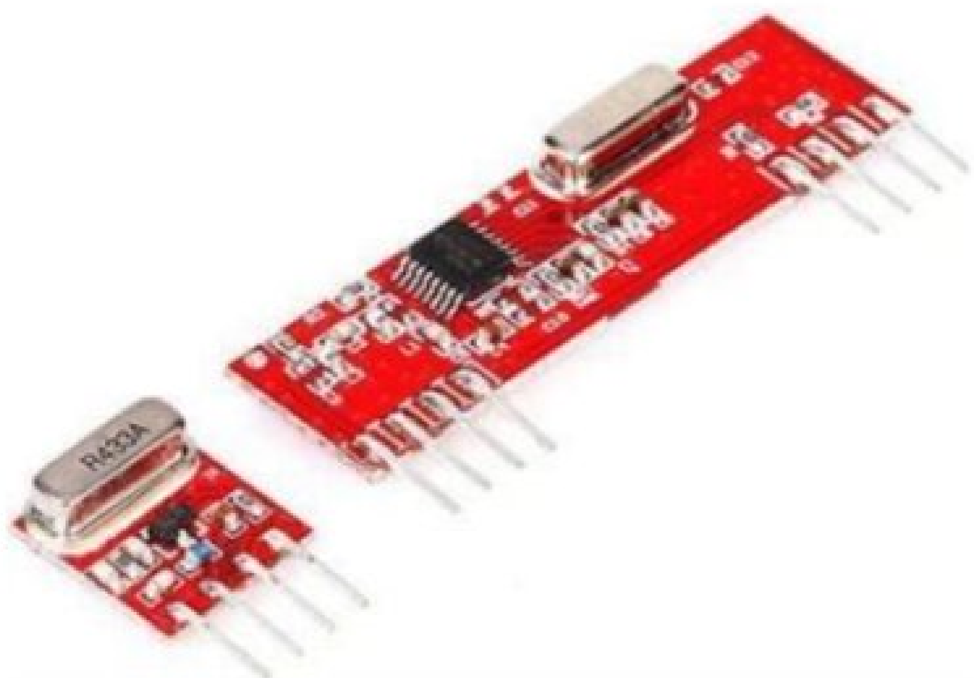

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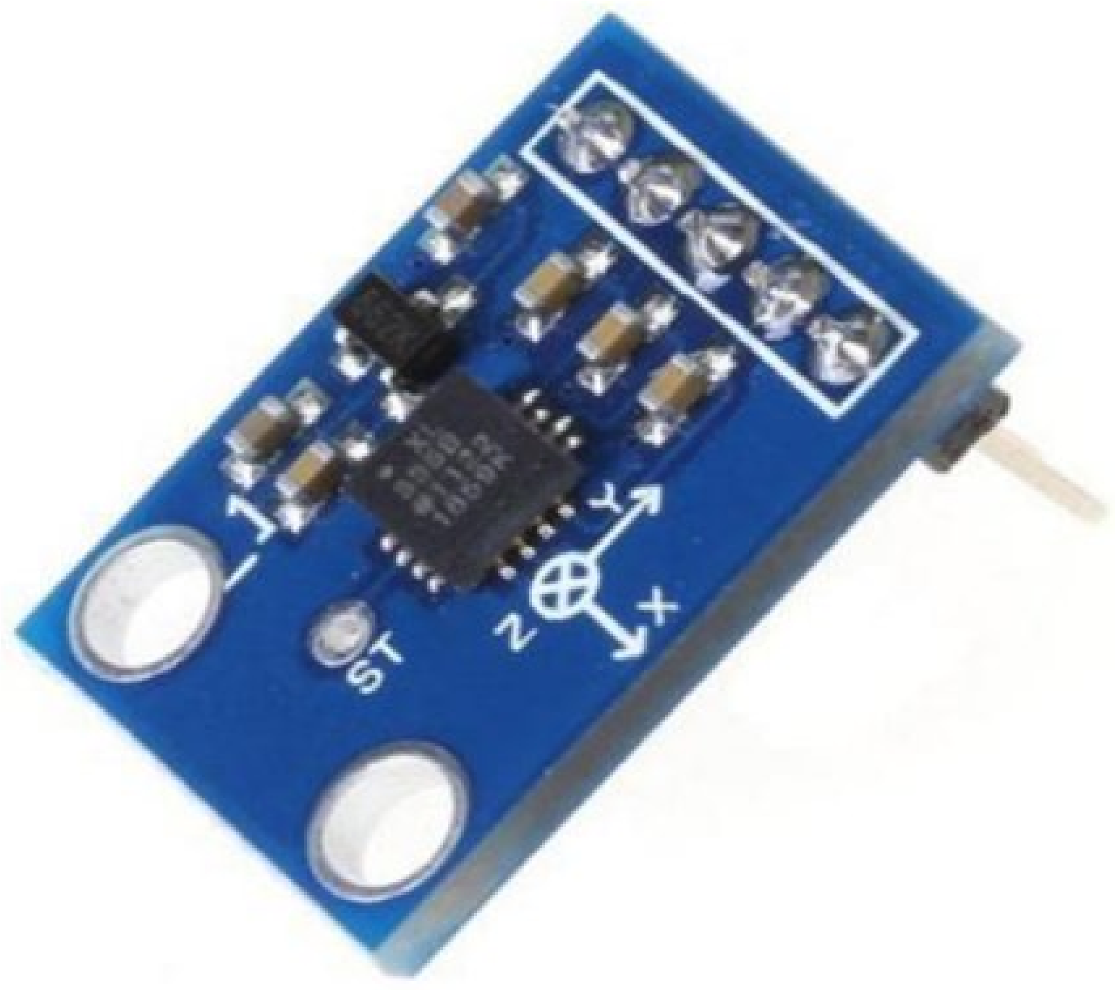

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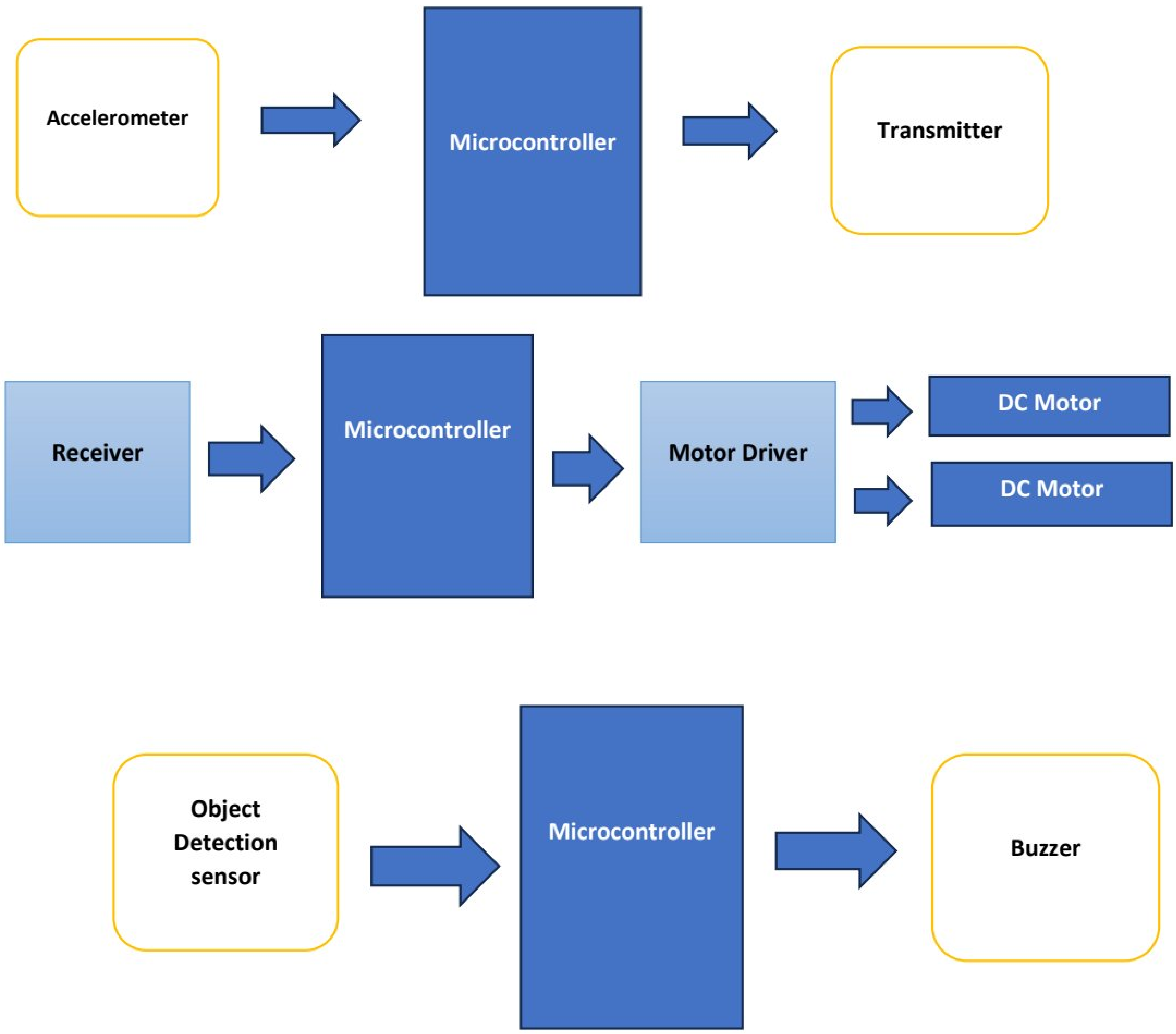

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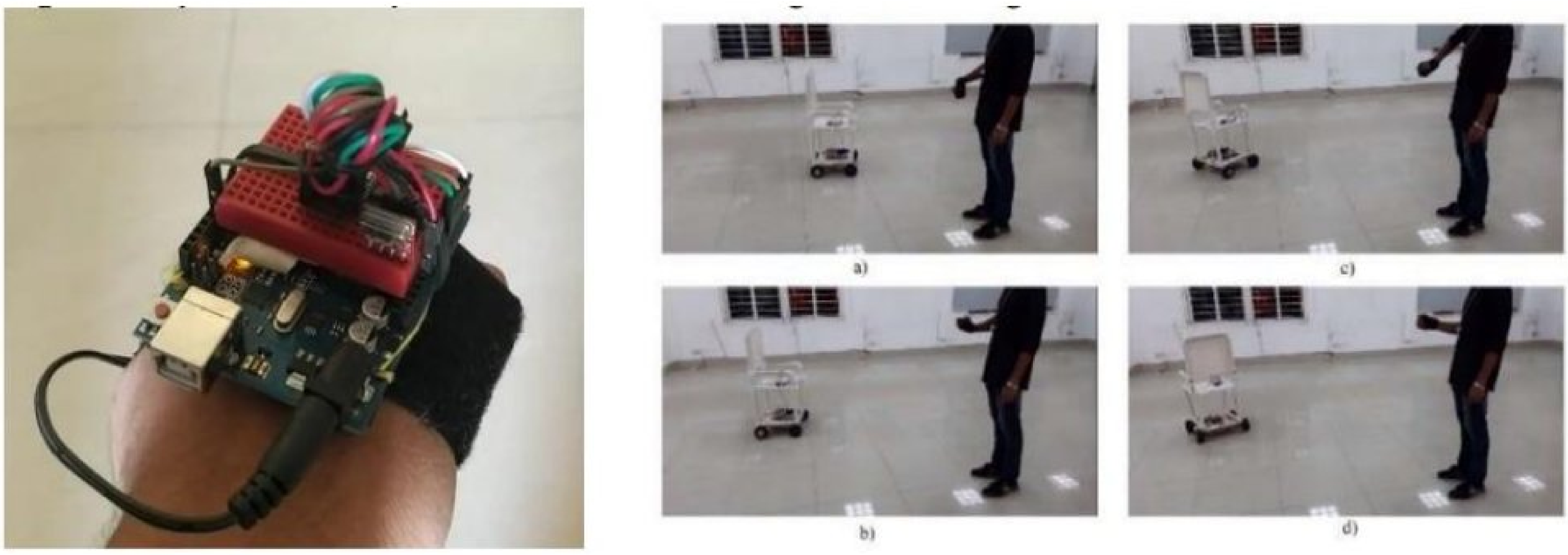

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5. Megalingam, R. K., Sreekanth, S., A, G., Teja, C. R., & Raj, A. (2017, January). Wireless gesture-controlled wheelchair. IEEE Xplore. Retrieved November 4, 2022, from https://ieeexplore.ieee.org/document/8014621.
6. Development of smart wheelchair system for a user with severe motor impairment international symposium on intelligent sensors 2012 in iris.
7. www.engineersgarage.com/electronic_circuits.
8. "Working Principle Of Arduino And Using It As A Tool For Study And Research" by Louis, IJCACS, Vol.1, No.2, April 2016, pp.21-29
9. "Automatic wheelchair for physically disabled persons" by Prof. R.S. Nipankar, V. Gaikwad, C. Choudhari, R. Gosavi, V. Harne, IJARECE, Volume 2, Issue 4, April 2013, ISSN: 2278 – 909X, pp.466-474
10. InvenSens, MPU 6000 and MPU 6050 Product Specification. Available at: https://www.invensense.com/wpcontent/uploads/2015/02/MPU-6000- Datasheet1.pdf, Accessed 09 Jun. 2018
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